LAS VEGAS VALLEY CHARBROILER EMISSIONS INVENTORY

APPENDICES

EXECUTIVE SUMMARY

As a result of this investigation, a total of 1,332 charbroilers were estimated to be in operation in the Las Vegas Valley (Valley). Of these, 56 facilities have chain-driven charbroilers. Using information from research done by the University of California at Riverside, emissions from the catalytic oxidizer manufactured by Ayr King were reported as follows:

- uncontrolled underfired charbroilers emit 34 pounds PM per 1,000 pounds meat cooked
- a chain-driven charbroiler without controls emits 7.2 pounds PM per 1,000 pounds meat cooked, and
- after installation of an Ayr King catalytic oxidizer, the same chain-driven charbroiler emits 0.7 pounds PM per 1,000 pounds meat cooked.

Using these emission factors, it can be concluded that emissions from underfired charbroilers are much greater than those from chain-driven charbroilers. However, a Best Available Control Technology (BACT) determination by SCAQMD led them to the conclusion that chain-driven charbroilers are the only type of broilers for which a cost-effective control technology (catalytic oxidation) has been developed. Therefore, a BACT rule for charbroilers would require controls on those charbroilers that do not contribute as much on a pounds emitted per pound meat cooked basis. Also, approximately 60% of charbroilers in the Valley are underfired, so controlling chain-driven charbroilers would have only a minor effect on PM and VOC emissions from charbroilers.

Approximately 5.3 million pounds of hamburger is cooked on chain-driven charbroilers in Las Vegas each year. Of this, approximately 3.7 million pounds per year is cooked on chain-driven charbroilers **with** control devices and 1.6 million pounds per year is cooked on chain-driven char-broilers **without** controls. Using the Ayr King emission factors, requiring those facilities without controls to put on controls would result in a reduction of approximately 5.2 tons PM per year.

Using the Clark County Comprehensive Planning's 1995 Valley-wide PM_{10} Emissions Estimate of 87,261 tons, this would account for a reduction of approximately 0.006% of valley-wide particulate emissions. Therefore, a BACT requirement of catalytic converters to reduce 0.006% of PM emissions does not warrant the manpower required to inspect and permit these facilities.

Based on the above, it is our recommendation that no charbroiler-specific regulations be adopted at this time by APCD. However, we also recommend that APCD monitor new technologies with regard to charbroilers; when control devices are available for all charbroilers it may be feasible to implement regulations at that time.

OBJECTIVE

Our objective for this survey was stated in our Notice to Proceed from the Clark County Health District (CCHD) Air Pollution Control Division (APCD):

Investigate and assemble a report that includes a description of data sources, an estimate of the number of restaurants in the Las Vegas Valley, an estimate of the percentage of restaurants which have charbroilers, an estimate of the quantity of meat cooked on charbroilers, and an estimate of PM_{10}, $PM_{2.5}$ and VOC emissions from charbroiler usage and the types of control equipment currently in use by the industry today, both locally and in areas with control regulations, such as South Coast Air Quality Management District (SCAQMD) or Washoe County.

In addition, the task order requested sufficient backup to allow APCD staff to recreate the emission estimates.

METHODS

Our original proposal for pursuing this project outlined the following series of steps:

1. Estimate the number of restaurants in the greater Las Vegas Valley,
2. Estimate the percent of restaurants that have charbroilers,
3. Estimate the range in the amount of meat cooked on the charbroilers,
4. If possible, establish restaurant types associated with ranges of cooked meat output, any catalytic oxidizers or other emissions control equipment already in use, types of charbroiling equipment (chain-driven, under-fired, etc.) and other relevant information, and
5. Estimate the PM and VOC emissions from charbroilers

As outlined in our proposal, we initially contacted all of the potential data sources that we thought might be useful. This was followed by a meeting with key staff from APCD, the CCHD Environmental Health Division (Environmental Health) and K/J to obtain APCD and Environmental Health ideas on information sources and the validity of our approach.

