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REGIONAL WORKSHOPS ON AIR QUALITY MODELING: A SUMMARY REPORT

APRIL 1981

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1.0 INTRODUCTION

The requirements placed on air quality control agencies by the Clean Air Act have dramatically increased the need for improved air quality modeling. The resulting increase in the use of models has also led to a substantial increase in the number and complexity of situations in which models are employed. The modeling guideline (Guideline on Air Quality Models, EPA-450/2-78-027, April 1978) addresses many of the problems in this relatively new and growing field, but much is left to the discretion of the reviewing agency since many complex problems are best solved on a case-by-case basis. However, because of the variety of technically correct solutions to any complex problem, different approaches with differing results have led to inconsistency in model applications from Region to Region. In an effort to improve consistency in the use of modeling techniques, three in-house workshops have been held since 1978. These workshops provide a forum for the Regional Office and Headquarters groups to discuss common problem areas and arrive at generally acceptable solutions.

Many recommendations were made in the course of the workshops. These have been reviewed by OAQPS and some have necessarily been modified and supplemented to ensure consistency with other modeling policies. This report clarifies preferred data bases and procedures for the application of specific models and modeling techniques in situations where the guideline permits a case-by-case analysis.

Recommendations contained in this report should be followed by the EPA Regional Offices until such time as the 1978 guideline is formally revised. Issues concerning the use of models not specified in this summary report or in the 1978 guideline, should be directed to the OAQPS Model Clearinghouse for review. The current procedures for submitting issues are provided in the Clearinghouse Operating Plan.

2.0 DATA BASES

2.1 Discussion

Estimated concentrations can vary widely depending on the source, meteorological, and air quality data used in preparing the estimates. Thus the need for consistency in the use of data and in the selection of data bases is apparent. Also, an accurate and reliable air quality data base is needed to evaluate the performance of a model.

Inconsistencies occur because adequate data frequently are not available for model input. Requirements for pre-application monitoring under PSD have alleviated some of the inconsistencies in data collection and use. However, additional guidance is still needed in the collection and interpretation of meteorological data.

Also, appropriate source data to reflect short-term variations in emissions are often unavailable. The relationship of source emission data to worst-case conditions can be another area of inconsistency.

This section identifies a few of the more frequent problem areas and provides recommendations to ensure consistency in the selection and use of data.

2.2 Recommendations

2.2.1 Acquisition of Data Bases

Guidance provided in the "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)," EPA-450/4-80-012, November 1980 should be used for the establishment of a special monitoring network for air quality analyses, including both air quality and meteorological monitoring techniques. Additional information is available in 40CFR Part 58 and in the quality assurance and site selection EPA guidance documents published on a pollutant-by-pollutant basis. The EPA Regional Office should review the network design prior to operation.

2.2.2 Background Concentrations

Techniques discussed in the Guideline on Air Quality Models should be used in establishing background concentrations.

2.2.3 Source Data

The load or operating condition of a plant that causes the highest ground-level concentrations should be determined through a screening analysis and this load should be used to establish emission limitations. As a minimum all sources should be modeled using 100 percent design capacity; however, when modeling large sources, e.g., 500 MW power plants or equivalent, 50 and 75 percent capacity should also be modeled.

Hourly sequential emissions determined for existing sources from continuous in-stack monitoring should be used in model evaluation where possible. Hourly emissions are critical where short-term concentrations are of concern in such evaluations.

2.2.4 Metecrological Data

Five years of representative meteorological data should be used when estimating concentrations with an air quality model. Consecutive years from the most recently available five-year period are preferred. The meteorological data may be data collected either on-site or at the nearest National Weather Service (NWS) station. If the source is large, e.g., emissions equivalent to a 500 MW power plant, the use of five years of NWS meteorological data or at least one year of on-site data is required.

Five years of on-site data are often not available. When considering shorter periods of meteorological data, care must be taken to ensure that the data used contain the appropriate worst-case conditions. On-site data should also be subjected to quality assurance procedures that will ensure that the data is at least as accurate and in as much detail as NWS data.

Hourly average wind directions reported to the nearest degree should be used where on-site data are used. The CRSTER randomization sequence (i.e., the established sequential random number set designated for use with the meteorological preprocessor to CRSTER) should be used with NWS wind data.

The surface wind reference height used in the model should be defined to agree with the actual height of the surface wind sensor. When wind is monitored at heights closer to plume height, the wind direction should be used to define the plume transport and the speed should be utilized to develop the appropriate vertical wind speed profile.

Guidance provided in Appendix A should be followed in the design of site-specific, on-site meteorological data collection programs.

3.0 FLAT TERRAIN MODELS

3.1 Discussion

Flat terrain, as used here, is considered to be an area where terrain features are all lower in elevation than the top of the stack of the source in question. Most Gaussian models perform adequately in such situations.

