

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

PRELIMINARY DRAFT STAFF REPORT:

PROPOSED AMENDED RULE 1138 - CONTROL OF EMISSIONS FROM RESTAURANT OPERATIONS

August 2009

Planning, Rule Development, and Area Sources

Deputy Executive Officer

Planning, Rule Development and Area Sources
Elaine Chang, DrPH

Assistant Deputy Executive Officer

Planning, Rule Development and Area Sources
Laki Tisopulos, Ph.D., P.E.

Director of Strategic Initiatives

Planning, Rule Development and Area Sources
Jill Whynot

Authors: Pamela Perryman, Air Quality Specialist

Technical Assistance: Glenn Kasai, Air Quality Engineer II

Reviewed by:

Tracy A. Goss, P.E., Program Supervisor
Jeri Voге, Senior Deputy District Counsel

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BARRY R. WALLERSTEIN, D.Env.

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EXECUTIVE SUMMARY

Restaurants emit particulate matter (PM) and volatile organic compounds (VOCs) which contribute to ozone formation. Emissions from all restaurants in the South Coast Air Basin (Basin) amount to approximately 11.3 tons/day of PM_{2.5}¹. Restaurant equipment contributing to the emissions of PM_{2.5} include charbroilers, griddles, and deep fat fryers. Charbroilers are further categorized as chain-driven and under-fired. Equipment descriptions are presented in the “Rule Development” section.

Proposed Amended Rule 1138 will reduce PM_{2.5} emissions from under-fired charbroilers with the highest volume of beef cooked. The current rule covers chain-driven charbroilers; this amendment would decrease PM_{2.5} from under-fired charbroilers, the largest contributor to overall emissions from restaurant equipment. Under-fired charbroilers were not previously addressed because there were no feasible, cost-effective controls commercially available.

The Bay Area Air Quality Management District (BAAQMD) adopted a rule in December 2007 to cover both chain-driven and under-fired charbroilers, prompting consideration of all feasible measures for the South Coast Air Quality Management District (SCAQMD) which is in non-attainment for PM standards. In June 2009, San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) proposed to amend Rule 4692 – Commercial Charbroiling in response to BAAQMD’s action for this source category and all feasible measures. The action was continued to the August Board hearing.

AQMD’s staff proposal is designed to cover 22% of the restaurant-related emissions and will apply to 7% (approximately 930) of the restaurants using under-fired charbroilers (13,300). The original Rule 1138 covering chain-driven charbroilers applied to mostly large chain operations. Staff examined the difference in BAAQMD and SJVUAPCD and the District’s exemption levels for chain-driven charbroilers (see Regulatory Background, below). This proposed amendment would apply to some large chains but also some larger independently owned restaurants. The proposed rule will implement Control Measure #2007 BCM-05 – PM Emission Reductions from Under-fired Charbroilers, and make progress towards attainment of federal and state PM_{2.5} standards. Implementation of the proposed rule will result in a decrease in visible emissions for this industry.

Commercially available control technologies include scrubbers and electrostatic precipitators (ESPs). Source tests for one scrubber device indicated a reduction of 85% PM_{2.5} emissions is possible. The proposal limits the requirements for controls to those devices cooking ≥1,250 pounds of beef per week based on a cost-effectiveness calculation of an \$8,400/ton reduced (capital cost approximately \$33,000). The costs would vary for parameters such as new versus retrofit, size of ventilation system, and equipment options. This size of operation constitutes approximately 7% (~930) of the universe of under-fired charbroilers. Emission reductions of PM_{2.5} are estimated to be 2.1 tons/day PM_{2.5} by mid-2013 with full rule implementation.

REGULATORY BACKGROUND

Control measures for emissions from this source category first appeared in the 1989 AQMP² as #88-C-3 - Control of Emissions from Commercial Charbroiling (PM₁₀, VOC), and in the 1991 AQMP³ as A-C-4 - Control of Emissions from Deep-fat Frying (PM₁₀, VOC). These control measures were combined in both the 1994⁴ and 1997⁵ AQMPs as PRC-03 - Control of Emissions from Restaurant Operations (PM₁₀, VOC).

In November 1997, the Governing Board adopted Rule 1138 - Control of Emissions from Restaurant Operations. This rule requires emission reductions from chain-driven charbroilers, the only equipment that, at the time of rule adoption, had a cost-effective control technology identified. The installation of flameless catalytic oxidizers, or equivalent control devices, to chain-driven charbroilers was estimated to reduce 0.5 tons/day of PM and 0.2 tons/day of VOC emissions by the final implementation date of November 1999. However, revised numbers from the 1999 Pacific Environmental Services, Inc. study titled "A Detailed Survey of Restaurant Operations in the South Coast Air Basin"⁶ indicated additional reductions could be achieved from chain-driven charbroilers by the implementation of Rule 1138. The original Rule 1138 staff report and subsequent SIP submittal focused on reductions of PM emissions even though testing showed the majority of emissions from restaurant operations are below PM_{2.5} because at the time there were no PM_{2.5} standards (state or federal). This amendment will be seeking credit for reductions in PM_{2.5} for progress towards attainment of those standards.

At the time of Rule 1138's development, industry requested that the rule be structured as a "total restaurant" rule covering all equipment operated at a restaurant. Thus, the title of the rule is intentionally broad "...Restaurant Operations" and the "Applicability" section indicated that future rule development was foreseeable for other restaurant cooking equipment. Specifically noted for future rule development efforts were under-fired charbroilers. Rule 1138 states that it applies to owners and operators of commercial cooking operations; however, only sources using chain-driven charbroilers are subject to the requirements of the current rule.

Rule 1138 included a commitment to address equipment other than chain-driven charbroilers with future requirements. The rule required a report to the Governing Board within 18 months of Rule 1138's adoption, on the feasibility of achieving further restaurant operations emission reductions, specifically under-fired charbroilers and potentially other commercial restaurant cooking equipment. The Board received a report at the May 14, 1999 Governing Board meeting, on emerging control technology for under-fired charbroilers and an overview of the work to date by the University of California Riverside, College of Engineering, Center for Environmental Research and Technology (CE-CERT)⁷. The report pointed out that a continuing effort to find cost-effective and technologically feasible controls for the restaurant industry had been ongoing since 1991. The earlier phases of this effort included the investment of significant resources in improving test methods and developing emission factors. The 1999 Amendment to the 1997 Ozone State Implementation Plan for the South Coast Air Basin⁸ listed PRC-03 – Emission Reductions from Restaurant Operations – Phase II, with reductions of 0.9 tons/day of VOC and 7.0 tons/day of PM₁₀.