As expected, of the five potential sources identified in our proposal (the restaurant association, meat distributors, local internet restaurant advertisements, the telephone directory Yellow Pages, and telephone interviews with restaurants), some were more cooperative and/or provided more useful information than others. In addition to these sources, we used restaurant equipment manufacturers, restaurant ventilation/fire protection equipment maintenance services, local business license bureaus, the Environmental Health food service permit database, local government fire prevention inspectors, restaurant chain offices, South Coast Air Quality Management District (SCAQMD) and other air pollution control regulatory programs, the University of California at Riverside, and a subconsultant expert from the food and beverage industry. A brief description of the data sources which proved useful is included in the following section, "Data Sources." The restaurant association is not listed because of the limited local membership and the limited data available on local members that can be released to nonmembers. Direct survey of regional offices of chain restaurants was useful in obtaining the type of restaurant equipment in use and the quantity of meat cooked in fast food and sit-down chain restaurants. Our most useful sources were:

- SCAQMD

- Meat suppliers
- Ventilation/fire protection equipment services
- The food and beverage industry subconsultant
- Restaurant equipment manufacturers
- Regional offices of chain restaurants

Meat quantity estimates from restaurant franchise chains were supplemented by information collected from the primary meat supplier. A private contractor who maintains ventilation and exhaust hoods for food establishments was also a very good source of supplemental information.

Surveys of Fast Food and Sit-Down Restaurants

The regional offices of fast food and sit-down franchise restaurants in the Las Vegas Valley were contacted via telephone and asked to provide information on 1) the types of equipment used to cook meat, 2) the amount of meat cooked, and 3) emission control devices in place. The list of restaurants surveyed was taken from the Las Vegas Telephone Directory Yellow Pages, with oversight and recommendations by the food and beverage subconsultant. The information collected from the regional offices is summarized in the results section of this report. The three tables of data are found in Appendix A.

Emission Calculations

Emission factors for PM and VOC depend on the type of meat cooked, the type of cooking, and emission control equipment used. Total emissions were calculated by multiplying the pounds of meat in ten categories of meat type and cooking method by the emission factor for the equivalent meat and method category from the SCAQMD Staff Report for Proposed Rule 1138—Control of Emissions from Restaurant Operations, known as the SQAQMD study or staff report. These factors were derived from emissions testing done in model kitchens operated by the University of California at Riverside. (Emission factors are found in Appendix C.)

The emission factors for PM and VOC emitted from cooked fish from the SCAQMD study was for Salmon filets. Salmon filets have a higher fat content than other types of fish. The quantity of fish cooked in the Valley includes all types of fish; therefore emissions from cooked fish may be over-estimated.

Ultimately only two restaurant categories were necessary, "fast food" and "sit-down dining," because restaurants other than fast food venues have little use for chain-driven charbroilers. This created a logical split because sit-down restaurants only use under-fired broilers. Another reason for choosing to split available information by these two categories was the availability of information from the database collected in the restaurant survey of the kinds and amounts of meat that are cooked on particular types of equipment by specific fast food chains. Using the total quantity of meat sold in the area, and accounting for the reported quantities of meat cooked in fast food and sit-down chain restaurants, the quantity of meat cooked in each of the ten categories was estimated.

The division between fast-food and sit-down restaurants clearly reflects the specific type of equipment used to cook meat. The five categories for sit-down restaurants are 1) hamburger cooked on an underfired charbroiler without controls, 2) hamburger cooked on a flat-top or grooved griddle, 3) steak cooked on an underfired charbroiler, 4) chicken cooked on an underfired charbroiler, and 5) fish cooked on an underfired charbroiler. The five categories for fast food restaurants are 1) hamburger cooked on a chain-driven charbroiler with controls, 2) hamburger cooked on a chain-driven charbroiler without controls, 3) hamburger cooked on an underfired charbroiler without controls, 4) hamburger cooked on a flat-top or grooved griddle, and 5) steak cooked on an underfired charbroiler.

Of the 73 million pounds of beef sold in the Valley each year, as reported by the meat supplier, an estimated 60% is sold as hamburger. This quantity of hamburger (43.8 million pounds per year) can be divided into hamburger served at fast food outlets and hamburger served at sit-down restaurants. The tabulated results of total meat sales is found in Appendix C.