A number of models have been made available by EPA and others for those applications where receptors are located at elevations less than the top of the stack. However, inconsistencies have resulted from the use of these models. Such inconsistencies occur in part because models may be developed at different times for specific applications and the various algorithms are improved, changed or added to accommodate a specific problem or to reflect recent research. This section provides recommendations to resolve these inconsistencies without limiting the range of applicability of flat terrain models.

3.2 Recommendations

3.2.1 Screening Techniques

Screening techniques and options as provided in "Guidelines for Air Quality Maintenance Planning and Analysis Volume 10 (R): Procedures for Evaluating Air Quality Impact of New Stationary Sources" should be used.

Where possible, screening procedures should be site and problem specific. Consideration should be given to: (1) terrain; (2) urban or rural dispersion coefficients; and (3) worst-case conditions when representative meteorological data or applicable detailed modeling techniques are not available. If screening is the sole basis for the analysis, adequate justification and documentation should be required for the use of averaging time factors.

3.2.2 Refined Analytical Techniques

The following table lists the preferred models for the indicated applications. These models should be used in Regional Office applications of models. For use of models and in applications that do not appear in this table or in the 1978 guideline, Regional Offices should follow Section 7 of this report.

Table 1. Preferred Model Use

SHORT TERM		MODEL
Single Source	Rural	CRSTER
	Urban	RAM
Multiple Source	Rural	MPTER
	Urban	RAM
Industrial Complexes	Rural/Urban	ISC
LONG TERM		
Single Source	Rural	CRSTER
	Urban	CDMQC or RAM*
Multiple Source	Rural	MPTER
	Urban	CDMQC or RAM*
Industrial Complexes	Rural/Urban	ISC

For all model applications in a rural area, the CRSTER techniques for wind speed profile, plume rise and terrain adjustment should be used unless other techniques can be shown on a case-by-case basis to provide more appropriate and accurate estimates.

Dispersion coefficients appropriate to either urban or rural settings should be used in accordance with Section 6.2.5. Sector averaging should be accepted only for seasonal or annual estimates where estimates are based on statistically summarized meteorological data.

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*The choice of RAM or CDMQC in urban applications is a function of the number of sources and the size of the area to be modeled, e.g., if only three or four sources in an urban area are to be modeled, RAM should be used.

3.2.3 Model Options

The options that are found in the ISC, CRSTER, MPTER, and PTPLU have greatly increased the technical options available. To ensure consistency in the use of these options, Regional Office users should follow the guidance below:

a. Stack Tip Downwash (CRSTER, MPTER, ISC, PTPLU*)

This option should not be used unless demonstrated to be applicable on a case-by-case basis. Although there is evidence that this phenomenon can occur, there are no data to support wide use of the option.

b. Plume Rise (CRSTER, MPTER, ISC, PTPLU)

In all cases, except stable conditions in complex terrain, the final plume rise option should be used. The restriction on the use of gradual plume rise is based upon the lack of specific data needed to quantify the dispersion during plume rise. In complex terrain where plume impaction is the identified problem, the use of transitional plume rise, during stable conditions, may be required to ensure that impaction on close-in terrain is considered.

c. Rural/Urban Options (ISC)

The selection of the rural or urban option should be based upon the determinations as outlined in Section 6.2.5 for determining whether an area is urban or rural.

d. Momentum Plume Rise (ISC, CRSTER, MPTER, PTPLU)

This is optional in the CRSTER and MPTER models and an integral part of the ISC and PTPLU models. It should be used in the CRSTER and MPTER models.

*PTPLU is found in UNAMAP (Version 4) and is a replacement for PTMAX.

4.0 COMPLEX TERRAIN MODELING

4.1 Discussion

Although the need for a refined complex terrain dispersion model has been acknowledged for several years, such a model has not yet been developed. The lack of extensive data bases and basic knowledge concerning the behavior of atmospheric variables in the vicinity of complex terrain presents a considerable obstacle to the solution of the problems and the development of a refined model.

This is complicated by the fact that each complex terrain location can be considered unique. A comprehensive study was begun recently by ORD in the vicinity of a 3-dimensional hill in Idaho, the purpose of which is to gain the basic knowledge of dispersion in complex terrain. Practical information from this study is still forthcoming. Until changes in the physical behavior of plumes in complex terrain are documented and new mathematical constructs developed, the existing dispersion algorithms adapted to complex terrain must be used.

For the purpose of this report, complex terrain is defined as any terrain exceeding the height of the stack being modeled.

4.2 Recommendations

4.2.1 Screening Techniques

The screening technique recommended for use in complex terrain situations to determine annual and 24-hour average concentrations is the Valley Model. The following worst-case assumptions should be used to determine 24-hour averages: (1) P-G stability of "F"; (2) wind speed of 2.5 m/s; (3) six hours of occurrence. For screening, the use of a sector greater than 22-1/2° in the Valley Model should not be allowed. Full ground reflection should always be used in screening analyses.

