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Title: PM2.5 Technology Assessment and Characterization Study in New York State (PMTACS-NY)
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Cost Sharing Partners: New York State Energy Research and Development Authority (NYSERDA) and New York State Department of Environmental Conservation (NYSDEC)
Research Category: Particulate Matter EPA "Supersites" Program
Sorting Code: 99-NCERQA-X1
Project Period: July – September 2003

Objective of Research:

As a result of recent clinical and epidemiological studies (NRC, 1998) associating adverse health effects in humans and fine particle mass, a new National Ambient Air Quality Standard for $PM_{2.5}$ mass (15 $\mu g/m^3$ annual and 65 $\mu g/m^3$ 24-hr average) has been promulgated in the United States (Federal Register, 1997). Significant scientific and technical issues surrounding the mitigation of the warm season PM2.5 /co-pollutant complex and its interdependence with O_3 air quality through coupled photochemical pathways, common precursors, and similar dependencies upon meteorology must be addressed if effective control strategies are to be implemented.

The long-term monitoring of the PM2.5/co-pollutant complex and its precursors at urban and regional representative sites provides the opportunity to track the impact of emission controls and their effectiveness on air quality. These data can to be used to verify that implemented PM2.5 primary and secondary precursor (including ozone precursor) emission controls are performing according to specifications and verify that PM2.5 and ozone air quality has responded to the emission changes achieved as expected. Without adequate monitoring systems to track the progress and effectiveness of implemented control programs, the air quality management approach remains unaccountable.

The PMTACS-NY Supersite program provides a unique and unparalleled opportunity to enhance our understanding of ozone/$PM_{2.5}$-precursor relationships and track progress in current precursor emission control programs and assess their effectiveness in achieving expected air quality responses. The impact of this research is highly significant, providing a sound scientific basis for informed effective decisions in the management of air quality in New York and will benefit its citizens both environmentally and economically.

The PMTACS-NY is designed around three major objectives and addresses a series of science policy relevant questions related to hypotheses to be tested using measurement data collected under the program. The subject quarterly reports provide highlights on the overall program status, the progress made in the context of the specific tasks associated with the three program objectives, identification of outstanding issues, project schedule and completion status by task, and a budget analysis.

Progress Summary/Accomplishments:

Objective I. Measure the temporal and spatial distribution of the PM2.5/co-Pollutant complex including: SO_2, CO, VOCs/Air Toxics, NO, NO_2, O_3, NOy, H_2CO, HNO_3, HONO, PM2.5 (mass, $SO4^{=}$, NO_3^-, OC, EC, Trace Elements), single particle aerosol composition, CN, OH and HO_2 to support regulatory requirements to develop cost effective mitigation strategies PM2.5 and its co-pollutants and to establish trends in the relevant precursor concentrations to assess the impact of recent and future emission reductions in terms of emission control effectiveness and air quality response.

Measurements at our two rural sites Whiteface Mountain and Pinnacle State Park and at our two urban sites IS 52 in the South Bronx and PS219 in Queens operated during this quarter as outlined in Table 1 of the QAPP.

We just learned that the construction of the NYS DEC's Queens College permanent monitoring facility would not be completed in time to host the PMTACS-NY winter intensive field study. We are currently exploring alternate deployment options with Queens College, using existing space on the campus.

Objective II. Monitor the effectiveness of new emission control technologies [i.e. Compressed Natural Gas (CNG) bus deployment and Continuously Regenerating Technology (CRT)] introduced in New York City and its impact on ambient air quality, thorough remote open path roadside, mobile platform, and fixed site measurements of CO_2, CO, NO, H_2CO, HONO, CN and aerosol chemical composition.

On July 29th we briefed MTA on a summary of our findings on particle and gaseous emission testing of diesel and CNG buses studied in New York City and its comparison with results from recent laboratory chassis dynamometer testing performed by DEC and collaborators on MTA buses. Figure 1 provides a summary of the non-refractory particulate matter (NRPM) emissions for a variety of vehicles sampled with the Aerodyne mobile platform during the summer 2001 field campaign. The Aerosol Mass Spectrometer used in these studies does not measure refractory materials (e.g. metals and elemental carbon) hence the designation NRPM. The comparison of in-use MTA Series 50 diesel power buses with and without Continuous Regenerating Technology CRT (diesel filter trap) control technology showed ~ 60% reduction in NRPM. The bar graph reports the mean values of the measured emissions; the number of vehicles sampled (i.e. "N=") within the designated classes and the standard deviation of the measured emission (vertical line overlaid on the bar graph).

