



# Project Summary

## Emissions from Street Vendor Cooking Devices (Charcoal Grilling)

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The U.S. EPA, working through the Clean Air Technology Center (CATC) and the U.S.-Mexico Border Information Center on Air Pollution (Centro de Información Sobre Contaminación de Aire Par la Frontera entre EE.UU. y México, or CICA), along with the Mexican Instituto Nacional de Ecología (INE), has jointly initiated a program to establish a reliable emissions inventory for street vendor cooking devices (charcoal grilling), a significant source of air pollutants in the Mexicali-Imperial Valley area.

*This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### Overview

Emissions from street vendor cooking devices, prevalent in the streets of Mexicali, Mexico, were investigated experimentally by measuring levels of particulate matter (PM), particle size distributions, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), aldehydes, and oxides of nitrogen and sulfur, emitted when meat is cooked on a grill over a charcoal fire. The test grill was carefully chosen to simulate street vendor cooking devices in Mexicali. Nine test runs were planned for the program. In order to investigate the emission rate, both beef and chicken were tested. Furthermore, both meats were marinated

with a mixture similar to that used by street vendors. Initially, it was planned to use only charcoal from Mexicali; however, difficulties in obtaining sufficient quantities necessitated using local charcoal for some of the tests. Both types of charcoal were compared to ensure similar physical and chemical properties. Some of the tests conducted were with non-marinated beef for comparison. Two blank runs were performed sampling charcoal fires without meat. Finally, a simple control device, normally used in an exhaust fan to trap grease over a kitchen stove, was evaluated for its effectiveness in reducing emissions. A summary of the test condition is shown in Table 1.

Each test run averaged approximately 3 hours of charcoal burning, of which meat-cooking lasted 1 to 2 hours. For each test run, approximately 5-6 kg of meat was cooked, and an average of 6 kg of charcoal was burned. Total PM and SVOCs were sampled using the EPA MM5G Method. PM with aerodynamic diameters equal to and below 10  $\mu\text{m}$  ( $\text{PM}_{10}$ ) and 2.5  $\mu\text{m}$  ( $\text{PM}_{2.5}$ ) were evaluated using an Andersen Mark III inertial cascade impactor. VOCs were sampled using SUMMA canisters. VOC and SVOC samples were analyzed by a GC-Mass spectrometer. Aldehydes were sampled using DNPH cartridges and analyzed by High Performance Liquid Chromatography (HPLC) as described in EPA Method 1P-6A. Carbon monoxide (CO), oxygen ( $\text{O}_2$ ), carbon dioxide ( $\text{CO}_2$ ), nitric oxide (NO), total hydrocarbons (THCs), and sulfur dioxide ( $\text{SO}_2$ ) were measured with continuous emission monitors (CEMs).

All of the emission parameters measured during the test runs are shown in Table 1. The summary of test conditions appears to be reasonable, except for the SO<sub>2</sub> measurements. Wide fluctuations of the SO<sub>2</sub> CEM readings for all the test runs suggest a malfunction of the SO<sub>2</sub> instrument or that the measuring range of the instrument was too high for the low level of SO<sub>2</sub> present. Emission results of the test runs are summarized in Tables 2 to 4. The results are tabulated as emissions based on total cooking time (Table 2), emissions per unit weight of meat and charcoal used (Table 3), and emissions per unit weight of meat cooked (Table 4).

## Conclusions

Based on an analysis of the test results, the following can be concluded about emissions from street vendor cooking devices:

- Emissions of total PM, total VOCs, and total SVOCs from street vendor cooking are basically the result of cooking meat; i.e., charcoal does not contribute to the emissions.
- Marinated meat yields increased total VOCs and total PM emissions compared to non-marinated meat.
- There are no significant differences in emission rates between chicken and beef.
- Emissions of CO and NO derive from the charcoal fire rather than the cooking meat.
- Emission of THC is almost entirely due to the initial burning of HCs present in the charcoal. THC emission was confined only during the first half hour of charcoal light off.
- Based on very limited observations, the simple screen placed in the stack (emission control device) appeared to be very effective in reducing emissions of PM, VOCs, SVOCs, and THCs from the street vendor cooking devices; however, since only one test was performed to evaluate this device, the results cannot be considered conclusive.
- Particle size distribution of all the test runs was very similar. Most particles had an aerodynamic diameter of less than 2.5 µm (PM<sub>2.5</sub>). Only 20 wt% of the particles had aerodynamic diameters between 10 and 2.5 µm.

