Project Summary

Texas Department of Transportation

0-5191: Investigation of Control Strategies for 8-Hour Ozone Standard

Background

Emissions that lead to the formation of ozone have distinctive temporal patterns, and the chemistry of ozone formation is non-linear and introduces time lags between emissions and ozone formation. As the transition is made between the 1-hour ozone National Ambient Air Quality Standard (NAAQS) and the 8-hour NAAQS, critical questions arise about the effectiveness of potential new mobile source control strategies for reducing 8-hour averaged ozone concentrations in Texas nonattainment areas.

What the Researchers Did

This project had two primary objectives. The first objective was to examine the relative effectiveness of potential new emission control measures, primarily from mobile sources, on 1-hour and 8-hour ozone concentrations and population exposure metrics in the Houston and Dallas areas. The first objective was addressed using the Comprehensive Air Quality Model with Extensions (CAMx) photochemical grid model. A total of 38 modeling simulations, summarized briefly in Table 1 (page 2), were conducted to examine a range of emission control strategies.

The second objective was to conduct a pilot-scale study to examine how portable emissions monitoring system (PEMS) technology can be used to characterize exhaust emissions from heavy-duty diesel vehicles and equipment during real-world driving conditions. This pilot-scale study demonstrated the successful deployment of the Sensors, Inc. SEMTECH-D PEMS on single-axle and tandem-axle dump trucks. Exhaust emissions were measured during typical Texas Department of Transportation (TxDOT) duty cycles, and a model emissions analysis was conducted.

What They Found

In the Houston/Galveston area, average differences in daily maximum predicted 1-hour and 8-hour average ozone concentrations due to the modeled emission control strategies shown in Table 1 ranged from 0.0 to 13.9 parts per billion (ppb) and 0.0 to 8.0 ppb, respectively. In the Dallas/Fort Worth area, average differences in daily maximum predicted 1-hour and 8-hour average ozone concentrations ranged from 0.0 to 8.7 ppb and 0.0 to 5.9 ppb, respectively. The modeling indicated that even with reductions in on-road and non-road mobile source emissions (as in “Bundle3”) greater than 40%, at least one monitor in each area is still predicted to remain in nonattainment.

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The PEMS pilot-scale study indicated that idling accounted for the most significant fraction (20%–46%) of the duty cycle and had the highest average and median fuel-specific emission factors for all pollutants. Differences in emissions between non-idling modes of operation varied by pollutant. CO_2 and NOx emissions were reasonably consistent between non-idling modes; CO and THC emissions exhibited greater variability with differences of a factor of two, or three in some cases. The range of NOx emission factors measured in this study showed very good agreement with emission factors measured through chassis dynamometer testing of the same engine types in previous studies.

Table 1 - Summary of 2010 modeled scenarios in the Houston/Galveston and Dallas/Fort Worth areas

Modeling Run	Description
Base 2010	Future year (2010) run with no additional reductions
VMT05LDV	5% reduction in light-duty vehicle emissions
VMT05HDV	5% reduction in heavy-duty vehicle emissions
VMT15LDV	15% reduction in light-duty vehicle emissions
VMT15HDV	15% reduction in heavy-duty vehicle emissions
VMT25LDV	25% reduction in light-duty vehicle emissions
VMT25HDV	25% reduction in heavy-duty vehicle emissions
VMT100HDV	100% reduction in heavy-duty vehicle emissions
I/M (Inspection & Maintenance)	Expand OBD program statewide, reinstate I/M program in Chambers, Liberty, and Waller Counties
Idle [HGB only]	Eliminate emissions attributed to extended idling from heavy-duty diesel trucks
LEVII	Estimated potential emission reductions from adopting California Low Emission Vehicle (LEV II) standards in Texas over current Tier 2 standards
RVP	Reduce statewide RVP to 7.0 psi in all Texas counties that currently allow RVP above this value
CBCP [DFW only]	Estimated potential emission reductions from a credit-based congestion pricing (CBCP) scenario for Dallas
Construct_Shift [HGB only]	Restrict construction equipment from operating from 6 a.m. through 12 noon
Zero_Construct	Eliminate emissions from construction equipment
15dieselNOx	15% reduction from on-road and non-road diesel mobile source NOx
Zero_Marine [HGB only]	Eliminate emissions from commercial marine vessels
Bundle 1	Includes RVP, I/M, VMT05LDV, VMT05HDV, Idle
Bundle 2	Includes RVP, I/M, VMT15LDV, VMT15HDV, Idle, LEVII, 15dieselNOx
Bundle2.areapt25	Same as Bundle2 with additional 25 % reduction to area and elevated point source emissions
Bundle 3	Includes RVP, I/M, VMT25LDV, VMT100HDV, Idle, LEVII, 15dieselNOx, Zero_Construct, Zero_Marine

What This Means

Given the challenges towards demonstrating attainment, it is recommended that TxDOT continue to investigate eligibility for Texas Emission Reduction Program (TERP) funding to reduce NOx emissions from on-road heavy-duty diesel vehicles and non-road equipment (particularly diesel construction equipment) and continue to pursue effective emission control strategies that can be adopted both locally and statewide to assist in obtaining regional NOx reductions.

Although emissions during this mode of operation may represent a smaller fraction of the total emissions on a mass basis, TxDOT should continue to examine the idling practices of its dump trucks with respect to the impacts on both emissions and fuel consumption. TxDOT should continue to characterize baseline emissions from other on-road and non-road equipment besides dump trucks during typical operations. New fuels and fuel additives, as well as new after-market emission reduction technologies, will be emerging from TERP, the New Technology Research and Development (NTRD) Program, and similar state or national-scale incentive programs, and when eligible, should be selected for in-use evaluation on TxDOT equipment.

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