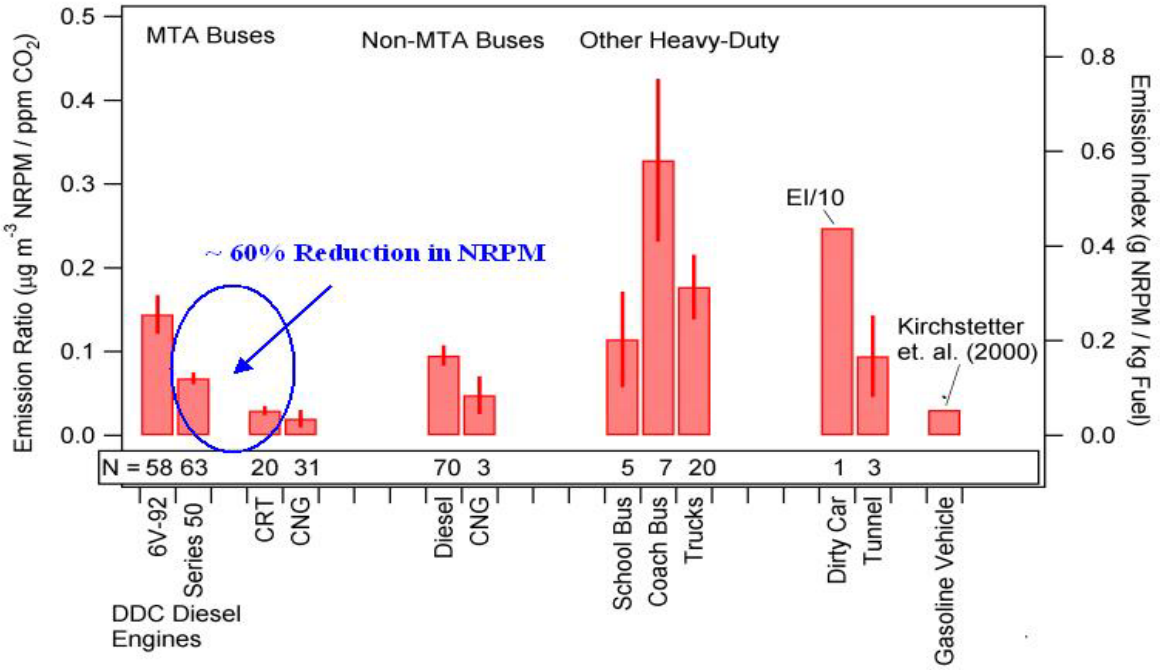

Figure 1. Non-refractory PM emission ratio and emission index for a variety of in-use vehicles as measured by a mobile platform sampling the exhaust plume during a chase event.

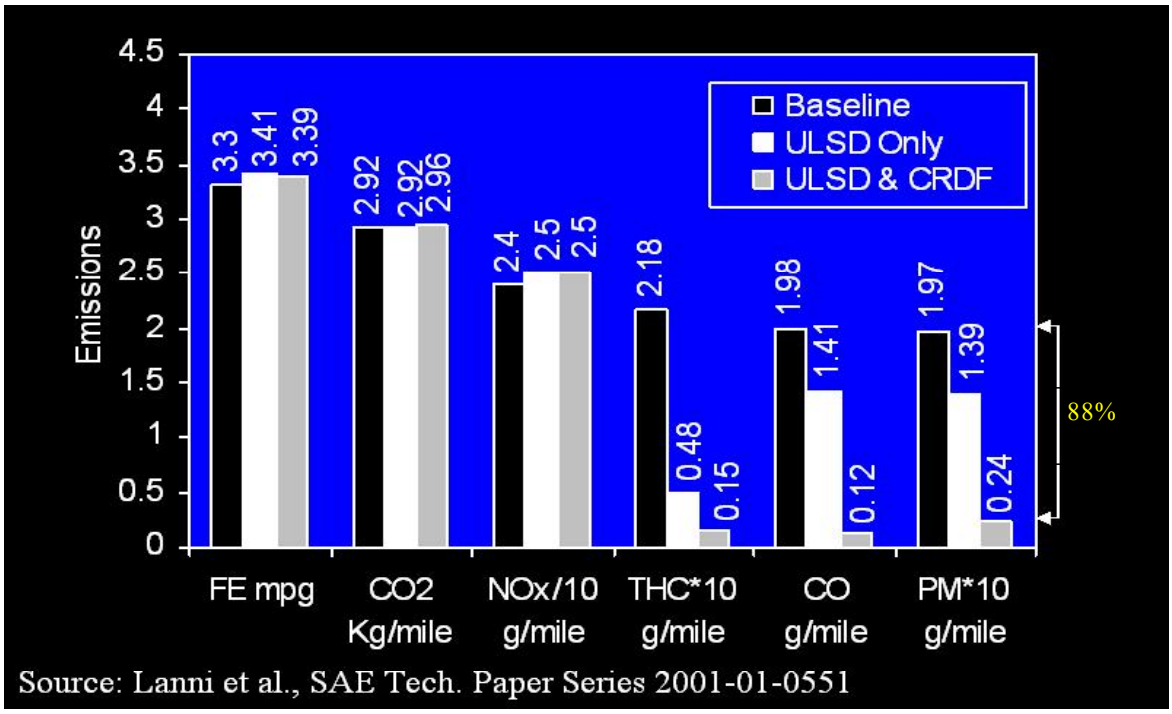

Figure 2. Dynamometer DDC S50 emissions results CBD Cycle: Baseline, with and without CRDPF; CBD=central business district; ULSD=ultra-low sulfur diesel

