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Questions and Responses at the 1981 Workshops on Procedures To Demonstrate Attainment of the NAAQS for Ozone in the 1982 SIPs

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Questions and Responses at the 1981 Workshops on Procedures To Demonstrate Attainment of the NAAQS for Ozone in the 1982 SIPs

by

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PREFACE

In April 1981, the Environmental Protection Agency (EPA) held workshops to describe procedures for demonstrating attainment of the National Ambient Air Quality Standard (NAAQS) for ozone in the 1982 State Implementation Plans (SIPs) prepared by State or local agencies. Workshops were held in three cities: Philadelphia (P), St. Louis (SL) and San Francisco (SF). A large portion of these workshops was spent explaining and demonstrating the use of the city-specific EKMA. A number of questions concerning EKMA and its use were raised by workshop attendees. These have been compiled and responses have been prepared by members of the staff of the Monitoring and Data Analysis Division, Office of Air Quality Planning and Standards, U.S. EPA.

The April 1981 workshops were divided into six broad topics dealing with city-specific EKMA:

I. The Conceptual Basis for EKMA and Relationship of the Modeling Procedure to the Form of the Ozone Standard;

II. Air Quality and Meteorological Monitoring Support Needed to Perform Analyses Using City-specific EKMA;

III. Generating Ozone Isopleth Diagrams for Use in City-specific EKMA;

IV. Application of Isopleth Diagrams in the EKMA Procedure;

V. Efforts to Validate EKMA;

VI. General Modeling Questions.

The questions and answers are included under the topic in which they were asked.

A number of the questions cover points which have not been explicitly covered in previous written guidance concerning city-specific EKMA, but yet were of concern to State and local air pollution, transportation and planning agencies. Therefore, the purpose of this document is to disseminate the questions and concerns of attendees raised at the workshops and the Agency's responses thereto.

QUESTIONS AND RESPONSES AT THE 1981 WORKSHOPS ON PROCEDURES TO DEMONSTRATE ATTAINMENT OF THE NAAQS FOR OZONE IN THE 1982 SIPs

I. Ozone Standard and Conceptual Basis for EKMA

1. Question: What should a State do if it only has the HC/NO_x ratio for one year but has ozone data for several years? (P, SF)

   Reply: The median $NMOC/NO_x$ ratio observed on modeled days during the year in which the precursor data are available should be used for other years. In the event fewer than five days are modeled during the year with precursor data, use the median ratio for all days with precursor data. See also pages 42-43 of the March 1981 Guideline for Use of City-specific EKMA in Preparing Ozone SIPs.

2. Question: If a 51% reduction is needed at one site, how can one be sure that this is adequate for all sites? (SL)

   Reply: One cannot be certain that a reduction which is sufficient to meet the standard at one site is sufficient to meet the NAAQS at all sites. Page 10 of the March 1981 Guideline suggests that the five days with the highest daily maximum ozone concentration at each site be modeled. This should provide an adequate safeguard that the upper portion of the control requirement distribution has been defined for each site. Selection of the highest site-specific control requirement is specified in the Guideline.

3. Question: Is the data for calendar years or ozone seasons? (SL)

   Reply: Data are for ozone seasons. See page 12 of the March 1981 Guideline.

4. Question: Original guidance suggested calculating 2nd highest value when two years of data are available, why has this changed? (SL, SF)

   Reply: The change was made because of the way in which the ozone NAAQS is worded and because the data base is discrete rather than continuous. The wording implies that the standard is met if, on average, no more than one daily maximum ozone concentration per year exceeds 0.12 ppm. If, after controls are implemented, 0.12 ppm is exceeded on only two days over a two year period, the NAAQS would be met. Hence, in calculating the control requirement, the controls must be sufficient to insure daily maximum ozone ≤ 0.12 ppm on all days except two over a two year period. With a discrete data base, this will occur if the third highest control calculation is selected at a site.

5. Question: If an area which has monitored for a long period of time changes its monitoring method, is it necessary to go back and change any values from earlier studies? (SF)

Reply: No.

