ATTAINMENT PROJECTIONS

Modeling is required to assess monitored exceedances of the PM10 NAAQS at all sites that cause the District to be classified as nonattainment for the 24-hour standard. Modeling is also required to evaluate contributions to the calculated annual average values at sites determined to be nonattainment of the annual standard. Modeling for each required site must determine whether emissions that contribute to PM10 at the site will be diminished sufficiently by existing and proposed emission reductions to achieve attainment of the federal PM10 standards at the earliest practical date.

ATTAINMENT DEMONSTRATION METHODOLOGY AND PROCEDURE

Analysis of PM10 concentrations uses emissions inventories, ambient data, meteorological analysis and mass balance and aerosol modeling.

The 1999 emissions inventory is used to represent the emissions associated with 1999 to 2001 annual average and 24-hour episode design value concentrations. The projected future year concentration is predicted based on annual and seasonal emissions inventories for the years 1999 and 2010. Each year is projected by source category, modified to address the disproportionate formation of nitrate particulates from reaction of nitrogen oxide emissions with ammonia in the atmosphere. The source contributions are projected for future years by increasing or decreasing the PM10 contribution assigned by modeling in proportion to changes in the emissions inventory that are projected to occur by the future year. The emissions projection considers regulatory action, population growth, predicted industry activity growth or decline and other related factors. Attainment is demonstrated if the predicted concentration is reduced sufficiently to achieve attainment of both the 24-hour and annual average PM10 standards.

Some of the observed PM10 sample is caused by emissions that are not included in the District's emission inventories, but are caused by natural sources or by emissions transported from areas outside the SJVAB. These emissions are indistinguishable from local emissions and must be estimated by evaluation of current technical literature. Because local control programs do not reduce natural emissions and emissions from outside the local region, these emissions are excluded from emission reduction calculations and added back to the resulting future year projection unchanged. The future year predicted concentration is the sum of the projected reduced local contribution plus the estimate of unaffected emissions.

Methodology for Simulation of Attainment Particulate Concentration

The Chemical Mass Balance Model (CMB version 8) was used to estimate source contributions for each site's design value.

For the annual analysis, monthly CMB source contributions were evaluated for February to December of the year 2000 and averaged with CMB episode analysis from January 2001 to determine the annual average composition comparable to the annual average design value. January 2001 episode data was used because the year 2000 reflected a lower PM10 level than the calculated design value. The January episode reflects the seasonal dominance of winter emissions and is therefore an appropriate adjustment to reflect the annual chemical composition. Other methods could have been used to adjust the 2000 annual monthly CMB contributions to match the required design value; however, scalar adjustments would have required recalculation of all monthly results and would have biased the annual value a few micrograms towards elevated geologic contributions that are not as reflective of actual seasonally elevated contributions. CMB modeling for the annual analysis was carried out for Bakersfield, Fresno, Hanford, and Visalia.

The 24-hour design values represent a specific day of monitoring at the site. CMB modeling requires day specific chemical composition data to determine how much each the various source types contributed to the observed PM10 concentration. In some cases the monitoring device or processing method for the filter sample used to obtain the concentration did not provide data on chemical species. Special procedures, in accordance with the modeling protocol, were used to provide chemical species data to perform modeling for design values that did not have full chemical data. Where a full compliment of speciated data was not available to support CMB modeling for a design day, either data from a nearby site on the same day were used, or data was used from the same site on an alternate day of the same time of the year that was similar in concentration. This is the best evaluation that can be made with existing data.

Supporting analyses included the examination of historical monitoring data, evaluation of source zones of influence, assessment of spatial representativeness of monitored episodes and meteorological and statistical analysis. Examining historical data provides the context for design value observations and an assessment of whether the design values are consistent with previous experience. Evaluation of source zone of influence is necessary for prediction of effects of control strategies with receptor and rollback techniques. Analyses of the spatial representativeness of monitored episodes is important to determine which episodes are dominated by local sources and which have significant contributions from larger portions of the region.