The restaurant survey provided hamburger quantities for the primary fast food restaurants. The large-volume fast food restaurants that cook hamburgers were identified by the food and beverage industry subconsultant and by the results of the survey by the type of equipment used. Chain-driven charbroilers are used only in high volume restaurants. Chain-driven charbroilers with emission control devices are used at Burger King. Chain-driven charbroilers without emission control devices are used at Carl's Jr., Fat Burger, and Jack-in-the-Box. McDonald's, Sonic, and Wendy's cook hamburgers on flat-top and grooved griddles. The survey provided an estimate of the quantity of hamburger cooked at each store per week, with the exception of Jack-in-the-Box. The quantity of hamburger cooked at Jack-in-the-Box was estimated by the consultant, based on comparison with similar volume restaurants, such as Sonic.

The food and beverage industry consultant estimated that the data collected by the survey on the quantity of meat from the seven primary hamburger-serving fast food restaurants (13.3 million pounds per year) is 85% of the total hamburger served by all fast food restaurants. The additional 15% of hamburger served by fast food restaurants is assumed to include hamburger served at concession stands, school kitchens, and privately owned operations. This estimate of hamburger cooked at the untapped data sources was assumed to be cooked on flat-top griddles. This assumption was based on data from the survey. Of the 200 schools and 22 concessions surveyed, all that provided information in the survey used a griddle.

The remainder of the 43.8 million pounds of hamburger sold in the Valley was estimated to be served at sit-down restaurants. The subconsultant estimated that 90% of hamburger served at sit-down restaurants was cooked on an underfired charbroiler, and 10% was cooked on a flat-top or grooved griddle. Very few "Clam-shell" griddles are used in the Valley. This estimate is confirmed by the information provided by the equipment maintenance contractor.

The estimated 73 million pounds of beef includes 29.2 million pounds of steak, as estimated by the meat supplier. Of the sit-down restaurants reporting, 42 of the 64 have underfired charbroilers. Steak is primarily cooked on underfired charbroilers, and our subconsultant estimated that almost all of the steak in sit-down restaurants is cooked on underfired charbroilers. For purposes of this study, the total steak quantities can be divided between fast food and sit-down. Carl's Jr. is the only fast food chain reporting steak cooked on an underfired charbroiler. The quantity of steak cooked at Carl's Jr. was subtracted from the total 29.2 million pounds sold per year. The remaining quantity of steak was estimated to be the pounds of steak cooked by underfired charbroiler in the sit-down category. Essentially, for this study, all the

estimated pounds of steak sold in the Valley each year is assumed to be cooked on an underfired charbroiler.

The subconsultant stated that very little chicken or fish is cooked on underfired charbroilers or griddles at fast food restaurants; it is typically breaded and cooked in a deep fat fryer or roasted. Estimates were made of the portions of chicken and fish served at fast food versus sit-down restaurants according to information on quantities cooked at the fast food chains reporting. Based on chicken cooked at Burger King, Kentucky Fried Chicken, and Wendy's, an estimated 1.2 million pounds (25% of the total quantity) of chicken is cooked by deep fat frying. According to the subconsultant, approximately 90% of the remaining chicken sold in the Valley per year is cooked on an underfired charbroiler at a sit-down restaurant. (The quantity of chicken cooked at fast food restaurants may be underestimated.) The quantity of fish cooked in fast food restaurants was estimated in the same manner, using data collected from eight fast food restaurant chains. An estimated 3% of the 2 million pounds per year is cooked at fast food restaurants. According to the subconsultant, at least 90% of the remaining fish is cooked on an underfired charbroiler.

The output of the data categorization, assumptions, and estimates described above is the amount of meat in each of the ten meat type and equipment use categories. The Results and Discussion section of this report includes a summary of results of this analysis. The tabulated data, including values estimated as shown above, are found in Appendix C.

Number of Restaurants

The primary sources of the number of restaurants are the business license records of Clark County, Las Vegas, North Las Vegas, and Henderson. These numbers were compared to the Environmental Health food service database. The much higher number of food service permits compared to restaurant business licenses is due to the large number of permits issued to businesses whose primary license is for another purpose (e.g. bars) and the many repetitive permits for temporary food service facilities. It is possible, however, that there are some broiler emissions from food service operations in facilities not classified as restaurants.