6. Question: Sunlight simulation is a function of latitude and longitude. Is a provision made for altitude? Isn't altitude considered by entering atmospheric values? (SF)

Reply: No provision is made for altitude in the OZIPP computer program. Altitude could only be considered by modifying the photolytic rate constants. This would be difficult, because not all rate constants would be affected similarly by the change in altitude.

7. Question: Does EKMA work well considering definite diurnal cyclic patterns? (SF)

Reply: The validation tests in which predictions obtained with OZIPP were compared with air quality observations and the EKMA procedure has been compared with changes in ozone predicted with more sophisticated models or observed with trends have all assumed diurnal cyclical meteorological patterns. For example, sunlight intensity and mixing height were varied diurnally in accordance with our best estimates.

Monitoring

8. Question: Is the "NMOC" monitoring method proposed by EMSL fast enough to be used in the field? (SF)

Reply: Yes. The method proposed by EMSL is described at length in a report, Determination of Nonmethane Organic Carbon (NMOC) by Cryogenic Preconcentration and Flame Ionization Detection (Frank McElroy, U.S. Environmental Protection Agency, MD-17, Research Triangle Park, North Carolina 27711, project officer).

An air sample is taken directly from the ambient air at the monitoring site or from a bag sample obtained previously. A fixed-volume portion of the sample is drawn through a tubular trap cold enough to "freeze" all organic compounds except methane (which passes through the trap). Helium is then flushed through the trap to remove any residual methane. The temperature of the trap is raised to 70-80 C so that the collected organic compounds are revolatilized and flushed into a conventional FID analyzer modified to operate with a helium carrier gas. The area under the resulting response peaks is then translated to concentration units using a calibration curve.

The cryogenic trap simultaneously concentrates the nonmethane organic compounds and separates and removes methane. Thus, the technique is both direct reading for NMOC and more sensitive than conventional NMOC analyzers. The method appears to be suitable for both upwind measurements as well as measurements taken in downtown areas.

9. Question: Assuming a State has 30 days worth of data for HC and NO_x and the five highest ozone days don't correspond to the 30 days, what should be done? (SF)

Reply: Use the median NMOC and NO_x concentrations from the days with data as a basis for computing post-8 a.m. emissions. To determine the NMOC/NO_x ratio for use in EKMA, calculate the 6-9 a.m. ratio for each day with NMOC and NO_x data. Use the median NMOC/NO_x ratio for all days with the necessary precursor data.

10. Question: If a State doesn't have any NMOC data at all, what should be done? Can they use default values (9.5:1) previously recommended in the city-specific isopleths? (SF)

Reply: Every effort should be made to obtain valid NMOC and NO_x data. This is the most credible way of deriving NMOC/NO_x ratios and considering the impact of "post-8 a.m." emissions. If it is impossible for a State to obtain these data in a timely fashion, alternatives need to be discussed on a case by case basis with the appropriate EPA Regional Office. Examples of alternatives which have been discussed thus far include use of current ambient ratios from similar, nearby cities; comparison of emission inventory information of another city with ambient data to derive a relation between emissions and ambient ratios which can be used in the city under review; and use of the 9.5:1 ratio (which was based on nationwide data from the mid-to-late '70's).

11. Question: What if a State has two different ratios in the urban area? (SF)

Reply: Procedures described on pages 42-43 of the March 1981 Guideline should be followed.

12. Question: In most cases precursor measurements are made near major roadways; isn't this inconsistent with saying don't use ratios from industralized areas that would not give areawide representation? (SF)

Reply: No. Roadways, unlike industrial areas (in most cities), are ubiquitous. Thus, even if a relatively large fraction of the NMOC and NO_x observed at a monitoring site is due to a nearby roadway, the monitor measures concentrations and relative amounts of NMOC and NO_x which are likely to be representative of a larger area.