Multiple sources should be treated individually in the Valley Model and the concentrations for specific wind directions summed. Only one wind direction should be used for 24-hour averages (see User's Manual, pages 2-15) even if individual runs are made for each source.

The receptor grid found in the Valley Model User's Guide may not be sufficient for all analyses if only one geographical scale factor is used. The Valley Model is very sensitive to ground-level elevation at the receptor, and the use of the standard polar grid could miss the worst-case receptor. If this situation occurs, the user should choose an additional set of receptors at appropriate downwind distances whose elevations are equal to plume height minus 10 meters.

4.2.2 Refined Analytical Techniques

If the results of the screening analysis demonstrate a possible violation of NAAQS or the controlling PSD increments, a more refined analysis should be conducted. In the absence of other models demonstrated to be more appropriate, the Valley Model is acceptable for selecting emission limitations in complex terrain situations.

5.0 MOBILE SOURCE MODELS

Regional meteorologists have not been involved in significant consistency problems with carbon monoxide or ozone models. Some guidance is found in the 1978 Guideline on Air Quality Models, and additional guidance with respect to the use of models and data bases for SIP revisions is contained in the Federal Register Volume 46, No. 14, p. 7182, entitled, "State Implementation Plans: Approval of 1982 Ozone and Carbon Monoxide Plan Revisions for Areas Needing an Attainment Date Extension."

6.0 GENERAL MODELING ISSUES

6.1 Discussion

This section contains recommendations concerning a number of different issues. The problem areas addressed are not specific to any one program or modeling area but need resolution in nearly all modeling situations.

6.2 Recommendations

6.2.1 Design Concentrations

If five years of NWS data are used in an analysis or if one year of one-site meteorological data are used, then the highest, second-highest short term concentration estimate should be used to determine the impact of the source. If less than five years of NWS data or less than one year of on-site data are used, then the highest concentration estimate should be used as an approximation to the second-highest short term concentration.

Block averaging times should continue to be used for modeling purposes.

6.2.2 Critical Receptor Sites

Receptor sites should be utilized in sufficient detail to allow estimates of the highest concentrations and the probability of a violation of a NAAQS or a PSD increment. The procedures listed below should be followed to locate receptor sites when a large source, such as a 500 MW power plant, is being modeled.

a. Apply PTPLU to identify the distance to the highest estimated concentration for each combination of atmospheric stability class and wind speed. PTPLU should be run using 0.10, 0.15, 0.20. 0.25, 0.30, and 0.30 as wind profile exponents for the six stability classes A through F respectively. The receptor elevation in PTPLU should be set to the highest terrain elevation above stack base found within a one-kilometer radius of the stack. Select the smallest of the distances obtained from PTPLU as the first receptor distance.

b. Select eight more distances by multiplying the first receptor distance by each of the following constants: 1.3, 1.7, 2.3, 3.0, 3.9, 5.2, 6.8, and 9.0. This geometric progression allows the user to most closely approximate the location of maximum concentration. There is no need for a receptor spacing closer than 0.1 kilometer. A tenth receptor distance may be used to locate receptors in a potentially high concentration area beyond the ninth receptor distance.

c. Check the PTPLU output to be sure that high concentrations with P-G D stability are not expected beyond the last receptor distance. If high concentrations are expected beyond the last receptor distance, then add additional rings to include those cases.

d. If the elevation of individual receptors is significant, those elevations should be specified as the greatest terrain elevation along the appropriate 10 degree arc for the receptor distance of concern; the height should not be limited to the center of the 10 degree sector. In some instances it may be desirable to locate receptors at the plant boundary. Additional rings may be needed for this.

For models capable of using a rectangular grid, including multi-source models, a one-kilometer square receptor grid extended outward in all directions from the source to a distance of 10 kilometers, or about 400 receptor sites, should be used. The grid should be extended farther if maximum 1-hour concentrations are estimated to occur beyond 10 kilometers. For urban models, this grid should cover the entire area being modeled. In addition, to identify concentrations that might be missed by the spacing of the rectangular grid, individual isolated receptor sites should be located downwind from the major source(s) for prevailing wind directions during conditions of maximum concentration. For each direction, four downwind distances associated with maximum one-hour concentrations for Pasquill-Gifford stability Classes A, B, C, and D as determined by PTPLU should be selected. Receptor sites should also be located at sites where monitored air quality data are available and sites where plume interactions from multiple sources are likely to be greatest. If the height of individual receptors is significant, those should be specified as the actual terrain height at the receptor location.

For sources smaller than those equivalent to a 500 MW power plant, receptors should be located following the above procedures, but in the actual model runs it may not be necessary to include all receptors for all directions and all distances. The selection of receptor sites is left to the discretion of the Regional Office, but should be based on wind roses for the area and the results of calculations using PTPLU or other comparable screening procedures.