Types of Emission Control Equipment in Use

Information on types of emission control equipment in use in the Las Vegas Valley is from a survey of franchise chains, equipment suppliers, and fire protection services with reality checks from our food and beverage subconsultant. Types of emission control equipment in place in areas with charbroiler emissions regulations were determined through information from California Environmental Associates, a consulting firm that is conducting a nationwide survey of charbroiler controls for the National Restaurant Association. Further information was obtained from telephone conversations with air quality officials at SCAQMD and the Washoe County Air Pollution Control Division.

DATA SOURCES

Environmental Health Division, CCHD

K/J staff contacted Rick Pangborn, ventilation inspector for Environmental Health. He supplied information on the types and locations of air emission control devices in use in the Las Vegas Valley.

Hope Arrington, Administrative Analyst, Environmental Health provided K/J with a count of restaurants in the Las Vegas Valley area, categorized by CCHD licensing code. This information was used to estimate the number of charbroilers in operation.

Restaurants and Restaurant Chain Executive Offices

Two types of restaurants, "fast food" and "sit-down" franchises, were surveyed by telephone. A copy of the survey form used is included in Appendix A.

Food and Beverage Industry Subconsultant

The food and beverage industry subconsultant reviewed our survey questions and targets for completeness, and provided information on restaurants in the Las Vegas Valley based on previous and current experience as a restaurant manager and consultant. The subconsultant contacted key individuals in the food and beverage industry in the Las Vegas Valley to collect information on the volume of meat sold and the methods of cooking the meat, as well as emission control devices in place.

Meat Suppliers and Distributors

The Las Vegas Valley's largest distributor of meat provided us with an estimate of the pounds of meat (including beef, chicken, and fish) sold to all food establishments in the Las Vegas Valley. Main accounts include Mirage Resorts, Inc., Caesar's Palace, The Hilton Corp., Station Casinos, Clark County School District, and independent operators. The distributor based his estimate on recent extensive research conducted by a nation-wide meat supplier to determine the quantity of meat sold in the Valley.

The supplier's information was also based on his thirty-year career in the meat packing and sales distribution business, and over fifteen years experience in Nevada. He has experience as a regional sales representative for the largest meat packing plant in the United States with sales to Burger King and McDonald's.

Restaurant Equipment Manufacturers

A manufacturer of chain-driven charbroilers was contacted for information on chain-driven charbroilers in the area and names of manufacturers of emission control devices. The manufacturer also provided information on the current status of research on restaurant emission control technology.

Municipal Business Licensing Bureaus

The Cities of Las Vegas, North Las Vegas, and Henderson and the Clark County Business License Bureaus were contacted for data on existing business licenses for food establishments. This information was used to estimate the number and types of restaurants and charbroilers in operation.

Restaurant Ventilation and Fire Protection Maintenance Firms

A representative of a national contractor for the restaurant industry was contacted to provide information on kitchen and emission control equipment. The services provided by his firm include exhaust and hood cleaning, filter and roof maintenance, and the servicing of fire protection equipment. Approximately 65% of the hoods and exhaust systems in restaurants in the Las Vegas Valley are serviced by this firm. There are no other firms of this size operating in the Valley. He has 12 years experience with the national maintenance firm.

This contact participated in the South Coast Air Quality Management District study assessing restaurant emissions from charbroilers as a consultant to Burger King.

Air Pollution Control Equipment Manufacturers

Manufacturers of catalytic oxidizers for chain-driven broilers and development companies working on emission controls for exhausts from commercial kitchens were contacted by telephone to determine which restaurants are using these devices. Examples of existing equipment provided by these manufacturers are included in Appendix F.

"VentMaster," a manufacturer of commercial kitchen exhaust systems, was contacted to establish how many units were in place in the Las Vegas Valley. Specifications for this equipment are included in Appendix F.

Air Pollution Control Regulating Agencies

An environmental consultant employed by the National Restaurant Association to study country-wide air quality regulations for commercial kitchens, recommended a search of specific sites on the Internet for information on current and pending regulations in different parts of the United States.

Pamela Perryman, Air Quality Specialist for the SCAQMD, was contacted to discuss several aspects of the study. She supplied information on the background of proposed Rule 1138, other information on SCAQMD restaurant regulation, and a discussion of how eating habits and other factors, such as tourism, in the Las Vegas Valley compare with those in the Los Angeles Basin.

