June 12, 1990

**MEMORANDUM**

Subject: Attainment Demonstration and Modeling Discussion for the South Coast FIP Notice of Proposed Rulemaking

From: John Vimont, Regional Meteorologist, Region IX

To: Dean Wilson, Model Clearing House, OAQPS

The following text is my proposed discussion on the "attainment demonstration" and modeling relative to the FIP. As we have discussed on the phone, the control measures in the FIP are not very explicitly defined. Most will ultimately take the form of "emissions from source type X will be reduced to zero by Y year." or will mirror a locally proposed rule and be backed off if the local rule proves to be sufficient.

I have tried to stress in several places that the analysis that has been done will necessarily be updated at a later time. The attainment date for CO is being proposed as 2000 and for $O_3$ as 2010. The assumptions built into an analysis, that relies heavily on projections that go out 20 years and on draconian measures to achieve the emission reductions, lead to far more uncertainty than the analysis techniques themselves. I have tried to disclaim the adequacy of the CO rollback as the ultimate analysis. However, since we have to rely on "backstop" measures to even get close to the needed emission reductions, I don't feel that we will gain any real insights into the solution to the CO problem by using more sophisticated analyses. I have explicitly included statements about the need for proper CO dispersion modeling.

Some of the hard numbers in the text are under revision, but the final estimates will be fairly close to the numbers cited herein. Please feel more than free to criticize the approach I have taken.

Attainment Demonstration

The Guideline on Air Quality Models (Revised) (EPA-450/2-78-027R, July 1986 & Supplement A, July 1987) provides recommendations on air quality modeling techniques that should be applied to State Implementation Plan revisions. It serves to identify, for all interested parties, those techniques and data bases EPA considers acceptable. It is not intended to be a compendium of modeling techniques. Rather, it should serve as basis by which air quality managers, supported by sound scientific judgment, have a common measure of acceptable technical analysis.

The federal plan, like State Implementation Plans, must provide an analysis to demonstrate that the identified control strategies in the plan are adequate to attain the NAAQS for $O_3$ and CO. This demonstration is generally accomplished through air quality dispersion modeling. Generally, the procedure consists of obtaining meteorological, air quality, and emissions data for inputs to the appropriate models; estimating the changes in emissions of existing regulations and future growth; then using the model to estimate the future year ambient air quality impacts and to estimate the emission reductions necessary to bring the ambient air quality levels down to the level of the NAAQS.

While implementation plans covering the complex problems and long time frames contemplated in this notice must "demonstrate attainment," the demonstration is not considered the final product dealing with the issue of analyzing the achievement of the standards. Revisions to the analyses must be carried out in order to account for improvements in our understanding of the technical issues associated with air pollution control and with more recent and accurate data on the variations of actual emission and growth patterns versus the projections upon which the plans are initially based. The attainment demonstration serves as an initial estimate of the level of emission reductions required to attain the standards, but will necessarily be modified and updated at a later time to ensure that the attainment goals will indeed be reached.

Ozone Modeling

The model preferred by EPA for $O_3$ SIP modeling is the Urban Airshed Model (UAM). The EPA proposes to use the UAM in its attainment demonstration. The most recent update to this model was used in the recent South Coast SIP. The model underwent rigorous model performance and sensitivity evaluations before it was used in the SIP development. The time period modeled covered a three day $O_3$ episode where ambient concentrations reached the design concentration of 0.36 ppm on the second and third days of the episode. The EPA will use the same modeling episode with some revisions to the base emission inventory, specifically the inclusion of running losses from mobile sources.