6.2.3 Long-Range Transport

Long-range transport should be considered where impact on Federal Class I areas is possible. The application of simple Gaussian models for downwind transport distances greater than 50 km should be evaluated on a case-by-case basis. Models that are more appropriate at these transport distances should be evaluated as alternatives to the simple Gaussian models. Models for long-range transport included in the references to the 1978 Guideline on Air Quality Models can be used as screening techniques. More complex and thoroughly documented models such as MESOPUFF, MESOPLUME or MESOGRID may be considered on a case-by-case basis for use as refined models within their established limitations.

6.2.4 Pollutant Half-life

Pollutant half-life should not be used in screening analyses.

For a refined analysis, if the need for half-life for SO_2 can be demonstrated, site-specific data should be used to define a rate of conversion of SO_2. Otherwise only those refined models with built-in conversion provisions should be used where conversion appears to be an obvious problem.

For nitrogen oxides, complete conversion from NO to nitrogen dioxide (NO_2) should be used in screening analyses. In refined analyses, case-by-case half-life conversion rates should be determined on the basis of scientific technical studies appropriate to the site in question. The methods suggested by Cole and Summerhays* should be considered.

An infinite half-life should be used for estimates of total suspended particulate concentrations when simple Gaussian models with exponential decay terms are employed. Deposition and removal should be directly considered in the model if it is a significant factor.

6.2.5 Urban/Rural Classification

The selection of either rural or urban dispersion coefficients in a specific application should follow the procedure below using land use or population density.

Land Use Procedure: (1) Classify the land use within the total area, A_o, circumscribed by a 3 km radius circle about the source using the meteorological land use typing scheme proposed by Auer**; (2) If land use types I1, I2, C1, R2, and R3 account for 50 percent or more of A_o, use urban dispersion coefficients; otherwise, use appropriate rural dispersion coefficients.

* Cole, H. S., and J. E. Summerhays, A Review of Techniques for Estimating Short Term NO_2 Concentrations, JAPCA, Vol. 29, No. 8, pp. 812-817, 1979.

**Auer, A. H., Correlation of Land Use and Cover with Meteorological Anomalies, JAM, Vol. 17, pp 636-643, 1978.

Population Density Procedures: (1) Compute the average population density, $\bar{p}$, per square kilometer with A_o as defined above; (2) If $\bar{p}$, is greater than 750 people/km^2, use urban dispersion coefficients; otherwise, use appropriate rural dispersion coefficients.

The land use procedure is considered the most definitive. Population density should be used with caution, especially in a highly industrialized area where the population density may be low but the area is sufficiently built up so that the land use criteria would be satisfied. Impacts from sources beyond the three (3) kilometers should be included in the background.

For analyses of urban complexes, the entire area should be modeled as an urban region if most of the sources are located in areas classified as urban.

6.2.6 General Model Evaluation

A model evaluation study should assess how closely the mathematical assumptions inherent to the model describe the physics and/or chemistry of the atmosphere. The process of model evaluation should consider all of the following: (1) assumptions inherent to design/algorithms of model; (2) purpose/objective of model; (3) purpose/objectives of monitors(s); (4) applicability of monitored data for comparison; (5) comparison of model estimates with monitor observations for upper end of frequency distribution, statistical analyses, and analyses of weakness in individual algorithms; and (6) analyses of critical meteorological and source conditions and their effect on individual algorithms. An analysis should also be made of the sensitivity of the algorithms to the meteorological input data.

For short-term model evaluation, all input data should be based on measured hourly averages. This includes mass emission rates, stack dynamic operating parameters and meteorological input. The spatial applicability of measured air quality data and tracer studies should be consistent with the scale of the model comparisons.

Calibration for short-term air quality concentrations is not recommended. Determination of the need for calibration and calibration procedures are contained in the 1978 guideline.

7.0 NONGUIDELINE MODELS

7.1 Discussion

Only a limited number of models or modeling techniques have undergone a sufficient evaluation to be considered "guideline" models, or to be recommended procedures for modeling certain aspects of plume behavior. There remain a large number of circumstances when no recommended technique is available and no guideline model is totally applicable. There are also circumstances when a model other than a recommended model may appear suitable. In those cases the Regional Office must decide on the acceptable procedures and approve or disapprove specific nonguideline modeling approaches for use in each specific situation.

7.2 Definition of Guideline vs. Nonguideline Models

Guideline models are those models specifically recommended for (general) use in the 1978 Guideline on Air Quality Models. All other models require review and evaluation on a case-by-case basis.

Changes made to a guideline model that do not affect the concentration estimates do not change the guideline status of that model. Examples of such changes are those required to run the program on a different computer or those that affect only the format of the model results. When such changes are made, the Regional Offices may require a test case example to demonstrate that the concentrations are not affected.

Use of a guideline model with other than recommended options changes the status of the model to nonguideline. Similarly, if a guideline model has been revised or changed such that it produces concentrations different from the original model for the same input data, the status of the model is changed to nonguideline.