Chris Ralph, a senior environmental engineer from the Washoe County Health Department, was interviewed regarding their regulations relevant to restaurant broilers.

Local Government Fire Prevention Inspectors

Fire Safety Inspection and Fire Prevention departments of the Cities of Las Vegas, North Las Vegas, and Henderson and of Clark County were contacted to determine if these agencies

maintain any database of restaurant equipment, especially charbroilers that are inspected by these agencies.

Published Restaurant Listings

A list of restaurants in the Las Vegas Valley from the Las Vegas Review Journal web site grouped by ethnic category was used to help identify the type of restaurants that might operate charbroilers.

The Las Vegas Telephone Directory Yellow Pages was the primary source used to locate restaurants, restaurant consultants, restaurant equipment, and service providers in the Las Vegas Valley.

Learning Institutions and Research and Development

Dr. Bill Welch, University of California at Riverside, was contacted regarding information on emission control devices developed and tested at the CE-CERT Lab and those restaurants that have those devices in place.

RESULTS

Data from Fast Food and Sit-down Restaurant Survey

K/J staff surveyed 40 restaurant chains in the Las Vegas Valley, which included 407 "stores" or chain restaurant locations. Three tables of results from the survey included in Appendix A are as follows: 1) a count of the kinds of equipment found in the restaurants, including charbroilers, 2) an estimate of how many pounds of meat are cooked, and 3) a count of the types of emission control devices in place.

Of the 407 chain restaurants surveyed, 56 use chain-driven charbroilers; 86 restaurants use "flame" or underfired charbroilers, and 311 restaurants use griddles. Nearly all (324 of the 407 restaurants) use deep fat fryers. Ten restaurants use wood-burning equipment.

Estimates from the chains surveyed indicate that a total of 13.7 million pounds of beef per year was cooked, with 321 of 407 fast food and sit-down chain restaurants reporting meat quantity data. A few high-volume restaurants did not report meat quantity data and are not included in this total volume of meat cooked.

The survey confirmed that the standard emission control devices in place in the Las Vegas Valley are filters and grease traps incorporated into commercial kitchen hoods. One fast food restaurant chain, Burger King, is using catalytic oxidizers with their chain-driven charbroilers. According to the survey data, 34 catalytic oxidizers are in operation at Burger King restaurants. Another 26 chain-driven charbroilers at other restaurants are operating without catalytic oxidizers.

The reason for the lack of controls on underfired charbroilers is that a best available control technology (BACT) determination by SCAQMD led them to the conclusion that chain-driven charbroilers are the only type of broilers for which a cost-effective control technology (catalytic oxidation) has been developed. SCAQMD does not believe that cost-effective controls are

available for underfired broilers. However, the University of California at Riverside is continuing work to identify and test appropriate underfired broiler control technology.

Some nationwide fast food chains are using catalytic oxidizers in all their facilities with chain-driven charbroilers regardless of local air quality regulations, in response to the SCAQMD determination.

The Number of Restaurants Operating in the Las Vegas Valley

The number of restaurants in the Las Vegas Valley can be estimated by totaling the number of business licenses on file in the municipalities of Las Vegas, North Las Vegas, Henderson and Clark County. The total of all licenses for restaurants is 2,214. There may be some redundancy in the 132 licenses for the "Take-Out" category for the City of Las Vegas. The tabulated results of restaurant business licenses is found in Appendix B.

The number of restaurants operating in Las Vegas can also be estimated by totaling the mutually exclusive categories restaurants according to Health District permits. The total number of permits is 1822, not including the 2093 permits issued to the category of "Restaurant/Take-Out". This category is a secondary license for most restaurants.

Estimated Restaurant Meat Charbroiled or Griddle-Fried in the Valley

The majority of meat sold in the Valley is cooked on devices which produce emissions (charbroilers and griddles). Some meat is deep-fat fried or cooked in a manner that does not produce significant emissions.