In August 2000, staff reported to the Board that cost-effective controls for under-fired charbroilers were limited and recommended substituting the remaining 0.9 tons/day of VOC emissions assigned to this source category with another control measure achieving excess VOC emissions. The 2003 AQMP included Control Measure PRC-03- Emission Reductions from Restaurant Operations to reduce PM₁₀ emissions by 1 ton per day by 2010. The limited emission reduction projection from a baseline of approximately 10 tpd was based on the fact that cost-effective controls for the majority of under-fired charbroilers had not been developed. A report to the Board in December 2004 recommending that findings of infeasibility be made, and substituting emission reductions from other adopted rules as required by the 2003 AQMP. Staff also recommended funding demonstration projects and although the Board authorized up to \$200,000 from mitigation fees from the Priority Reserve, no applications were received.

Further actions regarding charbroilers included the adoption of Rule 222 – Filing Requirements for Specific Emission Sources not Requiring a Written Permit Pursuant to Regulation II, at the September 11, 1998 Board meeting. This rule removed the requirement for charbroilers to obtain a Permit to Operate and instead offered a reduced-cost filing program. Charbroilers are no longer required to obtain permits thus, best available control technology (BACT) no longer applies to this source category. Emission reductions will be achieved through source-specific rules. Under the proposed rule amendments, control equipment for under-fired charbroilers will not require a Permit to Operate due to language in Rule 222 which lists “commercial charbroilers and associated air pollution control equipment.” The current fee for initial filing and the annual renewal fee are the same at \$163.71.

In November 2007, the BAAQMD adopted Regulation 6, Rule 2: Commercial Cooking Equipment. This rule requires controls on chain-driven charbroilers and on under-fired charbroilers meeting the requirements of: 10 square feet of surface area; purchasing 1,000 pounds of beef or more per week; and cooking 800 lbs. of beef/week. The BAAQMD based their decision on cost-effective values of \$17,300/ton of VOC and PM removed for HEPA filters and \$19,500/ton of VOC and PM removed for electrostatic precipitators. A socio-economic analysis compared the annual cost of these two compliance options to net profits and, although for some operations (those employing between 20 and 49 workers) the ratio exceeded 10%, it was stated that “businesses on individual and group bases can re-coup cost in” the controls “without any impact to typical service levels. Impacts are less than significant, in other words.”

Pursuant to Health and Safety Code Section 39614, AQMD is required to adopt control measures for commercial grilling operations (H&S §39614(b)(3)). Because the BAAQMD rule includes controls for under-fired charbroilers, AQMD must now consider and analyze controls for this emission source, and determine whether they are feasible and cost-effective for this District as required by H&S §39614. SJVUAPCD and the BAAQMD rules are compared to the District proposal in Table 4. The District has the ability to customize requirements for sources under its jurisdiction. SJVUAPCD

followed the BAAQMD regulatory approach with a similar proposal now under consideration by their Board.

The BAAQMD rule also lowers the exemption level for chain-driven charbroilers at 400 lbs of beef per week based on a survey of their restaurants and cost-effectiveness calculation. The SCAQMD set the Rule 1138 exemption level for chain-driven charbroiler at 875 lbs/week. This level of exemption was based on a calculation using an emission factor of 7.42 lb PM emissions/1000 lbs of meat cooked (at 21% fat content). On a daily basis, 135 pounds of meat cooked creates 1 pound of PM emissions. In an attempt to account for measurement uncertainties, the exemption level was set at 875 pounds per week (125 pounds per day x 7 days). Checking the District's registration system, no facilities were found to be operating under the exemption clause, if so they would take a permit condition limiting the amount of meat cooked. Thus, staff concludes that the current threshold is still appropriate for our jurisdiction and no change is warranted.

PUBLIC PROCESS

A Working Group of approximately 35 members from affected industry, equipment manufacturers and researchers was formed and met three times, October 15, 2008, March 19, 2009, and June 24, 2009. A Public Workshop is scheduled for August 21, 2009. Staff will continue to refine the proposal and plans to bring the proposed rule to the Governing Board in January 2010.

AIR QUALITY STANDARDS

The District staff monitors ambient air quality for criteria pollutants (ozone, carbon monoxide, particulate matter, lead and sulfate) at 32 locations within the Basin. The following table presents a summary of the federal NAAQS and State of California air quality standards for particulate matter. These air quality standards are set to protect public health. The Basin is not in attainment with the 24-hour or annual average National Ambient Air Quality Standards (NAAQS) for PM_{2.5}. The Basin is also not in attainment with State annual average air quality standards for PM_{2.5}. It should be noted that attainment of the federal PM_{2.5} annual standard is required in 2015, with demonstration being the year 2014.

Table 1
Summary of Particulate Matter Standards ($\mu\text{g}/\text{m}^3$)

Jurisdiction	PM10		PM2.5	
	Annual	24-Hour	Annual	24-Hour
Federal	--	150	15	35
California	20	50	12	--

Particulate matter is a term used to describe a mixture of ambient solid particles and liquid droplets. Those measuring less than 2.5 microns in diameter are referred to as “fine” particles. Those larger than 2.5 microns but less than 10 microns are termed “coarse” particles. Until recently, the federal standard, and most of the focus on controls and effect of particulate emissions, has been on particulate matter measuring 10 microns or less, termed PM_{10} .

$\text{PM}_{2.5}$ is a subset of PM_{10} and the proposed amended rule would reduce both. The majority of emissions from charbroilers are $\text{PM}_{2.5}$. The 1994 AQMP control measure called for reduction of PM_{10} which encompasses $\text{PM}_{2.5}$ but at the time of its original publication, the $\text{PM}_{2.5}$ emissions from chain-driven charbroilers had yet to be determined. This determination came about through the testing conducted for the rule development of Rule 1138. This testing showed a bimodal distribution of PM emissions with only 0-10% of the emitted particulates measuring greater than $1\mu\text{m}$. Therefore, the reductions sought under this proposed rule amendment are considered to primarily be $\text{PM}_{2.5}$.

HEALTH EFFECTS FROM FINE PARTICULATE MATTER

The health effects from exposure to particulate matter emissions are significant and the body of evidence is substantial. From CARB 1999-2000 air quality data, South Coast Air Basin cases per year due to $\text{PM}_{2.5}$ are as much as follows: premature deaths 5,400; hospitalizations 2,400; asthma & lower respiratory symptoms 140,000; lost work days 980,000; and minor restricted activity days 5,000,000. Overall, the residents of the South Coast Air District bare 52% of the nation-wide and 80% of the state-wide exposure.