7.3 Recommendations

The determination of the acceptability of a nonguideline model is a Regional Office responsibility. Proposed models should be evaluated from both a theoretical and a performance perspective. Proper support and documentation for the use of a nonguideline model will normally include air quality and meteorological data that have been collected using appropriate techniques and procedures as outlined in the "Ambient Monitoring Guideline for Prevention of Significant Deterioration (PSD)" EPA 450/4-80-012, November 1980. Data bases for other than the specific site in question may be acceptable if it can be shown that the data available represent similar topography, climatology, and source configurations. Any data base used must include appropriate periods of worst-case conditions.

An OAQPS document entitled "Interim Procedures for Evaluating Air Quality Models" is in preparation and will describe procedures and techniques for determining the acceptability of a nonguideline model for use in a specific application. When completed (Summer 1981) this document may assist in the Regional Office determinations.

8.0 USE OF MEASURED AIR QUALITY DATA IN LIEU OF MODEL ESTIMATES

8.1 Discussion

Dispersion model estimates, especially with air monitoring support, are the preferred basis for air quality demonstration decisions. Nevertheless, there may arise instances where the performance of recommended dispersion modeling techniques may be demonstrated by observed air quality data to be less than acceptable. Occasionally there may be no recommended modeling procedure. In these instances, air pollutant emission limitations may be established on the basis of observed air quality data.

8.2 Recommendations:

Modeling is the preferred method for determining emission limitations for both new and existing sources. Where a well-accepted, well-verified model is available, model results alone are sufficient. Monitoring will normally not be accepted as the sole basis for emission limitation determination in flat terrain areas. In some instances where the modeling technique available is only a screening technique, the addition of air quality data to the analysis may lend credence to model results.

In some instances a model that is applicable to the situation may not be available. Measured data may have to be used. Examples of such situations are: (1) complex terrain locations, (2) aerodynamic downwash situations, (3) land/water interface areas, and (4) urban locations with a large fraction of particulate emissions from non-traditional sources. However, only in the case of an existing source would monitoring data alone be an acceptable basis for emission limits. In addition, there are other requirements for the acceptance of an analysis based only on monitoring:

a. A monitoring network exists for the pollutants and averaging times of concern;

b. It can be demonstrated that the monitors in the network are located as close as possible to all points of maximum concentration;

c. The monitoring network and the data reduction and storage procedures meet all EPA monitoring and quality assurance requirements;

d. The data set and the analysis identify conclusively each individual source impact if more than one source or emission point is involved;

e. At least one full year of valid ambient data is available and a demonstration that the year was not sufficiently atypical to influence the resulting emission limits;

f. A demonstration that EPA recommended models are not applicable through the comparison of the monitored data with model results.

Sources should obtain approval from the Regional Office for the monitoring network prior to the start of monitoring to ensure that the situation requires the use of monitoring and to obtain approval of the monitoring network design and procedures.

The following are examples for some common situations where monitored data might be considered. It should be noted, however, that since the adequacy of a network is a function of the source configuration as well as the topography and the meteorology of the site, a large number of designs may need to be considered and no set pattern is applicable to any one of the problem areas.

a. For aerodynamic downwash, consider one or two background monitors plus two to four downwind monitors. The number of downwind monitors should be determined by a consideration of the frequency of the downwash events, the expected magnitude of the impact, and the areal extent of the impact.

b. For shoreline conditions consider one to two background monitors and three to eight downwind monitors. The number of downwind monitors should be determined by considering site characteristics, the magnitude and the areal extent of the predicted impact. It may be necessary to complement the stationary monitoring network with mobile sampling and plume tracking techniques.

c. For complex terrain, the air quality monitors should assess the maximum impacts for each averaging period for which an air quality violation is expected to occur. Approximately three to eight monitors should be considered necessary to monitor for each such averaging time. The exact number depends on the magnitude and extent of expected violations. At least two monitors for each contiguous area where violations are expected to occur is necessary except where these areas are large. In this case, more than two monitors could be required. As a guide, a 22-1/2° sector should define the maximum size of a large contiguous area. Based upon meteorological judgment, additional monitors may be required to evaluate the source impact depending on the complexity of the terrain.

d. For urban situations where the concern is particulates and the sources of violations appear to be fugitive and/or reentrained dust, extensive monitoring and receptor models may be needed to accurately assess the problem.

9.0 REVIEW OF PSD PERMIT APPLICATIONS

9.1 Discussion

Certain procedures with respect to the review and analysis of PSD permits also should be standardized to ensure consistency. A few of these are discussed below.

9.2 Recommendations

In those Regions where the Regional Office has the responsibility for permitting new sources, the Regional Office should provide permit applicants with a uniform PSD/NSR guidance package, including screening and modeling requirements. The attached Air Quality Analyses Checklist (Appendix B) is recommended as a standardized set of data and a standard basic degree of analysis to be required of PSD and SIP revision applicants. This checklist suggests a level of detail, including the necessary grid resolution, required to assess both PSD increments and the NAAQS. Special cases may require additional guidance.