Quantities of meat prepared at fast-food restaurants were based on survey results of the pounds of meat cooked per store per week. Approximately 3.7 million pounds of hamburger per year is cooked on chain-driven charbroilers with emission control devices. Approximately 1.6 million pounds per year is cooked on chain-driven charbroilers without controls. An estimated 9.2 million pounds of hamburger is cooked on griddles, with 70% of this total cooked at fast food restaurants. The quantity of hamburger cooked on underfired charbroilers is 27 million pounds per year, with only 6% of this total cooked at fast food restaurants. An estimated 29 million pounds of steak is cooked on underfire charbroilers, with only 0.3 % of all steak cooked at fast food restaurants. An estimated 4.5 million pounds of chicken is cooked per year, with 25% cooked in deep-fat fryers at fast food restaurants. Approximately 2 million pounds of fish is cooked per year, with 3% cooked in fast food restaurants. The tabulated results are found in Appendix C.

Emission Calculations

Using the results of the meat quantity analysis, emissions from charbroilers and griddles were calculated using emission factors established by the SCAQMD. The total emissions of PM (not differentiated between PM_{10} and $PM_{2.5}$) for all meats cooked is estimated to be 750 tons per year, or approximately 4,100 pounds per day. The total amount of VOC's emitted by all meat cooked is approximately 73 tons per year, or 400 pounds per day. VOC emission factors are much less than emission factors for PM. The tabulated results are found in Appendix C.

Data from CCHD Environmental Health

The CCHD categorizes restaurants by codes for purposes of issuing food service permits. These categories are based on the purpose of the kitchen, the place where the food is ultimately served, and the style of service. One restaurant may have more than one license. For example, a restaurant categorized under Health District Code 011, "Restaurant," may also have a license under Code 012, "Restaurant/Take-Out." Categories of food establishments that usually do not operate a charbroiler are not included in this report.

Food and Beverage Industry Subconsultant

The food and beverage consultant, relying on direct knowledge as a restaurant manager, estimated the percentage of charbroilers in the Las Vegas Valley in each of the categories used by the Health District. The highest percentage of restaurants using charbroilers was estimated to be in the "Special Kitchen," "Meat Kitchen," and "Banquet Kitchen" categories. All of the 290 restaurants (100%) included in these three codes were assumed to operate charbroilers. Eighty (80) percent of the "Concessions," and 75% of the "Kitchens," were assumed to operate charbroilers. The number of charbroilers estimated in the category "Restaurant/Take-Out" (142 units) was taken from the restaurant survey. A total of 1,332 charbroilers were estimated in this analysis to be in operation in the Las Vegas Valley.

The CCHD categories, codes, and definitions of categories with the estimation of numbers of charbroilers in each, are included in Appendix B.

Data from CCHD on Emission Control Devices in Operation

Several emission control devices are in operation in the Valley. Catalytic oxidizers are used in conjunction with chain-driven charbroilers in all Burger King locations. The Burger King at McCarran International Airport has recently installed an emissions control device to prevent grease from exhausting onto the terminal apron and forming deposits on the concrete and on airplanes. The "VentMaster" filtration system is the most popular brand of filtration air emission control device in the Valley. This device is in use at the MGM Theme Park, The Bellagio, The Paris, The Venetian, and the Las Vegas Speedway. "VentMaster" can be used for air re-circulation systems. Another emission control device operating in Las Vegas is manufactured by Gaylord. The Gaylord unit is an electrostatic precipitator, and is used to control emissions from the eateries at the MGM Theme Park. Information on these two devices is found in Appendix F.

Meat Suppliers and Distributors

The major meat supplier for the Valley was able to estimate that 73 million pounds of beef is sold in the Valley each year. An additional five million pounds of poultry products and two million pounds of seafood is sold each year. The supplier estimated that approximately sixty percent of the beef sold in the area is hamburger and approximately forty percent is steak. The fast-food industry is the major purchaser of hamburger meat. A table of these results is found in Appendix C.

Restaurant Ventilation and Fire Protection Maintenance Firms

Restaurants in Las Vegas that operate chain-driven charbroilers use the Nieco Model 960. SCAQMD regulations now require that all chain-driven charbroiler equipment be fitted with catalytic oxidizers or electrostatic precipitators. Burger King has made the decision to install emission control devices in all of their chain-driven charbroiler units. Our contact stated that Burger King, Inc. is the only restaurant chain that uses catalytic oxidizer emission control equipment in the Las Vegas Valley.