13. Question: What are the criteria for NMOC monitoring upwind of the city? (P)

Reply: Criteria for NMOC monitoring upwind of a city are as follow:

(a) To estimate surface NMOC

(1) Sample ≥ 40 km upwind of center city at least 200 m from any local source. Measurements should be representative of a large area (e.g., 20 km x 20 km or more).

(2) Sample 6-9 a.m. concentration using bag or cannister. If a bag is used, shelter from sunlight and extraneous organic sources prior to analysis.

(3) Use sum of species or cryogenic preconcentration technique to analyze contents of bag or cannister. If a bag has been used, analyze within 24 hours of collection. If a cannister is used, analyze within 1 week of collection.

(b) To estimate NMOC aloft

(1) Collect cannister samples upwind aloft via aircraft or some other device during early morning (6-9 a.m.) hours.

(2) Analyze contents of cannister within one week using sum of species or cryogenic preconcentration techniques.

14. Question: What is the relative sensitivity of the monitoring for ozone? (P)

Reply: Within a range of ozone concentrations of 0-0.50 ppm, the accuracy (i.e. reproducibility) of a well maintained chemiluminescent analyzer is within ± .003 ppm.

15. Question: What effect does changing the mixing height have? (P)

Reply: The sensitivity of control requirements to any particular city-specific EKMA input variable cannot be reported categorically. In general, control requirements tend to be relatively insensitive to changes in mixing height which are typically found throughout the U.S. However, this is not to say that specifying the mixing heights is unimportant. Control requirements could be sensitive to mixing height changes under some atypical set of conditions. Also, the change in mixing height also affects the importance of other factors, such as pollutants transported aloft and post 0800 emissions. Thus, the most practicable methodologies should be used to obtain best estimates.

16. Question: Clarify what is meant by changing mixing height during stagnation? (P)

Reply: During stagnation periods, the change of mixing height from morning to the afternoon maximum is similar to the normal pattern of mixing height change. On stagnation days, a strong inversion aloft, due to sinking air in the center of high pressure systems often causes lower than normal afternoon maximum mixing heights.

The mixing heights on any day (including stagnation days) can be found by following the procedures in Appendix A of the EKMA *Guideline* document.

17. Question: What do you do for upwind ozone surface measurements when cities merge or the city extends up to 40 km from CBD? (SL)

Reply: The purpose of making upwind measurements is to gain an indication of what is being transported into a particular city on a large scale. Hence, concentrations which are representative of a large (e.g., ≥ 20 km x 20 km) area are necessary. If cities merge, surface-based, morning upwind ozone measurements are still appropriate for use, provided there are no local sources of NO_x (e.g., within 200 m) which depress measured ozone levels. If it is not possible to obtain upwind surface measurements representative of a large area, direct measurements of ozone aloft (e.g., by aircraft) are necessary.

18. Question: What is the relationship between helicopter measurements and surface measurements obtained during the RAPS study in St. Louis? (SL)

Reply: St. Louis RAPS helicopter temperature soundings, when compared with nearby radiosonde data, show similar structures (e.g., inversions), although the measured temperatures may differ.

The ozone measurements taken above the surface-based mixed layer show different amounts of ozone than surface (in the mixed layer) ozone measurements. During morning hours, higher ozone values are observed above the mixed layer. In the mixed layer, some differences in ozone are seen due to the effect of wind shear (also see Question #76). The ozone above the mixed layer is entrained into the mixed layer as the mixing height rises. A method that uses surface monitors to estimate the effect of ozone from aloft is given on pages 20, and 22-24 of the EKMA Guideline document, and in more detail by Chan, Allard and Tombach (1979). This method gives reasonable agreement with helicopter measurements of ozone aloft.

19. Question: Does the NMOC cryogenic technique utilize GC? (SL)

Reply: No. The technique utilizes a preconcentration procedure and then modified conventional FID devices. See the response to Question 8 and Determination of Nonmethane Organic Carbon (NMOC) by Cryogenic Preconcentration and Flame Ionization Detection.