Ozone is not a directly emitted pollutant, but rather is formed in the lower troposphere through a series of chemical reactions involving volatile organic compounds (VOCs) and oxides of nitrogen ($NO_X$) in the presence of sunlight. The conventional approach to reducing $O_3$ concentrations, embodied in EPA's regulations, is to control VOC emissions rather than $NO_X$ emissions. The SCAQMD used the UAM to evaluate the feasibility of this conventional approach. It was found that when population and economic growth were taken into account, if all available VOC-only emission controls (controls which would affect VOC emissions with no impact on $NO_X$) were applied, the $O_3$ NAAQS could not be reached. The modeling analysis indicated that measures which significantly reduced $NO_X$, as well as VOC, would be required. The SCAB also exceeds the standards for $NO_2$ and $PM_{10}$ The $NO_2$ is formed from $NO_X$ emissions and the high $PM_{10}$ concentrations are heavily influenced by nitrate aerosols which are formed from $NO_x$ through a series of chemical reactions. Therefore, the SCAQMD is implementing $NO_x$ controls to reduce the ambient concentrations of $NO_2$ and $PM_{10}$

The underlying assumption made by EPA in estimating the emission controls necessary to attain the $O_3$ NAAQS, is that significant $NO_x$ emission reductions will occur, either through locally adopted measures or through changes accompanying VOC emission reduction measures. These $NO_x$ reductions, however, are not considered to be an integral part of the FIP emission controls, but rather a condition which must be considered in estimating the necessary VOC emission reduction targets. The modeling results indicate that by accounting for $NO_x$ in this manner, the estimate of the VOC reductions should represent the upper bound of the necessary control level which would bring the SCAB into attainment.

There are two methods by which the UAM can be used to indicate whether identified emission controls are sufficient to attain the standards. The most rigorous method involves applying each individual control measure to the appropriate source categories on a spatial and temporal basis and then run the model to see the effect on the ambient air quality. The other option is to reduce the emissions in a more generalized manner and use the model to identify, for lack of a better term, a "carrying capacity" of VOC and $NO_x$ which will bring the ambient concentrations down to the level of the NAAQS. The former method takes full advantage of the capabilities of the UAM model, but is highly dependent on the precision of the input data. The latter method yields a total emission reduction target without explicitly accounting for the subtleties of proposed controls, but it still has the advantage of providing an accurate simulation of the physical and chemical properties of the polluted urban atmosphere and the probable effects of controls.

For the Federal Plan, the EPA has used a combination of the above approaches. The SCAQMD SIP analysis took the first of the above approaches. The nature of the measures proposed in the Federal Plan does not, however, lend itself to such precise spatial and temporal specification. The SCAQMD analysis does establish a good estimate of what it will take to achieve the standards in the basin; it also applies controls to almost every conceivable source in the basin. From this a "carrying capacity" has effectively been established. Although the Federal measures are somewhat less precise than the locally proposed measures, they are being applied to the same sources. Therefore, the EPA is using the SCAQMD attainment analysis, with the aforementioned modifications to the emission inventory, to establish the carrying capacity of VOC and $NO_x$ and is comparing the emission reductions from the Federal measures against that carrying capacity for purposes of the attainment demonstration.

From the above analysis the EPA has determined that a VOC emission reduction of approximately 86% is necessary to bring the basin into attainment of the $O_3$ NAAQS. This is based on the assumption that the $NO_X$ emissions are reduced by 82%. As stated earlier, these numbers represent our current estimate. The target date for reaching attainment is well into the future. There will necessarily be a number of iterations of this analysis as we get more accurate estimates of the emissions and growth in the coming years.

Carbon Monoxide Modeling

The 8-hour primary NAAQS for carbon monoxide (CO) is frequently exceeded in the SCAB. The primary NAAQS for CO is defined as an ambient concentration of 9 ppm for an 8-hour average, not to be exceeded more than once per year. To demonstrate attainment, control strategies must be identified to reduce the "highest second high" CO concentration to the level of the 8-hour average CO NAAQS. For the SCAB, the "highest second high" ambient concentration is 23.4 ppm, which occurred during the night of 12-13 December 1988 at the Lynwood monitoring station in south-central Los Angeles county.