The following is an excerpt from Chapter 2, Air Quality and Health Effects, from the 2007 Air Quality Management Plan⁹.

A consistent correlation between elevated ambient fine particulate matter (PM_{10} and $\text{PM}_{2.5}$) levels and an increase in mortality rates, respiratory infections, number and severity of asthma attacks and the number of hospital admissions has been observed in different parts of the United States and various areas around the world. In recent years, studies have reported an association between long-term exposure

to air pollution dominated by fine particles (PM_{2.5}) and increased mortality, reduction in life-span, and an increased mortality from lung cancer.

Daily fluctuations in fine particulate matter concentration levels have also been related to hospital admissions for acute respiratory conditions, to school and kindergarten absences, to a decrease in respiratory function in normal children and to increased medication use in children and adults with asthma. Recent studies show lung function growth in children is reduced with long-term exposure to particulate matter. The elderly, people with pre-existing respiratory and/or cardiovascular disease, and children appear to be more susceptible to the effects of PM₁₀ and PM_{2.5}.

PURPOSE AND APPLICABILITY

The purpose of this rule amendment is to reduce PM_{2.5} emissions from under-fired charbroilers which on a 3-month rolling average cook 1,250 lbs of beef per week or more.

LEGAL AUTHORITY

The AQMD obtains authority to adopt, amend, or repeal rules and regulations which control air pollution from Health and Safety Code §§ 39002, 39614, 40000, 40001, and 40440.

AFFECTED INDUSTRY

A survey conducted by Pacific Environmental Services, Inc.⁶ in early 1999, indicated a population of approximately 29,000 restaurants in the Southern California area in the jurisdictional boundaries of the AQMD. Restaurant operations result in emissions from several types of cooking equipment. A brief description of this equipment follows:

Under-fired charbroiler This type of appliance consists of three main components: a heating source, a high temperature radiant surface, and a slotted grill. The grill holds the meat or other food while exposing it to the radiant heat. PM and VOC emissions occur when grease from the meat falls onto the high temperature radiant surface. Most under-fired charbroilers burn natural gas; however, solid fuels, such as charcoal or wood with or without the addition of ceramic stones, are sometimes used. This category includes: broilers, grill charbroilers, flamebroilers, and direct-fired barbecues.

Chain-driven (conveyorized) charbroiler This type of broiler has conveyor belts to carry the meat through the flame area. It also may have a belt to carry buns through the appliance. Typically, flames broil the meat on the top and bottom simultaneously. Most chain-driven charbroilers burn natural gas. This appliance normally produces lower PM and VOC emissions than under-fired charbroilers. This source category (chain-driven charbroilers) is currently regulated under Rule 1138, with controls in place since November 1999.

Deep Fat Fryers Fryers use an exposed hot metal surface to heat cooking oil, which is then used to cook the food. Typically, the food is totally immersed in hot melted shortening at about 350°F. The fryers may be either gas-fired or electric with fuel type not affecting emissions. Most of the raw food products have a water content in the range of 10% to 75% by weight prior to deep fat frying. Most of the water at the surface of the product vaporizes during the cooking process causing a carry-over of oil mist and oil distillation, resulting in VOC and PM emissions. Practically all fast-food establishments utilize deep fat fryers to prepare food in batches.

Griddles These appliances consist of an exposed metal plate used to cook food. The temperatures on the hot surface are typically lower than those encountered in broiling. Unlike deep-fat frying, the food is not immersed in shortening, rather the process is similar to sautéing, and the emissions include light oil particulates and odors. Some griddles are grooved in order to give a “broiled” appearance to the food. Most griddles are gas-fired, although electric griddles are also used. Fuel type does not affect emissions. Another griddle type, called a “clam-shell”™ employs a two-sided cooking configuration, lowering an upper hot plate on top of the food product to cook that side while a lower plate cooks the bottom of the product. This reduces cooking time and decreases emissions.

The focus of this proposed amendment is under-fired charbroilers. Chain-driven charbroilers are currently covered under Rule 1138. Other cooking devices produce negligible emissions compared to charbroilers.

Estimated Emission Inventory

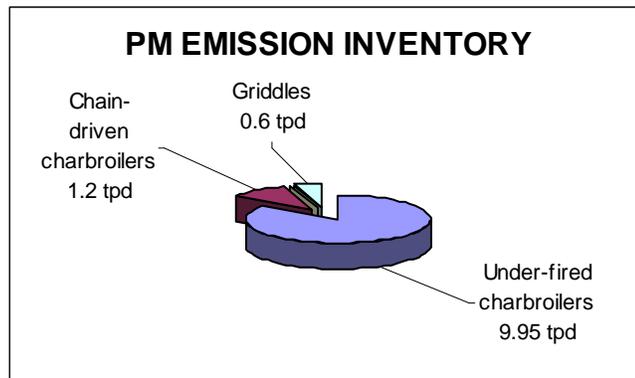


Figure 1

SUMMARY OF PROPOSED RULE AMENDMENTS

Proposed Amended Rule 1138 would apply to new and existing under-fired charbroilers which cook 1,250 or more pounds of beef per week on a 3-month rolling average. Under-fired charbroilers would need to be operated with pollution control equipment which reduces PM emissions, of which the majority is of the PM_{2.5} fraction, by at least 85% pursuant to the test protocol, *Test Protocol for- Determining PM Emissions from Under-fired Charbroilers* (Appendix II), within one and three years of the rule's adoption, respectively. The protocol was developed during the initial Rule 1138 rulemaking process with testing preformed at CE-CERT but the portion for under-fired charbroilers was not finalized at that time since the initial rule only applied to chain-driven charbroilers. The manufacturers would be responsible for certifying that the control equipment achieves at least an 85% reduction in PM_{2.5} emissions and the District envisions manufacturer testing control equipment by model numbers or families of similar models similar to what has been done for chain-driven charbroilers and water heaters. This will greatly reduce potential costs to restaurant owners and operators.

Existing under-fired charbroilers are defined as those in operation on or before the rule's adoption. The proposal requires those cooking more than 1,500 lbs of beef/wk to install controls no later than January 1, 2013; those cooking between 1,250 lbs of beef/week and 1,500 lbs of beef/wk to install controls by July 1, 2013. New charbroilers, those installed and operated after rule adoption must install controls no later than July 1, 2010 if they cook 1,500 lbs. of beef/wk, or no later than January 1, 2011 if they cook between 1,250 and 1,500 lbs. of beef/wk or at the time of the charbroiler's installation if that date is after the initial compliance date. Meat, for the purposes of this proposed rule, includes beef, lamb, poultry, fish, pork, and seafood cooked by this process. Beef means steak, hamburger, and other similar products from an adult bovine, including any attached bone, tendons, fat, and organs. This is consistent with the terminology used in the Protocol and throughout the testing process. The 1,250 lbs. of beef/wk threshold is based on a 3-month rolling average to account for abnormal spikes, perhaps due to a holiday or hosting a special function.