20. Question: Why is there a stipulation that monitors must not be located within 200 m of a major source when one is looking for the highest value of precursors? (SL)

Reply: It takes several hours for peak ozone concentrations to be formed as the result of chemical reactions among precursors. During this time, atmospheric dispersion also takes place. Hence, one is looking for high precursor concentrations which are representative of those within the city. We feel that locating a site within 200 m of a large individual source will not provide representative values unless there are many such sources throughout the city. See also the response to Question 12.

21. Question: Why does one look for the highest ozone and not the highest precursors? (SL)

Reply: The highest ozone is of interest to determine whether the NAAQS is currently being met and, in the event the standard is not being met, to provide assurance that proposed controls are sufficient to meet the NAAQS. The purposes for measuring ambient precursors are to find relatively high concentrations which are representative of the city so that they may be used to estimate prevailing NMOC/NO_x ratios and as a basis of considering the impact of post-8 a.m. emissions.

22. Question: In estimating mixing heights, does one interpolate between two NWS temperature soundings sites or is only one selected? (SL)

Reply: The nearest, most representative radiosonde sounding should be selected as explained in Sections A.1.1 and A.1.2 of the EKMA Guideline document. Interpolation is not recommended because the rate of change of temperature between the two soundings may not be linear, due to fronts or the effects of terrain on temperature aloft.

23. Question: What does one do if some of the required data are missing? (SL)

Reply: Missing data are of concern for two reasons: they are needed to generate ozone isopleths with the OZIPP computer program, or they are needed to estimate control requirements from the isopleth diagram(s) using the EKMA procedure. There are a number of built-in default procedures in the OZIPP computer program. These procedures are utilized in the event the user does not enter certain pieces of data. In other cases, the March 1981 Guideline document suggests procedures which can be followed in the event not all the information desired is available. One should familiarize oneself with the Guideline to learn what is possible if certain pieces of data are unavailable. In the event an appropriate course of action is still unclear, contact should be made with the appropriate EPA Regional Office and dealt with on an individual basis.

24. Question: Can one equate NMOC with NMHC? (SL)

Reply: No. The distinction between NMOC and NMHC is that the latter consists of hydrocarbon (i.e., organic molecules containing only carbon and hydrogen atoms), whereas the former contains other organic compounds as well. Since the smog chamber experiment against which the chemical mechanism in EKMA is calibrated included organic compounds other than hydrocarbons and the atmosphere does also, NMOC is the proper terminology.

25. Question: Since emission inventories include VOC which may exclude some emissions that may be measured by a monitor, does this present a problem? (SL)

Reply: Several nonreactive compounds are excluded from the emissions inventory (e.g., methane, ethane and several halogenated compounds). In contrast, these compounds (with the exception of methane) may be present in ambient NMOC samples. However, the concentrations of these nonreactive NMOC are a very small fraction of the total NMOC measured in an urban area. Thus, any resulting discrepancy between measured compounds and those included in the inventory is likely to be very small.

26. Question: Where does one site two wind monitors? (SL)

Reply: Table 1-1 of the EKMA Guideline document suggests that one site be placed in the high precursor area. The other site should be placed in an open area (but near the city) where the wind measurements taken would be most representative of the general wind flow through the urban area.

27. Question: Where is the list of NWS stations applicable to specific cities? (SL)

Reply: A list of NWS stations applicable to specific cities appears in Table A-1 on page A-3 of the March 1981 Guideline.

28. Question: Are there major changes between the draft and the final guidelines for city-specific EKMA? (SL)

Reply: There are enough changes between the draft and final Guideline to warrant obtaining a copy of the final version. Limited quantities of the final Guideline may be obtained by writing:

U. S. EPA Library
Mail Drop 35
Research Triangle Park, NC 27711

and requesting a copy of EPA-450/4-80-027, dated March 1981. The document is also available from the National Technical Information Service, Springfield, Virginia, as document PB81-118739 at a cost of $11.00.

III. Generating Ozone Isopleths for Use in EKMA

29. Question: How is temperature considered in the model? (P)

Reply: Surface temperature is used to estimate mixing heights as described in Table A-3 on page A-7 of the 1981 Guideline. The chemical kinetics mechanism in OZIPP uses certain rate constants which are most appropriate for temperatures of 80-90F.