All Las Vegas restaurants have hood and exhaust filters to remove odors and grease from the interior of the facility. The main reason for maintaining exhaust equipment is for sanitation and fire protection.

Up to 95% of the hamburger cooked in local restaurants industry is labeled as "80-20" (20% to 25% fat content in the ground beef). The average portion size is a 0.25 lb. patty. One pound of meat is cooked per minute on chain-driven charbroilers, reaching an internal temperature of at least 160°. Exhaust from the charbroiler reaches a temperature of 600°F and above.

The exhaust maintenance firm keeps no records of specific equipment at each restaurant. Service is provided based on sales volume per restaurant, the quantity of meat cooked, perceived need for service by management, and legal requirements for service.

Data from Air Pollution Control Regulating Agencies

Pamela Perryman, of the SCAQMD, supported the concept that the emission factors for types of meat and methods of cooking developed for the South Coast study, "Staff Report for Proposed Rule 1138 – Control of Emissions from Restaurant Operations" are applicable for those same types of meat cooked in the Las Vegas Valley. However, in her opinion, the overall rate of meat consumption per person in Las Vegas is probably greater than the rate of meat consumption in the South Coast area. Therefore, she expects that broiler emissions may be higher on a per capita basis.

Chris Ralph, a senior environmental engineer from the Washoe County Health Department Air Quality Management Division, explained their regulatory program. They seek to permit restaurants with more than two pounds of emissions per day (0.365 tons per year). Of the 1,500 to 1,800 restaurants in the County, about 100 have permits. The emission estimates are calculated, using the SCAQMD factors, based on the amount of meat cooked and method of cooking. If a restaurant falls between the 2-pound per day permitting limit and 10 pounds per day of emissions (1.825 tons per year), the restaurant is required to submit records of the amount of meat cooked. If the restaurant generates more than 10 pounds per day, the BACT limit is triggered and emission controls are required. Mr. Ralph also mentioned that Washoe County regulates two or three restaurants using mesquite-fired broiling by capacity determinations.

Information from the Restaurant Equipment Manufacturers

Chain-driven Charbroiler Manufacturer

Nieco Corporation of Burlingame, California, has been working together with the developers of catalytic devices for controlling emissions from chain-driven broilers. They were provided

assistance in developing background information for the SCAQMD study, "Staff Report for Proposed Rule 1138 – Control of Emissions from Restaurant Operations."

Emission control equipment is not sold by Nieco. These devices are manufactured by Ayr King/Prototech, Catalytic Combustion Corporation, and Englehard Corp. (formerly Grace Emission Control Products) and are under development at C2i, Ltd. The equipment from these manufacturers was tested at the University of Riverside CE-CERT lab. The equipment supplier for Nieco chain-driven charbroilers for this area is Golden West Equipment in La Habra, California.

In the Las Vegas Valley, catalytic oxidizers are used in Burger King Restaurants and a few other high volume restaurants, such as those in New York- New York and Mirage Resorts. Catalytic oxidizers are able to handle higher emissions concentrations than filtration systems. The Gaylord electrostatic precipitator is used in conjunction with VentMaster filtration systems.

Catalytic Oxidizer Manufacturers and Developers

Manufacturers and developers of emission control equipment for chain-driven charbroilers have tested their devices at the CE-CERT lab at the University of California at Riverside. At least five product development and manufacturing firms are working on this type of product.

The catalytic oxidizers operating in Burger King Restaurants are manufactured by Ayr King. The Ayr King device removes up to 90% of all emissions, with a 95% removal of VOCs. Ayr/King reported that an uncontrolled underfired charbroiler emits 34 lbs. of PM per 1000 lbs. of meat cooked. A chain-driven charbroiler emits 7.2 lbs. of PM per 1000 lbs. of meat cooked. After installing an Ayr King catalytic oxidizer, the same chain-driven charbroiler emits 0.7 lbs. of PM per 1000 lbs. of meat cooked.

All chain-driven charbroilers in the South Coast area, including the counties of Los Angeles, Riverside, San Bernardino, and Orange, are mandated to install emission control devices by November 2000. Ayr King devices are used in Burger King Restaurants in California, Colorado, New York City, and Boston. Phoenix may be the next city to regulate emissions.