Inherent uncertainties in any modeling approach affect the accuracy of predictions. The rollback procedure is considered to be a conservative estimate, which means that attainment is likely to be achieved even if the actual future emissions are slightly more than the calculated future rollback inventory. However, other uncertainties in the modeling and projection process suggest caution in considering the outcome as conservative. The distance and position of sources relative to the monitoring site is not considered by CMB modeling; therefore, the effect of emissions changes for a source or source category may be greater or less than projected by the linear rollback method. The accuracy of the projection is dependent on the selection of speciation profiles that are appropriate to identify emissions sources in the area being modeled, the accuracy of CMB modeling, and the completeness, precision

and representativeness of monitoring data and emissions inventories for the locations modeled. Accuracy will be affected if the monitoring data or emissions inventories are not typical and representative of the community.

Sites to be Analyzed for Attainment Demonstration

The modeling evaluations include monitored exceedances of winter episodes dominated by secondary particulate formation in urban areas and fall episodes dominated by emissions composed of geologic material found in San Joaquin Valley (SJV) soil.

Fall events are usually dominated by material found in SJV soil that becomes entrained in the atmosphere due to a variety of urban and rural activities. Most of the observed exceedances dominated by material found in SJV soil have been observed in the fall, but it is also possible to have similar events related to high winds or unusual activities.

Winter 24-hour exceedances are identified as being dominated by urban combustion and evaporative emissions. Nitrate particulates are formed from reaction of combustion related nitrogen oxides with ammonia in the atmosphere. Carbon compounds are directly emitted or formed from combustion and evaporative gases. The largest urban communities experience the highest winter PM10 levels.

The cities expected to experience the highest fall and winter PM10 levels are monitored in accordance with federal requirements. Sites identified in the following tables have a design value that does not meet the applicable federal 24-hour or annual average NAAQS and are required to be analyzed for their future compliance.

Table 6-1
Federal 24-Hour PM10 Design Values

Site Name	Design Value	1999	2000	2001
Bakersfield - California Ave.	**190**	143	140	**190**
Bakersfield – Golden #2	**205**	183	145	**205**
Clovis	**155**	151	114	**155**
Corcoran – Patterson Ave. (two events with the same 174 value)	**174**	**174**	128	165
Fresno – Drummond	**186**	162	130	**186**
Fresno – First	**193**	154	138	**193**
Hanford - Irwin St	**185**	143	119	**185**
Modesto – 14th Street	**158**	132	112	**158**
Oildale - 3311 Manor St	**158**	156	122	**158**
Turlock – 900 Minaret Street	**157**	**157**	104	148

Design Value Column – bold indicates value exceeds standard
Year Columns - bold indicates observed value that set the Design Value

Table 6-2
Federal Annual Average PM10 Design Values

Site Name	Calculated by SJVAPCD	Reported in EPA Notice
Bakersfield - Golden #2	**57**	**55**
Fresno - Drummond	50	47-**53**
Hanford - Irwin St	**53**	**51**
Visalia - Church Street	**54**	**54**

Bold indicates value exceeds standard

CMB Source Profiles

The CMB model analyzes ambient particulate samples to estimate the relative contributions of different source categories to the measured particulate concentration by using the known chemical composition (profile) of likely contributing sources. CMB source profiles were derived from the EPA source profile library, local geological and burning profiles and chemical profiles representing California motor vehicle fuel, type, age, and emission factor data (EMFAC).

Specific source profiles representative of the sources in the area during the season in which the design day occurred were identified for the 24-hour design day at each site. Performance evaluation of each analysis estimates the quality of the statistical fit of the source profiles to the observed event. Profiles were selected based on review of sources appropriate for the time of year, related emissions activities, and meteorological analysis to determine the probable area of contributing sources influencing the observation. CMB modeling has difficulty assessing source contributions from sources with very similar chemical composition. Contributions from paved and unpaved roads, agricultural harvesting, off-road activities and other source signatures described as fugitive dust emissions are essentially indistinguishable to the model. To address this limitation of CMB modeling without excluding important contributing sources, composite profiles were developed by combining the signatures of the various sources so that the affect of the group of emissions could be assessed by CMB modeling.

CMB Contributions

The results of CMB modeling can be used directly to project future concentrations from forecast future inventories that include estimated emissions reductions. The CMB method identifies the contributing sources and the proportional rollback method is used to predict future concentrations based on forecast emissions reductions.

CMB modeling assumes a direct relationship (linear) that predicts that emissions changes will be directly proportional to emission reductions. CMB modeling therefore has inherent difficulties predicting changes in particulates affected by non-linear factors. Non-linear relationships between emissions and particle formation occur due to complex chemical reactions in the processes of atmospheric chemistry.