30. Question: How can one get a better resolution for post 0800 emissions? (P)

Reply: It is possible to utilize a gridded, temporally-resolved inventory to compute post-8 a.m. emissions more precisely. However, for the reasons described on pages 31-32 of the March 1981 Guideline, resolution finer than 10 km x 10 km grid squares should not be used. It should be pointed out that fine spatial and temporal detail in the inventory is not particularly meaningful unless the wind field is accurately characterized. This is very difficult to do even with a data base commensurate with the use of Level I models. A depiction of the wind field which is accurate enough for use with finely resolved inventories is not likely with a Level III data base. Therefore, countywide inventories are recommended for use with city-specific EKMA.

31. Question: Must one calculate new post 0800 emissions everytime? (P)

Reply: As described on pages 47-48 of the March 1981 Guideline, when one applies the EKMA procedure to an isopleth diagram it is assumed in drawing the diagram that both initial conditions and post-8 a.m. emissions are reduced by the same proportion. Hence, for a given site, it is not necessary to calculate new post-8 a.m. emissions unless one is interested in seeing what happens if the reduction in post-8 a.m. emissions is not proportional to the reduction in initial concentration.

If one is concerned with modeling several different sites, the decision of whether or not to recalculate post 8 a.m. emissions becomes more subjective. Generally, if the new trajectory passes over the same counties at about the same time, it should not be necessary to recalculate post 8 a.m. emissions.

32. Question: Where do you start the column? (P)

Reply: Using a Level III or city-specific EKMA analysis, the column is assumed to start in center city near where the NMOC/NO_x ratio is measured.

33. Question: Assuming the parcel starts at center city, would one not recommend use of data later in the morning? (P)

Reply: No. The 6-9 a.m. NMOC/NO_x ratio is used as an indicator of the relative amount of NMOC and NO_x precursors available in the city to form ozone. The measurements are more reliable than later ones for two reasons. First, concentrations are higher and so the measurements are more accurate. Second, by mid-morning some of the photochemistry has proceeded. The result is that NO_x disappears more rapidly than NMOC, yielding higher ratios. Hence, it would not be appropriate to use such a ratio in the EKMA procedure.

34. Question: If one has HC/NO_x ratios later in the morning, can one use them? (P)

Reply: No. See the response to Question 33.

35. Question: Can one use an emission factor of zero? (P)

Reply: Ordinarily no. However, there are exceptions. For example, a trajectory which passed over a large body of water would have zero post-8 a.m. emissions.

36. Question: What are the advantages of the OZIPP program? (P)

Reply: OZIPP is relatively easy to run, is well-documented, allows one to consider local factors in assessing a city's ozone problem, allows consideration of both NMOC and NO_x in strategy development, provides isopleth diagrams which are very convenient for assessing the impact of a variety of strategies, and depicts relationships which are consistent with experimental data.

37. Question: To get the program on a tape, can you specify parameters needed for a specific system? (SL)

Reply: The OZIPP program is normally distributed on magnetic tape with characteristics which are fairly common to most computer systems. Upon special request, a specific tape characteristic will be processed, contingent on the capabilities of EPA's UNIVAC computer.

38. Question: Is the light intensity assumed in OZIPP based on clear sky values? (SL)

Reply: Yes.

39. Question: Large changes in predicted max - 1 hour concentration with varying light intensity seem inconsistent with small control requirement changes. (SL)

Reply: The workbook cites a study in which peak ozone levels were found to vary from 4 to 23% between two different light intensities, whereas control requirements varied by only 1 to 2%. First, it should be noted that peak ozone levels varied only between 4 and 7% for NMHC/NO_x ratios of 5:1 to 20:1 (the range most common in urban areas). Thus, the apparent large difference in sensitivity between peak ozone and control requirements is not that great under usual conditions. Furthermore, peak ozone levels were found to decrease proportionately with a decrease in light intensity. Therefore, a set of isopleths generated with lower light intensity should have the same relative shape and spacing as the isopleths generated with the higher light intensity. As a consequence, control requirements, which are a function of relative distance between two isopleths, should be nearly the same. Looking at this another way, light intensity affects the peak level under existing conditions and the case of reduced emissions corresponding to the standard. If changing the light intensity affects both of these levels by roughly the same degree, then the relative change between existing levels and the standard should be very nearly the same for different light intensities, as borne out by the results of the sensitivity analysis.