A pre-application meeting between source owner and Regional Office staff should be the norm and the Regional Meteorologist should be represented.

PSD air quality analyses should be based on information considered valid for the start-up date for the new or modified source.

The Regional Office should allow permit applicants to use "Procedures for Evaluating Air Quality Impact of New Stationary Sources" (EPA-450/4-77-001) for screening purposes. Air quality concentration estimates obtained using procedures in that Guideline on screening techniques or using the refined analytical techniques incorporating Pasquill-Gifford or McElroy-Pooler sigmas, are equivalent to one-hour values. Time-scaling of such estimates from any period shorter than one hour is generally not acceptable. Time-scaling of one hour estimates to longer period averages is not acceptable when the purpose is to obtain the highest or highest, second-highest concentration estimates and a refined analytical technique is appropriate for making one-hour estimates.

Regional Offices should require permit applicants to incorporate the pollutant contributions of all sources into their analysis. This should include emissions associated with area growth within the area of the new or modified source's impact. PSD air quality assessments should consider the amount of the allowable air quality increment that has already been granted to any other new sources. The most recent source applicant should be allowed the prerogative to re-model the existing or permitted sources in addition to the one currently under consideration.

This would permit the use of newly acquired data or improved modeling techniques if such have become available since the last source was permitted. When remodeling, the worst case conditions used in the previous modeling analysis must be one set of conditions modeled in the new analysis. All sources must be modeled for each set of meteorological conditions selected and for all receptor sites used in the previous applications as well as new sites specific to the new source.

APPENDIX A

ACQUISITION OF SITE SPECIFIC METEOROLOGICAL DATA

Models recommended in the 1978 Guideline on Air Quality Models require as input the following parameters:

- ° transport wind speed and direction;
- ° ambient air temperature;
- ° Pasquill-Gifford stability category.

Wind Measurements

In addition to 10 m surface wind measurements, the transport wind speed and direction should be measured at an elevation as close as possible to the effective stack height. To approximate this, if a source has a stack (or stacks) below 100 m, select the stack top height as a wind measurement height. For sources with stacks extending above 100 m, a 100 m tower is suggested unless the stack top is significantly above 100 m (200 m or more). For cases with stacks 200 m or above, the Regional Meteorologist should determine the appropriate measurement height on a case-by-case basis. Remote sensing may be a feasible alternative.

For routine tower measurements and surface measurement the wind speed should be measured using an anemometer and the wind direction measured using a horizontal vane. The specifications for wind measuring instruments contained in the "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)," EPA 450/4-80-012, November 1980 should be followed. Wind direction should be reported to the nearest degree.

Temperature

The temperature should be measured at or near standard instrument shelter height. Ambient temperature can be reliably measured using good quality linear thermistors or platinum resistance devices.

Stability Category

The Pasquill-Gifford (P-G) stability categories, as originally defined, incorporate subjectively determined insolation assessments based on hourly cloud cover observations. In lieu of such observations it is recommended that the P-G stability category be estimated using Table A-I. Use of this table requires the direct measurement of the elevation angle of the vertical wind direction. Measurements of elevation angle are difficult to make without a substantial commitment in maintenance, hence it is recommended that σ_ϕ be determined using the transform:

$$\sigma_\phi = \sigma_\omega / u$$

Where: σ_ϕ = the standard deviation of the vertical wind direction fluctuations averaged for a one-hour period;

σ_ω = the standard deviation of the vertical wind speed fluctuations observed for a one-hour period;

u = the average horizontal wind speed for a one-hour period.

It is recommended that a vertically mounted anemometer be used to measure the vertical wind speed fluctuations. The instrument should meet the specifications given in the Ambient Monitoring Guidelines referenced above. The instrument should compute σ_ω directly, one value each hour using 3600 to 360 values, based on a recommended readout interval of 1 to 10 seconds.

If σ_ϕ is computed using the output of the anemometer by other than direct application of the formula for a variance, the method should be demonstrated to be equivalent to direct computation.

Both the vertical wind speed fluctuations and the horizontal wind speed should be measured at the same level. Moreover, these measurements should be made at a height of 10 m for valid use in estimating the PG stability category. Trees or land use might preclude measurements as low as 10 m and in such cases the measurements will have to be made at heights above 10 m

If on-site measurements of either σ_ϕ or σ_ω are not available, stability categories may be determined using the horizontal wind direction fluctuation, σ_θ, as outlined by Mitchell and Timbre*. This method uses the NRC Safety Guide 1.23 categories of σ_θ listed in Table A as an initial estimate of the P-G stability category. This relationship is considered adequate for daytime use. During the nighttime (one hour prior to sunset to one hour after sunrise) the adjustments given in Table A-III should be applied. As with σ_ϕ, σ_θ should be adjusted for surface roughness by multiplying the measured σ_θ, by the average surface roughness length within 1 to 3 km of the source.