Under-fired charbroilers operating with an existing air pollution control device, such as an ESP, HEPA, or scrubber, installed and operation before July 1, 2009 may continue to operate that equipment for its functional life or until January 1, 2014, whichever comes first. After that, the equipment must be replaced with air pollution control equipment that has been tested according to the District protocol to achieve a minimal overall 85% emission reduction in PM_{2.5} emissions. This provision would apply to approximately 3 dozen facilities, with most of the control equipment already having been in use since the mid-1990's.

Table 2 summarizes these compliance dates.

**Table 2
Summary of Under-fired Charbroiler Compliance Dates**

Under-fired Charbroiler Installation Date and Amount of Beef Cooked (on a rolling 3-month average)	Compliance Date
Before (date of adoption) >1,500 lbs/wk ≥1,250 lbs/wk	January 1, 2013 July 1, 2013
On or after (date of adoption) >1,500 lbs/wk ≥1,250 lbs/wk	July 1, 2010 January 1, 2011

In an effort to reduce implementation costs, facilities subject to this rule will go through the District’s registration program pursuant to Rule 222 – Filing Requirements for Specific Emission Sources not Requiring a Written Permit Pursuant to Regulation II, as charbroilers and their associated control equipment currently do, not normal permitting procedures. Filing a registration with the District would cost \$163.71, which is approximately \$1,900 less costly than obtaining a permit. The phase-in schedule is also intended to make the installation of control equipment smoother.

Control equipment must be maintained, periodically cleaned, and operated in accordance with the manufacturer’s specifications in order to function properly and effectively reduce the emissions. Thus, the proposed rule will require owners and operators of under-fired charbroilers to maintain the equipment in good working order in order to minimize visible emissions to the atmosphere, and clean and operate it in accordance with the manufacturer’s specifications.

Practical experience has shown that control equipment that is not cleaned at the proper frequency can physically clog due to a build-up of salts on its surface, causing a noticeable amount of smoke in the cooking area. The appearance of smoke inside the cooking area or visible emissions outside the restaurant would indicate that the control equipment was not functioning properly. If the owner or operator experiences a problem with the control equipment, provisions of Rule 430 - Breakdown Provisions, may apply. In accordance with provisions of Rule 430, the owner or operator must report the failure to the AQMD within one hour of the breakdown but can continue operating the basic equipment until the end of the operating cycle or within twenty-four hours of the breakdown, whichever is sooner. The owner or operator may also file for an Emergency Variance to continue operating beyond the time limit specified in Rule 430.

Records of cleaning and maintenance, and replacement of the control device are required, as are the weekly amounts of beef cooked, on what device it is cooked and the monthly

amount purchased. These records would be required for all sources subject to the rule. Sources cooking less than 1,250 pounds per week may retain weekly records of the amount of beef cooked on an under-fired charbroiler and monthly purchase records to demonstrate they are operating under the exemption. This level of exemption is based on the current cost-effectiveness of commercially available control technology. Staff anticipates that as the market for controls matures, the cost of controls will decrease. This may enable expanding the applicability of this rule to include a larger percentage of this source-category for control in the future.

A survey, as discussed below, found records kept are mostly in paper format and from purchase records. Most restaurants use what is purchased with little inventory carry-over from week to week. Most distinguish what food is cooked on what device by recipe, or type of meat. No clear records are kept of what food is cooked on what device. Staff is seeking information on record retention and comments on the proposed requirement for recordkeeping.

ADDITIONAL STAFF EFFORTS

Staff made several site visits to view control technologies currently in operation in the Basin. The first staff visit was to an operation with two double-pass ESPs with water wash systems. One ESP is a single cell and vents the grill. The other has two cells and vents the main kitchen cooking equipment. The units are similar, except in capacity, and they have two-stage filters to capture the larger particles before small particles are electronically charged and captured on the ESP plates. The water wash system is set on a timer and cleans the plates daily. The units are serviced on a quarterly basis. The second site visit was to multi-restaurant facility using the UV water-wash system. According to the operator, the UV light changes the grease to a powder which is then washed off the bulbs by the water-wash. This system has increased the roof life due to lack of grease accumulation on the roofs. The third visit was to an air pollution control device with a HEPA (dioctyl phthalate) filter efficient at minimum 95% reduction in filterable PM emissions (0.3-0.7 μm) which was pre-staged by additional particulate reduction equipment. All cooking areas were vented through multi-stage collection systems starting from the grill with a baffle, followed by a grease particulate separator (GPS) and a UV light system. Dust created by the UV lamps then flows to the multi-stage filters, including a HEPA. Scrubbers and ESP were ruled out for this installation due to building design. Staff's fourth visit was to a restaurant using a scrubber to control emissions from the under-fired charbroiler. The equipment has a 2-stage filter system. This location has two 4 ft² under-fired charbroilers, one for meat (steak and burgers) and one for chicken and fish.

Another staff effort enlisted the assistance of the California Restaurant Association which sent a staff-developed survey to their members including hotels, chain operations, individually owned restaurants, and theme parks. The survey focused on: the amount of beef cooked; how it was cooked (on what device); how records are kept; and the use of air pollution control devices. Although the response was limited, staff was able to make some general assumptions from the information received, most notably the potential need

for additional recordkeeping. In summary, the majority of responses were from full service restaurants operating as corporations and employing more than 50 full-time workers with some part-time employees. Most had one under-fired grill and cooked most beef on the charbroiler. Records were generally paper and in the form of purchase receipts. The majority of respondents use what food is purchased with little inventory carry-over from week to week. Most restaurants distinguish how the beef is cooked by the recipe or perhaps the type of meat. None listed the use of add-on air pollution control devices.

EMISSIONS INVENTORY

Testing, initiated in 1995 at CE-CERT, was sponsored by the AQMD and the California Restaurant Association. This resulted in development of VOC and PM test methods and the determination of emission factors for various combinations of appliances and food. Testing encompassed a combination of four types of cooking equipment: under-fired charbroilers, chain-driven charbroilers (with and without a catalytic oxidizer), flat griddles, and deep-fat fryers. Five types of food were tested: hamburger patties, steaks, chicken, fish, and potatoes. Testing for PM emissions for fryers was below detectable level.

