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Category: 58 — Rural Areas

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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Research Triangle Park, North Carolina 27711

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SUBJECT: Application of RACT to Point Sources of VOC in Rural Areas

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TO: Joel Horowitz
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In recent weeks, members of my staff have been examining the pros and cons of the subject issue. During the past week, additional source material has been reviewed, tentative conclusions have been discussed with CR&D personnel, and a meeting has been held with Walt Barber to air these views. As a result of these activities, the enclosed discussion of the pros and cons of applying RACT in rural areas has been prepared. Although there are some uncertainties, our conclusion is that the weight of the available technical evidence dictates against imposing RACT on all point sources of NMHC in rural areas. There is a "gray" area which will warrant further monitoring on a case-by-case basis. Clusters (e.g., at least 3 or 4) of VOC point sources with interacting plumes, which are also exposed to NOx concentrations greater than .01 ppm, may have some potential impact on ambient ozone concentrations. NOx levels of this magnitude may be present if the industrial source complex is within about 20 miles of a small (50,000 - 200,000) city or if substantial (eg., >100 TPY) NOx emissions result from the industrial complex of sources. Inclusion of this caveat is based on modeling studies which show a small buildup of ozone on the second day of irradiation in an air parcel subject to continuous injection of fresh NMHC and NOx precursors, and upon small occasional ozone buildups observed over short sampling times in VOC point source plants exposed to NOx levels greater than about .01 ppm. Since it is likely that most such industrial complexes occur within the area of influence (i.e., the circle theory, of cities greater than 100,000, such case-by-case monitoring should be necessary only on relatively few occasions.

Enclosed is a discussion and listing of pros and cons concerning RACT in rural areas.

Robert E. Neligan

Enclosure

cc: W. Barber
R. Campbell
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Question

Should all point sources of volatile organic emissions located in the Eastern part of the U. S. be required to apply RACT?

Issue and Purpose

It is generally agreed that ozone is an area-wide problem with broad areas of the Nation suspected to be in violation of the ozone standard. Recently, designations of non-attainment areas for ozone were based primarily on measured ambient violations of the ozone standard (except in those areas where the States have designated areas as non-attainment with such data). Since ambient ozone monitors are not operated in many areas of the Nation, no direct evidence of violations of the ozone standard can be obtained. This situation is true in many parts of the South and Southeast. Consequently, many of these areas have not been designated as non-attainment even though it is believed that violations would be measured if ambient monitors would be placed in such areas. Under the control requirements set forth by the Clean Act Amendments and by EPA, only those areas that have been designated as non-attainment areas will be required to adopt control regulations. In other words, no controls will be required by EPA on existing sources in those areas that have not been designated as non-attainment areas. However, States may control such sources and are encouraged to do so.

Recently the State of New Jersey filed suit with EPA with respect to EPA's policy of designating attainment and non-attainment areas for ozone. The State of New Jersey claims that ozone and precursors are transported from broad areas upwind of their State. They state that since sources upward of New Jersey contribute to New Jersey's problem, that such sources should be controlled (by EPA requirement).

The purpose of this paper is to examine the technical basis for requiring RACT on stationary point sources in the Eastern part of the nation.

Discussion

Ozone is formed in the presence of organics, oxides of nitrogen, and sunlight. Our current understanding of ozone formation indicates that the prevailing ratio of non-methane hydrocarbons (NMHC) to NOx is especially critical to formulation of effective control strategies to reduce ozone-forming potential in the atmosphere. More specifically, when the ambient ratio of NMHC to NOx is low (i.e., less than 15 to20), there is strong likelihood that reducing ambient levels of organic pollutants will reduce ambient ozone levels. Typically, ambient NMHC/NOx ratios of about 10 are found in most urban areas (i.e.,200,000 population). On the other hand, when NMHC/NOx ratios exceed30, the sensitivity of ozone formation potential to changes in NMHC levels in the mixture is minimized. Typically, low NO2 concentrations are found in areas outside of major urban areas. This was demonstrated in the "circle" paper which essentially became the supporting basis of EPA's NMHC control requirements in urban areas with a population in excess of 200,000. The underlying rationale for these requirements was that if NOx is low, NMHC/NOx ratios are likely to be high. In general, in areas with a ratio in excess of 30, ozone-forming potential is most sensitive to

changes in levels of NOx. Since measured rural NMHC and NOx concentrations are both typically very low (generally about 0.1-0.2 ppmO and about .005-.007 ppm, respectively), the smog-forming potential of rural areas is low and it is doubtful that RACT applied to rural NMHC point sources would make any substantive difference in ambient ozone.