EPA guidance on carbon monoxide modeling is primarily focused on techniques for estimating hot-spot CO impacts (localized impacts from nearby roadways). The recommended techniques for hot-spot analyses utilize line source models which simulate the emissions and associated impacts from a very small number of roadway links. Data analysis, however, indicates that the CO non-attainment problem in the South Coast Air Basin is not solely related to hot-spots, but is rather a problem over a wide geographic area. EPA guidance on area-wide CO problems is to consider it on a case-by-case basis, without specifically identifying a recommended model. To further complicate the situation, the highest concentrations occur over this area under stagnation conditions (prolonged periods of very light winds). EPA does not have any recommended procedures appropriate for this circumstance. The guidance suggests that "...techniques specific to the situation and location must be developed. Such techniques might include empirical models or box models."

When the SCAQMD analyzed the CO problem in the basin, they chose to use a modified rollback approach wherein they assumed that the CO concentrations which have been measured at various monitors in the area are directly proportional to the CO emissions in the immediate vicinity of the individual monitor. They accomplished this by dividing the area into five kilometer grid cells and then assumed that the only emissions affecting a given CO monitor were from the grid cell in which the monitor happened to be located. EPA did not find that technique to be acceptable. EPA has concluded that emissions from a wider area must be considered when analyzing the elevated CO concentrations in the basin. Also, EPA guidance indicates that modified rollback techniques are not the most appropriate method for analyzing CO problems unless it shows that the area can be brought into attainment through the Federal Motor Vehicle Control Program.

The EPA has identified several possible modeling approaches for analyzing the area wide component to the CO problem in the South Coast Air Basin. One possibility is to use the RAM model, which is a gaussian plume model appropriate for use in evaluating urban area sources. Unfortunately, gaussian plume models do not adequately simulate the stagnation conditions of concern here. A technique which has been used under similar circumstances in Phoenix, Arizona and Denver, Colorado is to use the Urban Airshed Model to simulate the CO emissions and their impacts on the ambient CO concentrations. This model technically has the best treatment of this type of phenomenon, but also has extremely high data input requirements. Another possibility is the use of a ventilated box model. This technique has been used for evaluating high $PM_{10}$concentrations under stagnation conditions in several other parts of the country. These applications have primarily been in relatively confined, enclosed valleys. It has not been determined whether this modeling approach would be appropriate for the conditions which occur in south-central Los Angeles County. Some type of modified rollback could be used, albeit it lacks the technical underpinning EPA would find most desirable in an attainment demonstration. One assumption behind a rollback approach is that the monitoring locations used in the analysis are actually recording the highest concentrations in the area. The more rigorous modeling approaches allow the consideration of other receptors and the relative impacts of changes in the spatial and temporal distributions of emissions.

The EPA tested the RAM model to determine the potential for using it in evaluating the CO concentrations in the area, even though its formulation is not particularly well suited to evaluating stagnation conditions. When the model was tested for the stable conditions with a 1 m/s wind speed the concentrations were underestimated by a factor of 10. If the model was artificially constrained by assuming that the there was neutral stability with a very low mixing depth, then concentrations could be obtained that were close to the level of the observations. The data necessary to run the UAM was not available to test it, although it is potentially the best suited for simulating the conditions of concern.

The majority of CO emission reductions being proposed for federal implementation consist of reductions in on-road mobile source emissions, which constitute the vast majority of CO emissions in south-central Los Angeles County. The proposed emission reductions are similar to the Federal Motor Vehicle Control Program in that emission reductions will apply uniformly across the mobile sources inventory. Control strategies that dramatically affect traffic patterns and the distribution of the projected emissions are not being proposed in the federal plan for CO attainment. Also, while growth is projected to occur in this area, the basic patterns of traffic flow are not projected to change dramatically under the federal plan. Therefore, any of the above dispersion modeling approaches will essentially yield the same result as a modified rollback because of the uniformity of the changes in emissions.