C2i, Ltd., of Aptos, California, is a research and development group that is working on the application of catalytic emission control devices to various technologies. They are in the testing and approval cycle with a catalytic emission control device for the Nieco chain-driven charbroiler.

Englehard Corporation (formerly Grace Emission Control Products) has developed a catalytic oxidizer for the Nieco chain-driven charbroiler.

Prototech, Inc., of McHenry, Illinois, is a product development firm that performs fit, function, and style studies. They develop prototypes for manufacturers. They are currently working on emission control products that remove carbon particle dust for mold-making companies.

Gaylord Industries has manufactured electrostatic precipitators for emission control of commercial kitchens since 1972. These devices are operated in the Las Vegas Valley at the MGM and will be operating at the Bellagio where thirteen new units have been recently installed.

Catalytic Combustion Corporation manufactures catalysts for use with Nieco chain-driven charbroilers, the supplier of 90% of the Burger King Restaurants. Burger King plans to go global with emission control equipment on their chain-driven charbroilers. Other restaurants that use Nieco charbroilers in other locations are Red Robin and Carl's Jr.

Information from Las Vegas Valley Fire Safety Inspectors

Inspectors do not keep records of the number and location of charbroilers. They inspect the exhaust systems in commercial kitchens for capacity, according to the equipment that is under the hood. When the kitchen equipment is changed, the inspector certifies that the fire safety system is appropriate for that equipment. None of the local fire safety inspectors maintain a database, and they provided no information on charbroiler use or pollution control equipment.

CONCLUSIONS

Answers to Objective

Based on the results discussed in the previous section, the following answers are provided to the questions listed in our objective for the project:

1. There are approximately 2,000 facilities in the Las Vegas Valley which the consultant team would classify as restaurants.

2. Approximately 73 percent of these facilities have charbroilers (1400 facilities). Approximately 56 restaurants have chain-driven charbroilers. The remainder have underfired charbroilers, except for a few which have both.

3. Of the approximately 78.15 million pounds of meat charbroiled or griddle fried in the Las Vegas Valley each year, approximately 56% (or 43.8 million pounds) is hamburger , 37.4% (or 29.2 millions pounds) is steak, 4.4% (or 3.4 million pounds) is chicken and 2.2% (or 1.75 million pounds) is fish.

4. The total estimated particulate emissions from charbroiling and griddle frying of meat in the Las Vegas Valley is 1.5 million pounds per year (750 tons per year). The majority of these particulate emissions would fall within the $PM_{2.5}$ category, so PM_{10} and $PM_{2.5}$ emissions are approximately equal. Volatile Organic Compound (VOC) emissions from the same sources are estimated at 143,000 pounds per year (71.5 tons per year).

5. Other than the standard coarse filters used in most ventilation hoods, the types of air pollution control equipment used by Las Vegas Valley restaurants are as follows:

    - Sixty-one percent of chain-driven charbroilers at fast food restaurants use catalytic oxidizers.

    - Some three-stage paper filtration units (VentMaster) are used.

    - The MGM Theme Park restaurants use a single electrostatic precipitator.

The vast majority of griddle and underfired charbroiler emissions are uncontrolled. The only regulatory program so far that results in significant increases in the use of pollution control devices is the SCAQMD program which requires catalytic oxidizers as BACT on chain-driven charbroilers. SCAQMD requirements are, in fact, leading some fast food chains to install catalytic oxidizers nationwide, and at least one chain plans to install them worldwide. Research continues on technology which will meet SCAQMD economic cut-offs for BACT in controlling pollution from underfired charbroilers, which are the major emissions source.

Other Conclusions

In addition to the answers to the questions in our study objective, we wish to provide the following additional observations and conclusions:

- The Las Vegas Valley has a lower percentage of chain-driven and a higher percentage of underfired charbroilers than the Los Angeles Basin.

- Our estimate of chain-driven charbroiler emissions is only 1.7 percent of our total emissions estimate for all restaurant PM sources. SCQAMD estimates 4 per cent of their total restaurant PM emissions come from chain-driven charbroilers.

Significant reductions in PM emissions, especially in the Las Vegas Valley, from charbroiling will require development of low cost control technology for underfired broilers.