These efforts refined the relative contributions of the various restaurant cooking operations. Under-fired charbroilers account for 84% of the PM restaurant emission inventory. The reductions achieved through implementation of the original Rule 1138 and control of chain-driven charbroilers, reduced that equipment's contribution to the overall inventory by up to 83%, 0.5 tpd of PM emissions and 0.2 tpd of VOC emissions. Griddles account for less than 1% of the total emissions.

Source test protocols for PM and VOC emissions and emission factors for various cooking appliances cooking diverse foods were developed. Under-fired charbroiling is the cooking method which results in the largest amount of emissions of all appliances tested. The wide range of emissions from under-fired charbroiling depends on the type of food cooked. Hamburger meat (25% fat content) produced the most PM emissions (average 32.65 lb PM/1000 lb of meat cooked). Fish gave the least amount of emissions by this cooking method (average 3.3 lb PM/1000 lb); with chicken in the mid-range (average 10.48 lb PM/1000 lb.)

The 1998 survey conducted by Pacific Environmental Services concluded that there were an estimated 13,300 under-fired charbroilers operating in the AQMD, with essentially one unit per facility. Testing has shown that PM size was all below PM_{10} , and the vast majority was below $PM_{2.5}$. This agrees with an earlier study by GCA Corp. for the U.S. EPA.⁷ The 2007 AQMP lists the $PM_{2.5}$ inventory from restaurant operations as 11.3 tpd in 2002 and 13.2 tpd in 2013 accounting for growth. The 1997 AQMP control measure estimated reductions of 1.1 tpd of $PM_{2.5}$ from controlling emissions from under-fired charbroilers.

CONTROL TECHNOLOGY ASSESSMENT

The following discussions include proven technologies. PM is the pollutant of primary concern for restaurant emissions. Reduction of both PM and VOCs is accomplished with catalytic oxidizers for chain-driven charbroilers which have a concentrated heat source above the charbroiler to activate the catalyst as opposed to an under-fired charbroiler where the heat is dissipated over a larger area. In December 2004, the Board made a finding of infeasibility of controls for under-fired charbroiler due to the lack of commercially available cost-effective controls. At the same time the Board substituted the emission reduction commitment for under-fired charbroilers from the 2003 AQMP control measure PRC-03, with emissions achieved that were greater than the 1999 AQMP commitment through the implementation of Rules 1186 - PM₁₀ Emissions from Paved and Unpaved Roads, and Livestock Operations and 403 – Fugitive Dust.

Technologies reducing only direct PM emissions include ESPs and wet scrubbers. The BAAQMD focused on ESPs and HEPA filters as controls for under-fired charbroilers. The emissions from charbroilers consist of two phases or parts: the “filterable” part and the “condensable” part. The “filterable” part is that fraction of the total particulates that is caught on the filter of the particulate sampling train, while the “condensable” parts are collected in the sampling train's chilled water impingers. The condensable portion contains vapors in gaseous form, or consists of material that will condense to particles in a liquid or solid state once they are released to the atmosphere. The CE-CERT study included emissions from both filterable and condensable particulates when they determined the total particulate emission factor. ESPs and HEPA filters do not capture the vapor portion of the emissions. The scrubber tested at CE-CERT does capture both the vapor and filterable portions of the emissions and is the basis for the 85% reduction requirement for this proposed rule. The BAAQMD did not include condensable gases reasoning that these vapors behave as gases and cannot be removed through mechanical filtration.

HEPA (high-efficiency particulate arresting) filters (PM)

HEPA filters work as a series of filters that capture particles of decreasing size as the effluent flows through the device. In general, the first pre-filter collects coarser particles in restaurant operations and should be replaced relatively frequently (i.e., every 4 weeks). The second filter in the series is a disposable bag which collects smaller particles and must be replaced every other month. The final filter collects the finest particles and is a disposable HEPA filter replaced biannually. These filters have a 95% to 99% efficiency rating. Halton Company who makes the EcoloAir, a HEPA system, quoted AQMD staff an efficiency of 95%. However, HEPA filtration, a mechanical process, does not capture the condensable phase of the emissions. Therefore, the efficiency must be adjusted to account for both filterable and condensable emissions. Using testing performed at CE-CERT, staff adjusted efficiency using a value of 45% vapor content of the emissions. HEPA filters may encounter problems with heavy grease from under-fired charbroilers if the filters are not watched closely and changed as needed. Currently, there are no HEPAs with District permits to control emissions from charbroilers in the Basin.

HEPA filters trap small particles by one of three mechanisms: interception (particles come within one radius of a fiber and adhere to it); impaction (particles are forced to embed in one of the fibers), or diffusion (an enhancing mechanism resulting from gas molecules collision with small particles which slows their flow). Diffusion is the predominate mechanism below the 0.1 μm diameter particle size. Impaction and interception predominate above 0.4 μm . In the 0.3 μm range, diffusion and interception predominate.

Wet Scrubber (PM)

Wet scrubbers rely on a finely atomized stream of liquid to capture particulate and gaseous pollutants from an exhaust stream, such as from a restaurant charbroiler. Heat and mass transfer are accomplished by direct contact of the exhaust gas with finely atomized droplets of the scrubbing liquid. The gas stream is cooled and moistened as the scrubbing liquid evaporates. Liquids typically used in industrial settings with wet scrubbers include water, ammonia, suspension of lime, limestone or other absorbing agents. For restaurant applications the liquid commonly used is water.

After the exhaust gases leave the scrubber, they flow through an after filter to remove entrained liquid particles. PM removal efficiencies of 90% or higher have been achieved in service depending on particle size, load, flows and pressure drop. Presently, there are nine wet scrubbers permitted at restaurants located in the Basin. Figure 2 illustrates a typical wet scrubber.