40. Question: Has work been done to input intermediate mixing heights (other than early a.m. and max)? (SL)

Reply: Use of "intermediate" mixing heights has been evaluated by means of a city-specific EKMA sensitivity test. Results of these tests have shown that intermediate mixing heights are not important when the relative change between the early morning mixing height and the maximum afternoon level is small. The intermediate levels (i.e., the actual diurnal pattern) become more important for large differences. Usually, however, insufficient data exist to specify adequately the diurnal variation in mixing height, especially during the breakup of the nocturnal inversion that normally takes place in mid-morning. A characteristic curve algorithm for depicting the diurnal variation in mixing height is currently incorporated in Version II of OZIPP. This algorithm is based on observation of intermediate levels, as well as theoretical considerations, and provides a more realistic representation of the dilution process than was originally incorporated in OZIPP. Unless sufficient data exist to specify more precisely the diurnal pattern, use of the characteristic curve algorithm is recommended.

41. Question: With new nationwide VOC controls, will transport levels decrease? (SL)

Reply: Yes. Pages 52-60 and Appendix B in the March 1982 Guideline provide specific suggestions on how to consider this in city-specific EKMA.

42. Question: Is the NMOC transport aloft example in the workbook based on the new mixing height curve? (SL)

Reply: The sensitivity tests for precursor transport reported in the Workbook and Appendix B of EPA-450/4-80-027, Guideline for Use of City-specific EKMA in Preparing Ozone SIPs, were conducted prior to the incorporation of the characteristic curve in OZIPP, and thus the exponential algorithm originally in OZIPP was used. However, spot checks of the calculations were performed using the characteristic curve, and little, if any, difference was found. Again, these test results provide a general guideline for delineating regions in which transport levels may become important. They are not intended to be used for specific estimates of the effects of precursor transport for a given city.

43. Question: Are the NMOC concentrations in the surface and aloft transport additive for O_3? (SL)

Reply: In general, the effects of precursor transport aloft and in the surface layer are not additive. Apparently, this results from the nonlinearities associated with the ozone formation process.

44. Question: Has some type of analysis been done on ozone transport? (SL)

Reply: Yes. Over the past several years, efforts have been undertaken to (a) document the extent of transported ozone, and (b) note the impact of transported ozone levels on calculated control requirements. There are many references documenting the extent of transported ozone. The most recent edition of the Criteria Document for Ozone (EPA-450/8-78-004), as well as EPA-600/3-77-117 provide good starting points for those interested in learning about the extent of transport. EPA-450/2-77-021b provides one of the few published references on the sensitivity of EKMA to transport. Much, as yet unpublished, work on the sensitivity of EKMA results to transport has been done more recently. Some results are printed on pages 105, 107 and 133-138 of the Workbook which was distributed at the recent Workshops on Procedures to Demonstrate Attainment of the NAAQS for Ozone in the 1982 SIP's.

45. Question: Are direct measurements of precursors NMHC or NMOC, reactive or nonreactive? (SL)

Reply: There are very few volatile organic compounds classified as "non-reactive." With the exception of methane, these are generally present in small concentrations in the urban atmosphere. Hence, reported NMOC levels consist almost entirely of "reactive" compounds.

46. Question: Explain distinction between control points and control requirements? (SL)

Reply: Control requirements refer to the percent reduction in VOC emissions necessary to achieve the ozone standard. In sensitivity analyses, the importance of a particular variable is evaluated by its effect on the VOC control requirements, which necessitates speaking in terms of differences in control requirements. For example, the difference between 50% control and 45% control is 5%. Note that this does not refer to a percent difference. In one Workshop, the absolute difference (i.e., 5%) was referred to as control points, in order to distinguish between an absolute difference and a relative, or percent difference.