If, due to maintenance or instrument failure, σ_ω and σ_θ values are missing, the P-G stability categories can be estimated from the lower level wind speed (if tower measurements are used) with estimates of sky

*Mitchell, A. Edger Jr., and K. O. Timbre, Atmospheric Stability Class from Horizontal Wind Fluctuation, 72nd Annual Meeting APCA, Cincinnati, Ohio, June 24, 1979.

cover and cloud heights from some suitable NWS site (or obtained on-site) using the CRSTER preprocessor. However, the σ_ϕ categories and the modified σ_θ categories are anticipated to be better correlated to the actual dispersion, especially in complex terrain, than employing either estimates or measurements of insolation to estimate the P-G stability category.

Table A-I

P-G Stability Category Versus
Vertical Wind Direction Fluctuation, σ_ϕ

P-G Stability Category	*Standard Deviation of Vertical Wind Direction, σ_ϕ
A	> 12°
B	10° - 12°
C	7.8° - 10°
D	5° - 7.8°
E	2.4° - 5°
F	< 2.4°

From: Smith, T. B. and S. M. Howard, "Methodology for Treating Diffusivity," in MRI-72 FR-1030 6 September 1972.

* The table values of σ_ϕ should be adjusted for surface roughness by multiplying each of the values in the table by $(z_o/15cm)^{0.2}$ where z_o is the average surface roughness length within a 3 km radius of the source.

Table A-II

PG Stability Categories Versus
Horizontal Wind Direction Fluctuations, σ_θ

PG Stability Category	Range of Standard Deviation, Degrees*
A	$\sigma_\theta \geq 22.5$
B	$22.5 > \sigma_\theta \geq 17.5$
C	$17.5 > \sigma_\theta \geq 12.5$
D	$12.5 > \sigma_\theta \geq 7.5$
E	$7.5 > \sigma_\theta \geq 3.8$
F	$3.8 > \sigma_\theta \geq$

Adapted from Nuclear Regulatory Commission (NRC) Regulatory Guide 1.23, 1972.

* The table values σ_θ should be adjusted for surface roughness by multiplying each of the values in the table by $(z_0/15\text{ cm})^{0.2}$ where z_0 is the average surface roughness length within a 3 km radius of the source. A personal communication with Dr. R. Londergan of TRC indicates that in his evaluation of the use of σ_θ over very smooth surfaces (less than 10 cm) the adjustment for the roughness length produced values in disagreement with the PGT determined stabilities. Therefore, use of the roughness length correction with σ_θ when the surface is smooth, should take this finding into consideration.

Table A-III

Night Time P-G Stability Categories Based on σ_θ

If the σ_θ stability class is	And if the 10m wind speed, u, is: m/s	mi/hr	Then the stability class is
A	$u<2.9$	$u<6.4$	F
	$2.9 \le u<3.6$	$6.4 \le u<7.9$	E
	$3.6 \le u$	$7.9 \le u$	D
B	$u<2.4$	$u<5.3$	F
	$2.4 \le u<3.0$	$5.3 \le u<6.6$	E
	$3.0 \le u$	$6.6 \le u$	D
C	$u<2.4$	$u<5.3$	E
	$2.4 \le u$	$5.3 \le u$	D
D	wind speed not considered		D
E	wind speed not considered		E
F	wind speed not considered		F

Adapted from Mitchell and Timbre (1979)

APPENDIX B

AIR QUALITY ANALYSIS CHECKLIST*

1. Source location map(s) showing location with respect to:

   - o Urban areas**
   - o PSD Class I areas within 100 km
   - o Nonattainment areas**
   - o Topographic features (terrain, lakes, river valleys, etc.)**
   - o Other major existing sources**
   - o Other major sources subject to PSD requirements
   - o NWS meteorological observations (surface and upper air)
   - o On-site/local meteorological observations (surface and upper air)
   - o State/local/on-site air quality monitoring locations**
   - o Plant layout on a topographic map covering a 1-km radius of the source with information sufficient to determine GEP stack heights

2. Information on urban/rural characteristics:

   - o Land use within 3 km of source classified according to Auer, A. H. (1978): Correlation of land use and cover with meteorological anomalies, J. of Applied Meteorology, Vol. 17 p. 636-643.
   - o Population
     - total
     - density
   - o Based on current guidance determination of whether the area should be addressed using urban or rural modeling methodology

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* The "Guidelines for Air Quality Maintenance and Analyses," Volume 10 (Revised), EPA-450/4-77-001, October 1977 (OAQPS No. 1.2-029R) should be used a screening tool to determine whether modeling analyses are required. Screening procedures should be refined by the user to be site/problem specific.