Test Number	Type of Meat	Marinade	Emission Control
MC1	Beef	Yes	No
MC2	Chicken	Yes	No
MC3	Beef	No	No
MC4	None	None	No
MC5	None	None	No
MC6	Beef	Yes	No
MC7	Chicken	Yes	No
MC8	Beef	No	No
MC9	Beef	No	Yes

Test Number	Test Condition	NO	THC	PM	CO	Aldehydes	VOCs	SVOCs
MC1	Beef - Marinade	5.21	20.38	18.06	385.6	2.579	2.334	0.0056
MC2	Chicken - Marinade	16.46	20.17	22.65	376.3	2.160	2.383	0.0259
MC3	Beef - No Marinade	8.46	13.20	19.53	462.9	1.976	2.169	0.0152
MC4	Charcoal Only	13.15	1.43	1.27	435.7	0.360	0.253	ND*
MC5	Charcoal Only	16.34	4.53	2.81	494.3	0.346	0.485	ND
MC6	Beef - Marinade	14.16	6.89	32.49	484.3	3.177	2.941	0.006
MC7	Chicken - Marinade	6.62	3.53	34.94	556.7	3.281	3.607	0.0087
MC8	Beef - No Marinade	5.17	14.47	30.41	518.1	2.819	2.598	0.003
MC9	Beef - No Marinade - control screen	6.26	1.19	23.70	574.5	1.776	1.157	ND

\*ND - none detected

Test Number	Test Condition	NO	THC	PM	CO	Aldehydes	VOCs	SVOCs
MC1	Beef - Marinade	2.55	9.98	8.85	188.9	1.263	1.105	0.002
MC2	Chicken - Marinade	7.85	9.62	10.80	179.4	1.030	1.089	0.0116
MC3	Beef - No Marinade	3.33	5.19	7.68	182.1	0.777	0.826	0.0053
MC4	Charcoal Only	5.98	0.65	0.58	198.1	0.163	0.115	ND*
MC5	Charcoal Only	10.30	2.85	1.77	311.5	0.218	0.300	ND
MC6	Beef - Marinade	4.35	2.11	9.97	148.7	0.975	0.866	0.0018
MC7	Chicken - Marinade	1.90	1.02	10.05	160.2	0.944	0.998	0.0022
MC8	Beef - No Marinade	1.35	3.77	7.91	134.8	0.734	0.653	0.0008
MC9	Beef - No Marinade - control screen	1.51	0.29	5.71	138.5	0.428	0.268	ND

\*ND - none detected

<b>Table 4.</b> Total Emission per Unit of Meat, g/kg of meat cooked								
Test Number	Test Condition	NO	THC	PM	CO	Aldehydes	VOCs	SVOCs
MC1	Beef - Marinade	2.36	9.21	8.16	174.3	1.165	1.055	0.0025
MC2	Chicken - Marinade	6.37	7.80	8.76	145.5	0.835	0.921	0.0100
MC3	Beef - No Marinade	3.32	5.19	7.67	181.8	0.776	0.852	0.0060
MC4	Charcoal Only	NA*	NA	NA	NA	NA	NA	NA
MC5	Charcoal Only	NA	NA	NA	NA	NA	NA	NA
MC6	Beef - Marinade	4.70	2.29	10.79	160.8	1.055	0.977	0.0020
MC7	Chicken - Marinade	2.02	1.08	10.68	170.2	1.003	1.102	0.0027
MC8	Beef - No Marinade	1.45	4.06	8.52	145.2	0.790	0.728	0.0008
MC9	Beef - No Marinade - control screen	1.76	0.33	6.64	161.1	0.498	0.325	0
*NA - not applicable								

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**Paul M. Lemieux** is the EPA Project Officer (see below).

*The complete report, entitled "Emissions from Street Vendor Cooking Devices (Charcoal Grilling)," (Order No. PB99-146995; Cost: \$33.00, subject to change) will be available only from*

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