47. Question: Why simulate initial concentrations when one has measured data? (SL)

Reply: A variety of initial conditions are simulated in order to generate an isopleth diagram. Such a diagram provides a convenient short hand way of depicting changes in peak ozone levels which might accompany a variety of changes in NMOC and/or NO_x.

48. Question: Can one assume uniform emissions during the day? (SL)

Reply: This is an acceptable procedure if there is no good basis for making better estimates.

49. Question: Does one consider major sources along the trajectory line? (SL)

Reply: Yes, unless there is reason to believe that the effective plume height is greater than the afternoon mixing height.

50. Question: Can one input a city-specific propylene/butane fraction? (SL)

Reply: No. The equivalent propylene/butane split has not been established for any atmospheric mix other than the automotive mix used in the original Bureau of Mines Smog Chamber Studies. Thus, there is no basis for making other assumptions.

51. Question: Can one monitor in an area heavily impacted by traffic to adjust ratio? (SL)

Reply: No.

52. Question: For NO_2/NO_x ratio, would one average results for all sites? (SL)

Reply: Yes.

53. Question: How will fractions change when emissions from stationary sources are reduced? (SL)

Reply: Ordinarily, the emission fractions would not change. The default assumption in the EKMA isopleth diagram is that both initial concentrations and post-8 a.m. emissions are reduced in the same proportion.

54. Question: Should data collected in an area dominated by industrial sources be used? (SL)

Reply: If the precursor data are dominated by individual sources or if there is reason to believe that the ambient chemical composition of the air is radically different from that of the urban area, these data should not be used in Level III EKMA analysis. This is consistent with the propylene/butane split derived from the Bureau of Mines Smog Chamber data.

55. Question: Can the model be adjusted to give NO_2 levels? How good are the predictions? (SL)

Reply: A modified version of the OZIPP program is needed to generate peak hourly NO_2 isopleths. The model's NO_2 predictions agree well with smog chamber data. However, there has not been an extensive effort underway to evaluate the performance of the model in predicting NO_2 using other criteria.

56. Question: What is the basis for the statement that NO_2/NO_x is not important? (SL)

Reply: Neither predicted peak ozone concentrations nor estimated control requirements appear sensitive to the initial NO_2/NO_x ratio.

57. Question: Does free format only apply to PLACE?

Reply: A free format card follows the PLACE option card, and one also follows the TITLE option card. Several of the other option cards may require subsequent fixed format cards in some cases. Input formats for the OZIPP option cards are summarized on pages 57-67 of EPA-600/8-78-014a, User's Manual for Kinetics Model and Ozone Isopleth Plotting Package.

58. Question: Why use CALCOMP plotter? (SL)

Reply: The CALCOMP plotter can be used to generate an isopleth diagram. A diagram generated in this fashion is neater, more precise and usually easier to work with than the standard line printer generated diagram.

59. Question: If there are two options for control needed, does one use PLOT or CALCULATE option? (SL)

Reply: The CALCULATE option is used to perform a single simulation - i.e., make a prediction of peak ozone from a given set of NMOC and NO_x initial concentrations. The ISOPLETH option is used to generate an isopleth diagram, i.e., produce a diagram showing peak ozone concentrations as a function of variable initial NMOC and NO_x concentrations. The isopleth diagrams are used to calculate control requirements. The PLOT option is used with the ISOPLETH option to generate a plotter version of the diagram. The PLOT option does not apply to the CALCULATE option.

60. Question: What is UNIVAC capacity? What size computer is needed for the model? (SL)

Reply: The OZIPP program requires about 50k word storage on the UNIVAC computer. This corresponds to approximately 200k bytes of storage.

61. Question: Can data only be input on cards? (SL)

Reply: The OZIPP program is a batch oriented program, reading input data from cards. On some computer systems, input data can be stored in files in card-image format and input to the program. That capability is completely system dependent, and must be determined on a case by case basis.

