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LAKE MICHIGAN OZONE CONTROL PROGRAM

PHOTOCHEMICAL MODELING AND DATA ANALYSIS PRELIMINARY FINDINGS

Pursuant to the Clean Air Act Amendments of 1990 (and the Settlement Agreement in the case of Wisconsin v. Reilly, No. 87-C-0395), the States of Illinois, Indiana, Michigan, and Wisconsin must adopt revised implementation plans for ozone. These plans will include additional controls for volatile organic compounds (VOC), oxides of nitrogen (NOx), or both. To determine the most effective control path, photochemical grid modeling and ambient data analyses have been performed for LMOS Episode 1 (June 24-28, 1991) and Episode 2 (July 15-19, 1991). The purpose of this document is to summarize the major preliminary findings related to control preference based on the modeling and data analyses.

OVERVIEW OF MODELING AND DATA ANALYSES

A comprehensive emissions, meteorological, and photochemical modeling system has been developed as part of the Lake Michigan Ozone Study (LMOS). The photochemical model (Urban Airshed Model, Version V), as well as the emissions and meteorological models, are being evaluated using measurements from four episodes which occurred during the 1991 LMOS field program. Acceptable model performance has been achieved for the LMOS Episodes 1 and 2. (Testing continues for LMOS Episodes 3 and 4.) To determine the change in modeled ozone concentrations due to changes in precursor emissions, a series of model runs involving across-the-board reductions in VOC and NOx emissions were performed with UAM-V.

An independent assessment of the relative benefits of VOC and NOx control was made by analyzing the 1991 field data. These analyses focused on identifying areas of VOC- and NOx-limited conditions, reviewing measured ozone and NOx concentrations throughout the domain, and tracking the ozone and ozone precursor concentrations in the urban plume as it moves downwind over the Lake. Combined with a conceptual model of the formation and transport of ozone in the LMOS region, these analyses provide some information on the effectiveness of VOC and NOx control.

The data and the modeling both indicate NOx-limited conditions along the upwind boundaries, VOC-limited conditions in the Chicago/NW Indiana area (and, to a lesser extent, in Milwaukee and Grand Rapids), and NOx-limited conditions farther downwind. An important issue is the downwind extent of the region of VOC-limited conditions (i.e., the transition from VOC-limited to NOx-limited conditions downwind of Chicago/NW Indiana). According to the modeling, this distance is on the order of 100 miles, implying that VOC controls (in Chicago/NW Indiana) are more beneficial in the Chicago/NW Indiana area and in high ozone concentration areas in southeast Wisconsin and western Michigan. The ambient data, although limited spatially and temporally over the Lake, indicate that this distance may be closer (i.e., 50 miles), implying that NOx controls (in Chicago/NW Indiana) may be beneficial in southeast Wisconsin and western Michigan. Further modeling and data analyses may define this critical distance better.

Two caveats should be noted with respect to the modeling and data analyses:

* Modeling and data analyses have only been performed for Episodes 1 and 2. Episodes 3 and 4 need to be considered to provide for a more complete assessment.

* The modeling results reflect base year conditions. Future year changes in the mix and relative amount of local and transported precursor emissions will be the subject of more refined modeling.

FINDINGS

Based on the modeling and data analyses, several important conclusions should be noted:

* Across-the-board VOC control...

  will reduce peak daily ground-level ozone concentrations in and downwind of Chicago/NW Indiana

  will be less effective in reducing peak daily ground-level ozone concentrations far downwind (beyond 100 - 200 miles from Chicago/NW Indiana)

* Across-the-board NOx control...

  will increase ground-level ozone concentrations in the Chicago/NW Indiana area and in areas downwind where the highest modeled concentrations occur will reduce ground-level ozone concentrations farther downwind (beyond 100 miles of Chicago/NW Indiana) in areas where the modeled concentrations are less than the National Ambient Air Quality Standard for ozone

may reduce ground-level ozone concentrations within 100 miles, and as close as 50 miles, downwind of Chicago/NW Indiana

will produce increases in ground-level ozone concentrations of greater magnitude than decreases in ground-level ozone concentrations

of upwind NOx sources may reduce ground-level ozone concentrations coming into region

* Elevated source NOx control...

  will increase ground-level ozone concentrations under certain conditions and for certain sources in the near source region

  will reduce ground-level ozone concentrations farther downwind (beyond 100 miles, and possibly as close as 50 miles)

  will produce lesser increases and decreases in ground-level ozone concentrations than surface-level source NOx control

* Boundary conditions...

  significantly affect modeled ozone concentrations in the Lake Michigan area

  are currently so high (i.e., 80 - 100 ppb) that a possibly unachievable (and infeasible) level of local control would be needed to model attainment

  in future years are somewhat uncertain due to questions about projected regional emission inventories and regional (ROM) modeling methodologies

  can be reduced in future years most effectively through a National control strategy developed and implemented by USEPA