A comparison of the PM emission reduction observed in the Series 50 diesel powered buses as report in the in-use chase study experiments with chassis dynamometer emission testing

experiments for similar bus systems is shown in Figure 2. The chassis dynamometer emissions data indicate an 88% reduction in PM emissions when compared to the Series 50 diesel powered buses with and without the CRT-DF trap control technology. The dynamometer experiments use filter-based gravimetric techniques to measure PM mass and therefore in principal measure both the refractory and non-refractory materials. If we assume that the majority of the refractory material is elemental carbon and that the typical EC/OC fraction in diesel is ~ 3/1 (see table 3D-4a), the 60% reduction is consistent for the OC only measurement.

TABLE 3D-4a. ORGANIC AND ELEMENTAL CARBON FRACTIONS OF DIESEL AND GASOLINE ENGINE PARTICULATE MATTER EXHAUST

	Organic Carbon	Elemental Carbon
Heavy-duty diesel engines[a]	19 ± 8%	75 ± 10%
Heavy-duty diesel engines (SPECIATE)[b]	21 - 36%	52 - 54%
Light-duty diesel engines[c]	30 ± 9%	61 ± 16%
Light-duty diesel engines (SPECIATE)[b]	22 - 43%	51 - 64%
Gasoline engines (hot stabilized)[a]	56 ± 11%	25 ± 15%
Gasoline engines ("smoker" and "high emitter")[a,c]	76 ± 10%	7 ± 6%
Gasoline engines (cold start)[a]	46 ± 14%	42 ± 14%

[a]Fujita et al. (1998) and Watson et al. (1998).
[b]U.S. EPA SPECIATE database.
[c]Norbeck et al. (1998).

Source: U.S. Environmental Protection Agency (2002).

We were also soliciting MTA interests in supporting further mobile platform chase studies for our NYC winter field intensive. Although they have found these research results to be of great interest and are gratified to see that the control technologies they have introduced on their fleet are performing well, they feel it is not in MTA's mission to research and monitor its emissions, but highly recommend and support measurement studies of this kind to agencies with such missions. There were no further measurements planned or performed with this technology during this quarter.

Objective III. Test and evaluate new measurement technologies and provide tech-transfer of demonstrated operationally robust technologies for network operation in support of the development of process science and observation based analysis tools and health based exposure assessments.

In our previous quarterly report we discussed our on-going FDMS field evaluation and intercomparison studies. During this quarter the FDMS instruments experience several

operational malfunctions related to water management problems experienced by the system under high temperature and humidity conditions. The systems were returned to R&P for an engineering design upgrade that is expected to improve the water management system and minimize this problem in the future. In addition, we would like to correct a misstatement made in our last quarterly report regarding an operational detail of the FDMS system, that is, it is the FDMS purge filter that is maintained at 4°C and not the TEOM mass sensor head as was stated in the previous report.

Presentations and publications: 1) July 29, 2004, Metropolitan Transit Authority, "Particle and Gaseous Emission Testing of Diesel and CNG Buses in New York City"; 2) July 31, 2004 EPA Region II, Briefing "PM2.5 Technology Assessment and Characterization Study in New York – PMTACS-NY; 3) September 11, 2004 Seminar John Hopkins Bloomberg School of Public Health "U.S. EPA Speciation Trends Network: Summary and Brief Review of the PM2.5 Speciation Data Set"; 4) September 26, 2003, Seminar SUNY College of Environmental Science and Forestry, Department of Chemistry "Characterization of PM2.5 Air Quality and Sources in New York". Publication: 1) F. Drewnick, J. J. Schwab, O. Hogrefe, S. Peters, L. Husain, D. Diamond, R. Weber and K. L. Demerjian, Intercomparison and Evaluation of Four Semi-continuous PM-2.5 Sulfate Instruments Atmospheric Environment, 37 (2003) 3335-3350.

Future Activities and Outstanding Issues: During the next quarter planned activities include: 1) participation in NYSERDA EMEP conference October 7-8; 2) participate in the 3rd annual Environmental Symposium at Syracuse, October 27-28; 3) identification of a host site for 2004 winter intensive field study; and 4) planning for the winter 2004 field campaign deployment.

Supplemental Keywords: ambient air, atmospheric aerosols, ozone, particulate matter, metals, nitrogen oxides, sulfates, organics, atmospheric chemistry, monitoring, measurement methods, northeast air quality.

Relevant Web Sites: http://www.asrc.cestm.albany.edu/pmtacsny/