**Within 50 km or distance to which source has a significant impact, whichever is less.

3. Emission inventory and operating/design parameters for major sources within region of significant impact of proposed site (same as required for applicant:

- o Actual and allowable annual emission rates (g/s) and operating rates*

- o Maximum design load short-term emission rate (g/s)*

- o Associated emissions/stack characteristics as a function of load for maximum, average, and nominal operating conditions if stack height is less than GEP or located in complex terrain. Screening analyses as footnoted on B1 or detailed analyses, if necessary, must be employed to determine the constraining load condition (e. g., 50%, 75%, 100% load) to be relied upon in the short-term modeling analysis.

  - location (UTM's)
  - height of stack (m) and grade level above MSL
  - stack exit diameter (m)
  - exit velocity (m/s)
  - exit temperature (°K)

- o Area source emissions (rates, size of area, height of area source)*

- o Location and dimensions of buildings (plant layout drawing)

  - to determine GEP stack height
  - to determine potential building downwash considerations for stack heights less than GEP

- o Associated parameters

  - boiler size (megawatts, pounds/hr. steam, fuel consumption, etc.)
  - boiler parameters (% excess air, boiler type, type of firing, etc.)
  - operating conditions (pollutant content in fuel, hours of operation, capacity factor, % load for winter, summer, etc.)
  - pollutant control equipment parameters (design efficiency, operation record, e.g., can it be bypassed?, etc.)

- o Anticipated growth changes

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*Particulate emissions should be specified as a function of particulate diameter and density ranges.

4. Air quality monitoring data:

   o Summary of existing observations for latest five years (including any additional quality assured measured data which can be obtained from any state or local agency or company)*

   o Comparison with standards

   o Discussion of background due to uninventoried sources and contributions from outside the inventoried area and description of the method used for determination of background (should be consistent with the Guideline on Air Quality Models)

5. Meteorological data:

   o Five consecutive years of the most recent representative sequential hourly National Weather Service (NWS) data, or one or more years of hourly sequential on-site data

   o Discussion of meteorological conditions observed (as applied or modified for the site-specific area, i.e., identify possible variations due to difference between the monitoring site and the specific site of the source)

   o Discussion of topographic/land use influences

6. Air quality modeling analyses:

   o Model each individual year for which data are available with a recommended model or model demonstrated to be acceptable on a case-by-case basis

     - urban dispersion coefficients for urban areas
     - rural dispersion coefficients for rural areas

   o Evaluate downwash if stack height is less than GEP

   o Define worst case meteorology

   o Determine background and document method

     - long-term
     - short-term

   o Provide topographic map(s) of receptor network with respect to location of all sources

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*See ** on page B1 of checklist.

- o Follow current guidance on selection of receptor sites for refined analyses
- o Include receptor terrain heights (if applicable) used in analyses
- o Compare model estimates with measurements considering the upper ends of the frequency distribution
- o Determine extent of significant impact--provide maps
- o Define areas of maximum and highest, second-highest impacts due to applicant source (refer to format suggested in Air Quality Summary Tables)

  - long-term
  - short-term

7. Comparison with acceptable air quality levels:

   - o NAAQS
   - o PSD increments
   - o Emission offset impacts if nonattainment

8. Documentation and guidelines for modeling methodology:

   - o Follow guidance documents

     - Guideline on Air Quality Models, EPA-450/2-78-027, April 1978
     - Workbook for Comparison of Air Quality Models, EPA-450/2-78-028a,b, May 1978
     - Guidelines for AQMA, Vol. 10(R), EPA-450/4-77-001, October 1977
     - Technical Support Document for Determination of Good Engineering Practice Stack Height (Draft), EPA, July 1978
     - Ambient Air Monitoring Guidelines for PSD, EPA-450/2-78-019, May 1978
     - Requirements for the Preparation, Adoption and Submittal of Implementation Plans; Approval and Promulgation of Implementation Plans, Federal Register, Volume 43, No. 118, pp 52676-52748, August 1980.

AIR QUALITY SUMMARY

For New Source Alone

Pollutant ________*	________**		________**		
	Highest	Highest 2nd High	Highest	Highest 2nd High	Annual
Concentration Due to Modeled Source (μg/m³)					
Background Concentration (μg/m³)					
Total Concentration (μg/m³)					
Receptor Distance (Km) (or UTM Easting)					
Receptor Direction (°) (or UTM Northing)					
Receptor Elevation (m)					
Wind Speed (m/s)					
Wind Direction (°)					
Mixing Depth (m)					
Temperature (°K)					
Stability					
Day/Month/Year of Occurrence					

*Use separate sheet for each pollutant (SO_2, TSP, CO, NO_x, HC, Pb, Hg, Asbestos, etc.)

**List all appropriate averaging period (1-hr, 3-hr, 8-hr, 24-hr, 30-day, 90-day, etc.) for which an air quality standard exists

Surface Air Data From ________ Surface Station Elevation (m) ________

Anemometer Height Above Local Ground Level (m) ________

Upper Air Data From ________

Period of Record Analyzed ________

Model Used ________

Recommended Model ________