PM10 episodes that are heavily dominated by primary emitted particles from sources that emit carbon and soil based emissions from roads, agriculture, construction and related activities are suitable for direct CMB analysis and rollback. However, SJVAB episodes and annual concentrations include contributions from nitrate and sulfate particulates produced from complex non-linear atmospheric chemistry reactions. Evaluating the complexity of the relationships involved in particle formation provides information to determine how to adjust the CMB assumption of linear response to modify modeling methods for improved prediction of secondary particle formation.

UAM Analysis

Episodes involving large quantities of secondary particulates formed from gaseous precursors (such as NOx, VOC, and NH3) need to be evaluated with an understanding of the atmospheric processes and the best information available about atmospheric chemistry and formation rates. Particle formation rates may vary due to influences of meteorology and precursor ratios. Temperature, relative humidity, photochemical energy flux, wind speed and atmospheric mixing affect the formation rates of secondary particulates. The balance of precursors and concentrations of ozone and carbon dioxide also influence particle formation.

Regional modeling, using a version of the Urban Airshed Model modified to assess nitrate particle formation (UAM 8-Aero), was used to determine the precursor and formed particle relationships specific to the SJVAB. Evaluation and modeling of extensive data collected for a typical winter episode from the IMS 95 project, an early element of the CRPAQS research program, was used to establish formation rates and ratios for secondary particulates. This modeling analysis determined that the formation of nitrates associated with NOx emissions does appear to have a nonlinear response in the SJVAB. While more recent projects of the CRPAQS research program have collected additional information, modeling of this information is not yet available. Modeling with newer information would enhance the precision for determining formation ratios but would not alter the finding that the relationship of emissions to reductions is nonlinear due to atmospheric chemistry.

The results of the regional modeling were used for modification of rollback projection by estimating the degree of variation from linear assumptions for formation rates of secondary particulates. The District does not have sufficient information to model the chemistry of each event with a regional photochemical model with aerosol chemistry. The regional modeling evaluates the relationship of gaseous precursors to fine particle formation to address the inherent limitation of CMB modeling to consider atmospheric chemistry. Based on the preliminary findings of the assessment of the IMS95 atmospheric chemistry, conversion factors were used for precursor formation of secondary particulate matter in conjunction with results of the CMB modeling to modify the rollback projection of secondary particulates. The approach is used in making reasonable assessments of future annual average and 24 hour episode response to emission precursor reductions.

The regional modeling provides technically improved understanding of secondary particulate formation, but is not being used to model primary particulates. Technical

difficulties preclude an attainment demonstration for PM10 based entirely on grid-based photochemical modeling. In addition to the lack of sufficient information to model the chemistry of each event with a regional photochemical model including aerosol chemistry, the regional model would be burdened by limitations and uncertainties in available information for area source particulate emission rates and distributions and deposition rates for directly emitted large particles. Regional modeling requires estimation of these influences in its effort to predict what will occur in the atmosphere. Regional modeling also has difficulty representing the dispersion of coarse particle falloff distances that are less than the grid spacing, the minimum area for which the model provides a prediction. Using smaller grid spacing and/or using a coupled grid and dispersion approach would improve regional modeling of primary particulates, but available data sets lack sufficient data density to provide suitable input information for fine scale regional modeling.

As a receptor technique analyzing observed filter samples, CMB modeling avoids the limitations in input data that affect predictive regional modeling by relying on analysis of the contents of observed samples that inherently reflect the end result of all processes. CMB modeling does not need to know the distances that particles travel to produce an analysis of contributing sources but accordingly is limited in the information it provides concerning the area that influenced the observation. The District and ARB addressed this limitation through thorough analysis of meteorology associated with each event to determine the probable area of influence represented by the observed episode.

NOx Ratio Methodology

UAM-Aero modeling of an IMS95 January episode was used to establish a ratio relating NOx emission changes to changes in ambient ammonium nitrate concentrations. The ratio was then used in the rollback projection. The first-day (January 4, 1996) measurement was assumed to represent regional background nitrate levels. We then examined the response of ammonium nitrate concentrations on the third day of the episode (January 6, 1996) to a 50 percent reduction in NOx emissions. The response was calculated as the percent change in ammonium nitrate concentration in excess of background.