The EPA is proposing to use a modified rollback approach, in spite of its inherent limitations. The EPA has concluded that the data bases to run the UAM, the model with potentially the best technical applicability, are not available at this time. The formulation of a gaussian plume model, such as RAM, does not adequately simulate the observed conditions. EPA has not identified a suitable box model for this application. The emission controls proposed in the federal plan affect the emission inventory in the same relative sense as the Federal Motor Vehicle Control Program. Therefore, for the purposes of this plan, using a modified rollback should yield a reasonable estimate of the controls necessary to attain the CO NAAQS. While this technique yields a reasonable estimate of what will be required, it can not yield information on areas which are not monitored. Therefore, EPA maintains that future modeling for the SCAB must be refined by using a suitable area-wide model combined with CO hot-spot analyses to adequately evaluate the total CO problem in the SCAB and that further controls may need to be identified as a result of that analysis.

From analysis of the data at the various monitoring locations in the SCAB, the EPA has defined a sub-area where the rollback analysis will be applied. EPA's selection of the sub-area is constrained by the traffic data available. The subset of data available for evaluating the emissions changes, including growth, were "Regional Statistical Areas (RSAs)," defined by Southern California Association of Governments (SCAG). The selected RSAs encompass the area where the highest CO concentrations have been measured and run from the Los Angeles Central Business District, west to the coast, and south to Long Beach. The overall VMT growth in these areas is projected to be approximately 13%. As discussed elsewhere in this document, the goal is to achieve attainment by 2000. Based on the design concentration of 23.4 ppm, emission reductions of at least 60%, relative to the 1987 baseline emissions, are necessary to bring ambient air quality levels down to the NAAQS.

<u>Emission Inventory and Mobile Source Controls</u>

The emission inventory used for the CO analysis is different than that assembled by the SCAQMD. Mobile source CO emissions are dependent on vehicle speed and on temperature; generally emissions increase as speed or temperature decreases. The SCAQMD used a temperature of 75°F for their analysis. The EPA's analysis was based on an ambient temperature of 59°F which is representative of conditions during high CO events in the area. The EPA emission estimates are based on the MOBILE4 emission model, modified to account for the California emission standards, whereas the SCAQMD analysis was based on CARB's EMFAC7-D emission model.

Table I identifies the base case emissions for 1987, 2000, and 2010 and the effects of the proposed controls on those emissions. The mobile emissions are based on traffic data for the RSAs listed above. The "offroad" emissions for this area were calculated based on an appropriate proportion of the total offroad emissions. Implementation of the various mobile source control measures identified in this table will result in a net emission reduction of approximately 46%, relative to the 1987 baseline emissions, by 2000. This still leaves a shortfall of

**Table I - Summary of CO emission reduction measures**

| | 1987 | 2000 | 2010 |
|---|---|---|---|
| Baseline On-road (TPD) | 1293 | 883 | 926 |
| Baseline Off-road (TPD) | 164 | 161 | 151 |
| Baseline Stationary (TPD) | 61 | 46 | 40 |
| Total Baseline (TPD) | 1,518 | 1,090 | 1,117 |
| Estimated Ambient CO Concentration (ppm) | 23.4 | 16.8 | 17.2 |
| Mobile Inventory after Control Measures (Cumulative Effect) | | | |
| Clean Fuels (TPD) | | 846 | 740 |
| RVP 10.0 (TPD) | | 722 | 632 |
| Oxygenated Gasoline (TPD) | | 606 | 591 |
| Total Cumulative Mobile Control Measures plus Stationary and Off-road (TPD) | | 813 | 782 |
| Estimated Ambient CO Concentration (ppm) | | 12.5 | 12.1 |
| Necessary Backstop Reductions (TPD) | | -197 | -166 |

approximately 200 TPD. The additional emission controls to achieve this reduction are obtained through the various backstop measures discussed elsewhere in this notice.