There is, of course, some technical uncertainty to this hypothesis. One alternative hypothesis is that organics emitted over broad geographic areas can be transported long distances. It has been suggested that organics emitted in non-urban areas may, under the presence of multi-day atmospheric stagnation conditions participate in ozone formation. Under this hypothesis, non-urban organics can become mixed with an urban plume which has sufficient NOx to participate with the non-urban organics to form ozone. There is little, if any, documentation to support this theory; however, it appears conceivable that such conditions could exist. On the other hand, there is some information which suggests that this may not be a significant mechanism. For example, available information on transported organics indicates that extremely low ambient hydrocarbon concentrations are measured in areas outside of urban areas. This is evidenced by examining the St. Louis RAPS data base which measured NMHC at varying distances from the urban area and measurement of NMHC during several special studies conducted for EPA. Non-methane hydrocarbon concentrations at the peripheral or rural sites are extremely low in comparison with urban concentrations. Although limited observations suggest that certain hydrocarbons can be transported long distances aloft overnight, it does not appear that these concentrations are high or that high concentrations of hydrocarbons are generated by natural sources. High ambient ozone concentrations have been observed simultaneously over large areas of the Eastern U.S. Ozone transported aloft overnight is stable enough so that it can impact far downwind the next day. However, the half life of ozone is much shorter during daytime so that it is questionable whether ozone formed on one day impacts significantly on ambient levels observed two days hence. Thefore going observations suggest that organic emissions from the South and Southeast do not contribute to the ozone problem in New Jersey. If they do participate in ozone formation, it is probable that they contribute to the ozone problem in New Jersey. If they do participate in ozone formation, it is probable that they contribute over a more limited geographic area (say within 50-300 miles). According to the NEDS hydrocarbon point source emission inventory, 98% of all point sources within 300 miles of Trenton are within counties which have been designated as non-attainment areas.

Given the technical uncertainties described above, and the magnitude of the urban emissions and the generally limited resources available to most control agencies, the current EPA oxidant control strategy concentrates its control efforts on urban sources of organics. The pros and cons of expanding this strategy to includepoint sources of organics outside of urban areas are discussed below.

Pros of Ract in Rural Areas

1. It is likely that non-attainment of the NAAQS for oxidant is more widespread than current designations imply. This is suggested by aircraft data as well as ground level data at rural sites which have already been declared non-attainment areas.

2. Transport of high ozone concentrations at ground levels has been documented in the Northeast for over-water trajectories and in Texas over distances of about 200-300 miles.

3. Multi-day stagnation periods occur relatively frequently during the Summer/Autumn in the Eastern U.S. Four day episodes have occurred at least 10 times in 35 years. It is likely that 2-3 day episodes have occurred as well.

4. Although NOx concentrations are generally low in rural areas, non-negligible concentrations are detected in rural areas occasionally. Typical NO2 concentrations are in the noise range of commercially available instruments. Peak hourly NO2 concentrations observed at rural sites in EPA summer studies ranged from .02-.08 ppm. Such high concentrations don't necessarily coincide with meteorological conditions conducive to high ozone formation, however.

5. As population increases in the sun belt States, NOx emissions may increase. In future years, control of NMHC in such areas may be more effective. Presumably, the increase in NOx emissions will increase available NOx to participate in ozone synthesis. Future urban VOCcontrols may result in NO2 levels increasing slightly further downwindfrom cities.

6. Although synthesis in rural areas is less than in urban areas,ozone decay is slower at night. This effect is particularly pronounced aloft at night, over water and over rural land masses. This slow decay in rural areas may allow buildup of ozone in rural areas during stagnation.

7. Ozone buildup has been observed in point source NMHC plumes, though infrequently. In three studies of isolated NMHC plumes in rural areas, at least 90% of the time no ozone buildup was observed in the plume. Small buildups (<0.03 ppm) were occasionally observed within about 15 miles of the source in the presence of NOx.* It is likely that such isolated plumes become diluted so that incremental impact on ambient ozone is negligible.

8. Modeling of small continued injections of NMHC and NOx has suggested the occurrence of increased O3 concentrations on the second day of irradiation at a time of day in which rural peaks are typically observed in the atmosphere. These peaks are less than those downwind of large urban areas, however. Presence of both NMHC and NOx is necessary for this phenomenon to be observed.

Cons of RACT in Rural Areas

1. Daytime half life of ozone is generally too short to make transport over 30-36 hours significant. Transported O3 aloft overnight is stable so that transport over 12-24 hours is likely to be significant. However, during daylight hours, ozone half life is likely to be less than 2 hours. At night, near the surface of a land mass, ozone half life in an urban plume appears to be about 2-3 hours, whereas over rural land, the half life appears to be less

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* These observations were made from aircraft and are for sampling periods much less than one hour.

than 14 hours.

2. Residence time of an air parcel within a stagnating high pressure system is more limited (2-6 days?) than presence of the system over the continental U.S. would suggest. Since ozone and precursors are carried along by the wind rather than a weather system, and wind speeds are characteristically low during periods of high ozone, the area of impact on a monitoring site is probably limited to 200-300miles.

3. Rural areas are typically characterized by low NOx concentrations and high NMHC/NOx ratios. Furthermore, rural NMHC measurements are typically low as well. Under such conditions, smog chamber experiments suggest that the ozone-forming potential of the air is low and that this potential would not be appreciably reduced by reducing ambient levels of NMHC.

4. Only very small ozone buildups (< .03 ppm) are occasionally observed in HC point source plumes. These observations are aircraft observations which are much less than one hour's duration. Frequently(>90% of the time), there is no observed buildup. It is likely that these plumes become so diluted that their impact on ambient O3 in urban areas is negligible.

5. Large O3 gradients are observed upwind and downwind from cities in contrast to rural regions. This implies that the major synthesis of ozone occurs in urbanized regions where there are ample quantities of NMHC and NOx. The stability of ozone transported aloft overnight may explain widespread high ozone concentrations which have been observed.

6. Upon review of the NEDS VOC point source emission inventory, 85% of the emissions reported from Regions I-V are within counties already designated as non-attainment. Ninety-eight percent of point source emissions within 300 miles of New Jersey are in designated non-attainment areas. It is unlikely that imposition of RACT on the remaining 15% of emissions (most of which are in Region IV) would have any impact on a Northeastern State such as New Jersey.