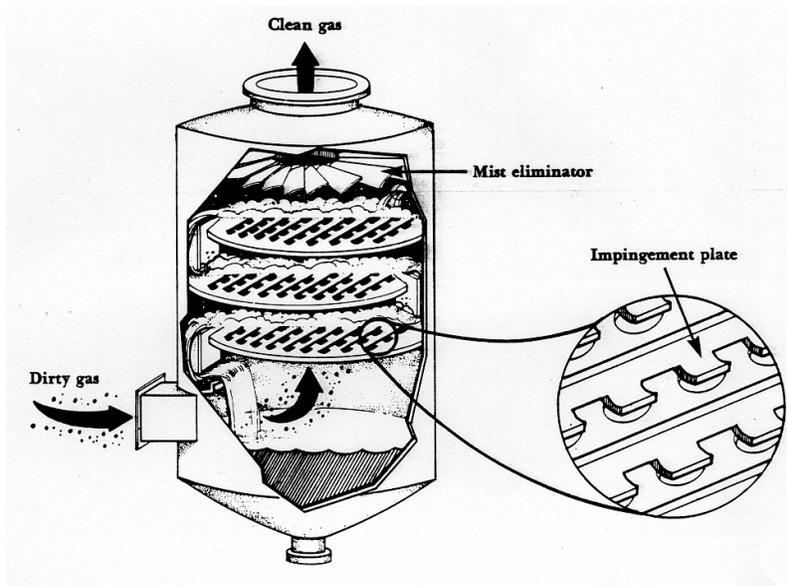


Figure 2^[10]
Wet Scrubber

Electrostatic Precipitators (PM)

ESPs have been used since the early 1940s to collect particulate material from exhaust gas streams in a wide range of industrial processes. ESPs rely on imparting a high voltage direct current (DC) charge to the particulate materials while simultaneously ionizing the carrier gas, producing an electric corona. The particles, either negatively or positively charged, are attracted to the ESP electrode of the opposite charge and finally removed from the electrodes by rapping or washing the electrodes. Again, this technology does not collect the condensable phase of the emission.

The Penney-type ESP applicable to cleaning charbroiler particulate emissions is a two-stage device. Particulate laden air enters the first stage from the hood and associated filters. Particulate is charged in the first stage and subsequently collected in a second stage of the ESP. Such ESPs are designed to collect the fine particulate associated with the exhaust "smoke" produced by charbroilers and similar sources. A 220-volt AC power supply to the ESP is transformed and rectified to a high DC voltage. Usually, the inlet air stream is cleansed of gross particles in a pre-filter. Next, the exhaust particles are ionized in the charging system and finally collected in the collecting section. An after filter is sometimes used to provide back pressure and ensure good gas distribution in the ESP. Collection efficiencies exceeding 90% are common in many applications. Specific source tests for control efficiencies of ESPs on under-fired charbroilers are not available. The efficiency used in calculating cost-effectiveness will take into account the lack of destruction of the condensable phase and as this portion is less than the total emissions, the efficiency must be downgraded. Some ESPs are equipped with an automatic wash system.

In restaurant applications, some problems with PM_{10} removal efficiencies have been found when the ESP was not properly cleaned. Typically, restaurant workers are not trained to do a professional cleaning job. Thus, properly trained maintenance personnel sometimes provide this service on a contract basis, leading to higher removal efficiencies and a lower chance of fire. ESPs have been installed to correct smoke and odor problems at restaurants. At present, there are 27 ESPs permitted and operating at restaurants located in the Basin. Figure 3 illustrates a typical ESP.

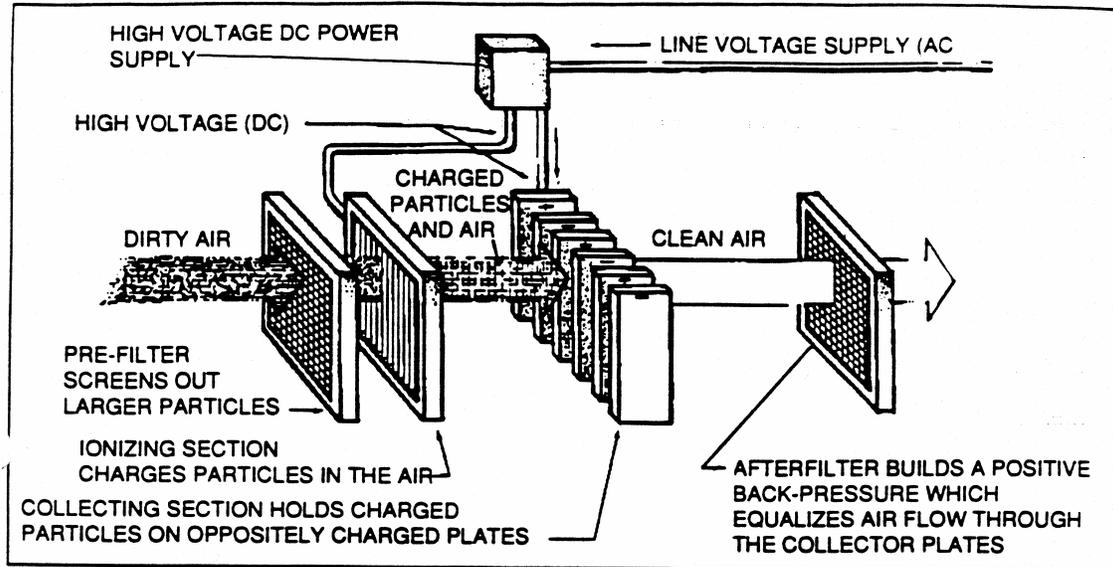


Figure 3 ^[11]
Electrostatic Precipitator

Ultra-violet Light Technology (PM)

The use of UV lights is currently being employed in restaurants to supplement ESP and HEPA controls for particulate matter emissions. The UV light system is most often used with a water-wash system. The UV light changes the grease to a powder form, which is then washed off the bulbs by the water-wash system. A grease particulate separator (GPS) is placed before the UV lamp-stage in the hood is key to and makes the grease particles the optimum size for UV destruction. This technology is currently in use at some very unique, large operations. This technology may be applicable to other restaurants to remove the larger grease particles. Staff is seeking cost and performance data on the UV technology.

COST-EFFECTIVENESS

The primary target pollutant for the proposed rule is PM, most all from the PM_{2.5} fraction, which is the more prevalent pollutant associated with restaurant equipment. Using an 85% reduction off a baseline of 2.5 tpd, the proposed rule would reduce PM_{2.5} emissions by an estimated 2.1 tons per day. Reductions in PM_{2.5} are particularly important in light of the federal standards for PM and the AQMD's non-attainment status for this pollutant. Table 3 highlights three commercially available technologies and compares their capital cost, percent reduction and cost-effectiveness.

**Table 3
BARCT Control Technology Summary**

Control Equipment	% Reduction	Capital Cost	Cost-effectiveness, \$ per ton*	Comment
HEPA	52%	\$40,700	\$23,000	Efficiency testing not confirmed with source-test
ESP	47%	\$67,200	\$33,700	Efficiency testing not confirmed with source-test
CAST Scrubber	85%	\$32,350	\$8,400	Source-test confirmed

*For reference: BACT cost-effectiveness for PM is \$ 4,300/ton, which is not comparable to BARCT

The restaurants where this control equipment will be installed present various installation situations for new facilities which will plan for the installation and existing facilities which will require retrofits. For existing facilities there are those that will only need to balance their air systems, locations which will need to modify or replace their fire-suppression system, and a few which will need to replace their fire-suppression system and existing hoods.