Table 6-3 shows the percent reduction in ammonium nitrate concentrations above background due to a 50 percent NOx reduction at the four IMS95 monitoring sites: Fresno-Einstein Park, Bakersfield-Van Horn School, Kern Wildlife Refuge, and South West of Chowchilla. The average response to a 50 percent NOx control was 35 percent reduction in ammonium nitrate. This corresponds to a 1.4 to 1 NOx to ammonium nitrate reduction ratio, i.e., for each 1.4 tons of NOx emission reductions, ambient ammonium nitrate mass drops 1 ton.

Table 6-3
Reduction in Ammonium Nitrate Concentrations
due to 50% NOx Reductions
January 4, 1996 to January 6, 1996 Episode

Monitoring Site	Percent Change*
Average	35%
Bakersfield Van-Horn	53.3%
Kern Wildlife Refuge	58.8%
Fresno Einstein Park	8.6%
South West of Chowchilla	19.9%

** Represents percent change of ammonium nitrate in excess of background concentrations.*

To be reasonably conservative, given the limits of the IMS95 modeling, the NOx ratio was rounded up to 1.5 to 1. The nominal assumption without regional secondary particulate modeling is a NOx to ammonium nitrate ratio of 1 to 1. The 1 to 1 ratio was used in the San Joaquin Valley's 1997 PM10 plan. The more health–protective 1.5 to 1 ratio provides increased confidence that the NOx reductions will yield the ammonium nitrate reduction relied on in the attainment demonstration. The NOx ratio will be updated if the CRPAQS modeling shows that the 1.5 to 1 ratio does not provide for attainment. If the ratio proves to be closer to 1 to 1, it could result in earlier attainment of the PM10 standard.

CMB Rollback Calculations

Combining CMB modeling results with grid-based photochemical aerosol chemistry modeling analysis (UAM 8 Aero) provides the best available methodology to establish a reliable rollback analysis. In this approach, CMB modeling provides source apportionment for primary particles and the grid-based photochemical model provides conversion factors of precursors into secondary particles that were used to correct the proportional rollback analysis of secondary particulates. The area of influence affecting the episode was determined by separate meteorological analysis of the days before and during the observed episode.

The CMB modeling analysis used chemical profiles to divide the observed episode concentration into contributions associated with a limited number of categories. The CMB categories are very broad, including contributions from many different types of sources. Emissions inventories prepared by the District and ARB contain a much finer division of sources in smaller categories. To predict the effect on future PM10 concentrations from control programs, the CMB categories were linked proportionally to the sum of comparable emissions inventory categories. The 24-hour and annual connections between CMB and emissions inventories are different due to seasonal differences and other factors. Fugitive windblown dust contributes to the annual average values and was used in the connection to CMB; however, the 24-hour episodes occurred primarily during stagnation events so fugitive windblown dust emissions were excluded from the 24-hour analyses.

Utilizing the methodology described in this chapter, projections of the effect of control programs and emissions trends have been prepared for the annual and 24-hour design values at all required sites.

Simulation of Future Year Particulate Concentrations

From the CMB receptor modeling identification of emissions source contributions by chemical species, future source contributions have been estimated from baseline and projected inventories with rollback techniques to evaluate the effects of trends and proposed emissions reductions in future years. The design value concentrations were modeled at each site where concentrations were measured that exceeded the federal PM10 NAAQS and where adequate data was available to support a valid analysis.

Rollback calculations for each monitoring site determine future compliance with federal NAAQS for PM10 by calculating the effect of emission reductions predicted for the major source categories as defined in the CMB receptor modeling. The predicted PM10 concentration may also be achieved by different reductions of precursor and PM10 emissions as long as the total particulate reduction is equivalent. Attainment is demonstrated for each site that is projected to have future concentrations at or below the federal NAAQS.

Table 6-4
Simulated Future Year 24-Hour PM10 Values

Site Name	Design Value	2010 without additional reductions	2010 with additional reductions
Bakersfield, California Ave.	**190**	**186**	137
Bakersfield-Golden #2	**205**	**203**	151
Clovis	**155**	145	120
Corcoran, Patterson Ave.	**174** **174**	**185** **197**	143 138
Fresno-Drummond	**186**	**181**	140
Fresno-First	**193**	**182**	144
Hanford, Irwin St	**185**	**189**	143
Modesto, 14th Street	**158**	144	121
Oildale, 3311 Manor St	**158**	151	120
Turlock, 900 Minaret Street	**157**	162	116

Analysis indicates that the following sites will comply with the 24-hour PM10 NAAQS without additional action: Clovis, Modesto, Oildale, and Turlock. The following sites require the commitments in Chapter 4 to achieve compliance by 2010: Bakersfield-California Ave., Bakersfield-Golden, Corcoran, Fresno-Drummond, Fresno-First, and Hanford.

Bakersfield Golden State was the highest design value and the most resistant to emissions change. Final analysis of this site included rechecking of baseline

emission growth projections and incorporated final elements of reductions from State and District emission reduction commitments that were the last items to be quantified.

Table 6-5
Simulated Future Year Annual PM10 Values

Site Name	Design Value	2010 without additional reductions	2010 with additional reductions
Bakersfield-Golden #2	**57**	**58**	49
Fresno-Drummond	**50**	50	45
Hanford-Irwin St	**53**	52	47
Visalia-Church Street	**54**	52	46

Analysis indicates that Fresno, Hanford, and Visalia will comply with the annual PM10 NAAQS by the year 2010 without additional action. Bakersfield requires the proposed commitments in Chapter 4 to achieve compliance in 2010.

ATTAINMENT PROJECTION RESULTS

Projection of the future PM10 concentrations after all reductions are applied and the attainment projection for each site including additional supporting information and evaluations are contained in Appendix N. All sites are projected to attain the annual and 24-hour PM10 NAAQS by December 31, 2010.

Table 6-6
Projected 24-Hour PM10 Values

Site Name	Design Value	2010
Bakersfield - California Ave.	**190**	137
Bakersfield - Golden #2	**205**	151
Clovis	**155**	120
Corcoran - Patterson Ave. (two different events with the same 174 value)	**174**	143 138
Fresno - Drummond	**186**	140
Fresno – First	**193**	144
Hanford – Irwin St	**185**	143
Modesto – 14th Street	**158**	121
Oildale - 3311 Manor St	**158**	120
Turlock – 900 Minaret Street	**157**	116

Table 6-7
Projected Annual PM10 Values

Site Name	Design Value	2010 Projected Value
Bakersfield - Golden #2	**57**	49
Fresno - Drummond	50	45
Hanford - Irwin St	**53**	47
Visalia - Church Street	**54**	46

CONCLUSION

Procedures for analysis have been selected to provide objective and reliable conclusions that have the highest confidence that can be established to determine that the SIP is comprehensive and sufficient for the entire District to achieve attainment of the federal PM10 NAAQS. Reductions of emissions included in the SIP establish an attainment demonstration of the federal PM10 annual and 24-hour standards by successfully addressing all identifiable exceedances that classify the District as nonattainment. Measures implemented throughout the District provide compliance with the NAAQS in communities that are monitored based on their selection as areas expected to experience peak PM10 concentrations. This provides assurance of compliance throughout the District in the communities and areas not directly monitored. If there are exceptions caused by currently unknown special circumstances or sources, the District will assess the special conditions or areas by appropriate action when they are detected.

This PM10 plan has been prepared consistent with the requirements of the Federal Clean Air Act Amendments and applicable federal guidance documents, providing an overview of existing conditions, previous plan commitments, proposed control strategies, required emission inventories, and a modeling discussion. The fall and winter 24-hour PM10 episodes in the SJVAB occur under calm conditions that make identification of contributing sources and development of effective controls difficult. Control strategies have been identified and extensive efforts are underway to gain a better understanding of the components that contribute to episodes in the SJVAB, in order to develop and quantify effective control options.

Modeling has indicated that all monitoring sites within the district will attain the federal average annual PM10 NAAQS by December 31, 2010. Modeling further indicates the current state and District actions and commitments will not achieve attainment of the federal 24-hour standard before 2010, and additional measures as contained in this plan are required to ensure that the District will reach attainment of the federal 24-hour PM10 NAAQS. These cumulative strategies and actions will result in attainment of the federal PM10 NAAQS by December 31, 2010.