There are two types of fire-suppression systems, “wet” and “dry” chemical types. Since November 1994, when United Laboratories (UL) required re-testing of all automatic fire system, the dry systems have not met the UL standard because the dry systems were not tested. Some local authorities might require existing dry systems to be replaced with the wet systems if appliances are changed outside the guidelines for those original dry chemical UL testing, or fire nozzles or hood are relocated. Thus, the addition of the control equipment will trigger this change but is not the only reason a facility might need to replace the fire-suppression system. All of these factors result in a range of costs for installation of the control equipment. Below are cost-effectiveness estimates developed for the scrubber as the emission control equipment.

A complete average cost-effectiveness analysis is included as part of this staff report. A socioeconomic impact analysis will be available as part of this staff report at least 30-days prior to the Public Hearing.

Assumptions:

From the PES report, there are 13,300 under-fired charbroilers in the Basin. Setting the threshold level at 1,250 lbs of beef/wk cooked would create a universe of 931 charbroilers affected by the proposed rule. An average restaurant using an under-fired charbroiler cooking 1,250 lbs/week of beef would cook:

- 681 lbs hamburger/week
- Emission factor for hamburger meat (25% fat content) is 32.65lbs PM/1,000 lbs hamburger meat
- 569 lbs steak/week
- Emission factor for steak is 17.19 lbs PM/1,000 lbs. steak
- Discount Cash Flow (DCF) Method is used for deriving cost-effectiveness with 10-year equipment life and 4% per year real interest rate, and therefore present worth factor = 8.11.
- Number of under-fired charbroilers impacted by proposed rule = 931

Emissions from a restaurant cooking 1,250 lbs. of beef/wk.:

Days of operation from the PES report = 341 days/yr/52 wk/yr = 6 days/wk.

$$PM_{2.5} \text{ Emissions} = [((681 \text{ lb/wk} \times 32.65 \text{ lbs/1000 lbs cooked}) + (569 \text{ lb/wk} \times 17.19 \text{ lbs/1000 lbs cooked}))/6 \text{ days/wk}] \times 931/2000 \text{ lb/ton} = 2.5 \text{ tons/day}$$

It is assumed under PAR 1138 that a minimum 85% emission reduction is achieved (testing by CE-CERT on the CAST scrubber system 88%).

Assuming a 10-year equipment life, and a 4% real interest rate, and

<i>Equipment capital cost</i>	\$ 32,350
<i>Installation costs (electrical, plumbing, setting costs)</i>	\$ 1,300 (for new) (\$5,500 for retrofit)
<i>Annual operation and maintenance costs:</i>	\$ 3,300

Estimated cost-effectiveness = costs/emission reduction.

$$\begin{aligned} \text{New installation} &= \$ [(\$33,650 \text{ (capital cost + installation)} + 8.11 \text{ (present worth factor)} \times \$ 3,300 \text{ (annual O\&M)}) \times 931 \text{ (no. of equipment)}] / (10 \text{ (life of equipment)} \times 341 \text{ (annual days of operation)} \times 0.85 \text{ (control efficiency)} \times 2.5 \text{ (base emissions)}) \text{ ton } PM_{2.5} \\ &= \$ 7,850 \text{ per ton of } PM_{2.5} \text{ reduced.} \end{aligned}$$

Following the same calculation but using \$5,500 for installation cost for retrofit, the cost-effectiveness is \$8,400 per ton of PM_{2.5} reduced. This cost applies to the 931 existing restaurants that have been identified as falling under this rule amendment.

For comparison purposes, the BARCT cost-effectiveness for the original Rule 1138 was \$1,680 per ton of VOC and PM reduced. Note that the cost-effectiveness calculation for PAR 1138 is PM only. Other PM rule cost-effectiveness numbers present a range of values as follows: \$1,200 for street sweeping to \$6,000 for paving roads, under Rule 1186 - PM₁₀ Emissions from Paved and Unpaved Roads, and Livestock Operations;

\$11,000 to \$27,400 per ton of PM_{2.5} reduced for Rule 445 - Wood Burning Devices; and \$8,700 to \$10,000 for Rules 1133 – Composting and Related Operations – General Administrative Requirements, Rule 1133.1 – Chipping and Grinding Activities, and Rule 1133.2 – Emission Reductions from Co-Composting Operations.

INCREMENTAL COST-EFFECTIVENESS

Health and Safety Code Section 40920.6 (a)(3) requires the calculation of incremental cost-effectiveness for potential control options, when the District adopts “rules or regulations to meet the requirements for best available retrofit control technology [BARCT] pursuant to Sections 40918, 10919, 10920, and 10920.5, or for a feasible measure pursuant to Section 40914.....” All of these referenced laws are contained in Chapter 10, which deals with district plans to “achieve and maintain state ambient air quality standards for ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide...”. Thus, Section 40920.6 does not apply to rules relating to achieving other standards, such as PM₁₀. Proposed Amended Rule 1138 seeks to reduce PM emissions only.

COMPARATIVE ANALYSIS

Health and Safety Code Section 40727.2 requires a written analysis comparing the proposed amended rule with existing federal, State and District regulations. This analysis must include averaging provisions, operating parameters, work practice requirements, and recordkeeping, monitoring, and reporting requirements associated with existing applicable rules and proposed regulations.

Federal and state regulations do not contain rules for the source category of under-fired charbroilers. As previously stated BAAQMD adopted Regulation 6, Rule 2: Commercial Cooking Equipment, in November 2007 and in August 2009, SJVUAPCD is proposed to amend Rule 4692 – Commercial Charbroiling. Table 4 compares the Bay Area adopted rule and San Joaquin’s proposed rule with the District staff’s proposal.

Table 4
Comparison of Proposed Amended Rule 1138 with
BAAQMD Rule 2 and SJVUAPCD Proposed Amended Rule 4692

Rule Element	SCAQMD Proposal	BAAQMD Rule	SJVUAPCD
Applicability	Cook \geq 1,250 lbs of beef/wk	Must meet all 3 criteria: <ul style="list-style-type: none"> • >10 sq. ft. cooking area; and • purchases \geq 1,000 lbs. of beef/wk; and • cooks > 800 lbs. of beef/wk 	Cooks > 800 lbs of meat/wk
Operating Parameters	85% reduction in PM emissions through add-on control equipment (manufacturer certification)*	Certify control equipment to reduce PM ₁₀ emissions to 1 lb/1,000 lbs of beef cooked*	90% reduction in PM emissions through add-on control equipment (manufacturer certification)*
Universe	7% of the universe (approx. 930 of 13,300 under-fired charbroilers)	4% of universe (approx. 200 restaurants)	30% of universe (approx. 600 restaurants)
Emission Reductions	2.1 tpd PM _{2.5} (filterable and condensable)	0.28 tpd PM ₁₀ (filterable only)	0.26 – 2.5 tpd of PM ₁₀ (filterable only)
Cost-effectiveness	ESP - \$33,700/ton PM ₁₀ reduced HEPA - \$23,000/ton PM ₁₀ reduced Scrubber - \$8,400 ton PM _{2.5} reduced	ESP - \$19,500/ton PM ₁₀ & VOC reduced HEPA - \$17,300/ton PM ₁₀ reduced Scrubber - \$26,100/PM ₁₀ & VOC reduced	ESP - \$20,300 - \$201,400/ ton PM ₁₀ reduced HEPA - \$5,800 - \$57,600/ton PM ₁₀ reduced Scrubber - \$17,000 - \$168,500/ton PM ₁₀ reduced
Recordkeeping	Maintain records of beef cooked (under-fired) and meat cooked (chain-driven) weekly and purchased monthly. Maintain records of installation, changing and maintenance of control equipment.	Maintain records demonstrating cooking less than 800 lbs of beef/wk for under-fired charbroilers and less than 400 lbs of beef/wk for chain-driven charbroilers. Date equipment installed. Maintain records of installation and maintenance of control equipment.	Maintain records of amounts cooked weekly.

Rule Element	SCAQMD Proposal	BAAQMD Rule	SJVUAPCD
Work Practices	Maintain equipment in accordance with manufacturers' specifications.	Maintain equipment in accordance with manufacturers' specifications.	Maintain equipment in accordance with manufacturers' specifications
Compliance Schedule	New equipment - July 1, 2010 (>1,500 lbs/wk); January 1, 2011 (cooking 1,250 – 1,500 lbs/wk) Existing – January 1, 2013 (cooking > 1,500 lbs/wk); July 1, 2013 (cooking 1,250 – 1,500/wk)	New – January 1, 2010 Existing – January 1, 2013	New (after Jan. 1, 2011) at time of installation Existing – July 1, 2014

*The District’s proposal is in keeping with the structure of the original Rule 1138 and is based on a control device efficiency. The BAAQMD rule is based on an emissions rate not to be exceeded. They are, therefore, not comparable. SJVUAPD allows the use of uncertified control equipment if the source accepts Permit to Operate conditions.

ANALYSIS OF ALTERNATIVES

Staff evaluated the impacts of alternative applicability thresholds under the proposal. These are summarized as follows:

As proposed, establishing the threshold at 1,250 lb of beef cooked/week captures approximately 7% (930) of the universe (13,300) of under-fired charbroilers resulting in a 2.1 t/day reduction of PM_{2.5} at a retrofit cost-effectiveness of \$8,400. Alternatively, if the threshold were 1,000 lbs of beef cooked/wk, the number of restaurants included in the proposal would be 1,200 resulting in a 2.2 t/day reduction and a cost-effectiveness of \$10,300. A threshold of 1,500 lbs. of beef cooked/wk. would include 665 restaurants with a 1.8 t/day reduction and a cost-effectiveness of \$7,000.

Staff believes the amendments, as proposed, represent an appropriate balance of emission reductions and cost based on available control technology.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

Pursuant to the California Environmental Quality Act (CEQA) and AQMD Rule 110, the appropriate CEQA documentation will be prepared to analyze any potential adverse environmental impacts associated with PAR 1138. Upon completion, the CEQA document will be released for public review and comment, and will be available at AQMD Headquarters, by calling the AQMD Public Information Center at (909) 396-2039, or by accessing AQMD’s CEQA website at: www.aqmd.gov/ceqa.

SOCIOECONOMIC ANALYSIS

The Socioeconomic Analysis will be included as part of the Public Hearing package and made available to the public at least 30-days prior to the Public Hearing.

DRAFT FINDINGS UNDER THE CALIFORNIA HEALTH AND SAFETY CODE

Before adopting, amending or repealing a rule, the California Health and Safety Code requires AQMD to adopt written findings of necessity, authority, clarity, consistency, non-duplication, and reference, as defined in Health and Safety Code §§ 40727 and 40920.6. The draft findings are as follows:

Necessity - The AQMD Governing Board has determined that a need exists to adopt Proposed Amended Rule 1138– Control of Emissions from Restaurant Operations to assist in the attainment of State and federal PM_{2.5} standards for the South Coast Air Basin.

Authority - The AQMD Governing Board obtains its authority to adopt, amend, or repeal rules and regulations from Health and Safety Code §§ 39614, 40000, 40001, 40440, 40463, 40702, 40725 through 40728.

Clarity - the AQMD Governing Board has determined that Proposed Amended Rule 1138 – Control of Emissions from Restaurant Operations, is written and displayed so that the meaning can be easily understood by persons directly affected by it.

Consistency - The AQMD Governing Board has determined that Proposed Amended Rule 1138 – Control of Emissions from Restaurant Operations, is in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, federal or state regulations.

Non-duplication - The AQMD Governing Board has determined that Proposed Amended Rule 1138 – Control of Emissions from Restaurant Operations, does not impose the same requirements as any existing state or federal regulation, and the proposed rule is necessary and proper to execute the powers and duties granted to, and imposed upon, the AQMD.

Reference - In adopting this proposed rule, the AQMD Governing Board references the following statutes which the AQMD hereby implements, interprets or makes specific: Health and Safety Code Sections 40001 (rules to achieve ambient air quality standards); 40440(a) (rules to carry out the AQMP); 40440 (c) (cost-effectiveness); and Federal Clean Air Act Section 172(c)(1) (RACT).

CONCLUSION

Adoption of Proposed Amended Rule 1138 will result in a 2.1 tpd reduction in PM_{2.5} by July 2013, implementing Control Measure #2007 BCM-05 in the 2007 AQMP, and

assisting in progress towards attainment of federal and state PM_{2.5} standards. Implementation of the proposed amended rule will result in a decrease in visible emissions for this industry. The 85% reduction requirement is based on the scrubber technology which has been source-tested. Although HEPA filters have a high control efficiency, they only reduce the filterable portion of emissions. Thus, the scrubber, costing less and with source-test data to substantiate reductions, is the appropriate choice for a rule-based emission reduction requirement. With increased production of control devices, the availability of other control option and costs for these devices will most likely be reduced and smaller operations could be added in the future.

REFERENCES

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