62. Question: Are there procedures to check-out program on a State's computer? (SL)

Reply: An Addendum to the OZIPP User's Manual explains Version II of OZIPP, and contains two example OZIPP runs. These examples may be used as benchmarks to insure proper operation on individual computing systems.

63. Question: Can one compare results against standard EKMA curves? (SL)

Reply: One can make such comparisons, but city-specific EKMA is likely to give somewhat different answers. Because of the conservative assumptions in standard EKMA, city-specific EKMA will likely show lower control requirements in most, but not necessarily all, situations.

64. Question: Is the 250 m height just an example or is this the value to be used as a minimum? (SL)

Reply: 250 meters is to be used for the mixing height at 0800 LCT if 1) the mixing height estimated by the method in Appendix A of the Guideline document is less than 250 meters, or 2) if no morning mixing height value is available.

65. Question: Is 250 m a default value for OZIPP? (SL)

Reply: No. If one fails to specify a morning mixing height, the OZIPP program assumes a value of 510 m. This is based on the climatological mean value for Los Angeles. Note, however, that 250 m is the recommended minimum morning mixing height.

66. Question: Does one also use 250 m when calculated value is < 250 m? (SL)

Reply: Yes. This is generally a good idea when utilizing Level III EKMA (with the trajectory beginning in the urban area). It is based on observations of urban vertical profiles which suggest significant levels of precursors can exist above the calculated morning mixed layer in urban areas. Hence, if one used a morning mixing height substantially less than 250 m, one would overestimate the amount of dilution of initial precursor concentrations occurring later in the day.

67. Question: Is there a maximum height for the program? (SL)

Reply: The computer program used to estimate mixing heights (published as EPA-450/4-81-022) uses a value of twice the normal daily summer maximum mixing height to warn the user of a possible high value for mixing heights. The value is entered by the user and can be found in Table A-1 of the EKMA Guideline document or in AP-101. This feature allows the user to check the high mixing height for accuracy before entering it into EKMA/OZIPP.

68. Question: Is diagram presented in the workbook typical for cities other than Philadelphia? (SL)

Reply: The diagram of pollutant and temperature vertical profiles for Philadelphia is similar to profiles measured by helicopter on other days in Philadelphia and during the St. Louis RAPS. The inversion above the urban mixed layer (see Questions 74 and 91) will trap most pollutants emitted near the surface. This causes a layer of pollutants to be trapped below the cleaner air above the inversion. The ozone concentration below the inversion is less than the concentration above due to scavenging of the ozone by nitric oxide emissions.

69. Question: In coastal situations, if one has two measurements of mixing height, one on the coast and one further inland, which one should be used in OZIPP? (SF)

Reply: The mixing height that is most representative of the urban area (where the EKMA/OZIPP trajectory is assumed to start) should be used for the 0800 LCT mixing height.

The choice for maximum mixing height depends on where the downwind ozone peak occurs. If the site observing peak ozone is in a coastal situation (e.g., a sea breeze) at the time of maximum ozone, the coastal mixing height should be used. Otherwise (even if the EKMA/OZIPP trajectory passes over water), the inland mixing height should be used for the maximum mixing height.

70. Question: In the draft guideline, the minimum morning mixing height of 150 m was recommended instead of 250 m as now presented, which is correct? (SF)

Reply: 250 m. See the response to Questions 64 and 66.

71. Question: What are the criteria for not using mixing height program for 0800? (SF)

Reply: If a radiosonde site that is meteorologically representative of the urban area cannot be found, due to a front between the city and nearby radiosonde stations, the method for finding the 0800 LCT mixing height, as explained in the Guideline document should not be used and a value of 250 meters should be used for EKMA/OZIPP. (See pages A-1 through A-4 in the Guideline document.)

72. Question: Is this method strictly for urban use? (SF)

Reply: The method for estimating mixing heights as described in Appendix A of the EKMA Guideline document and the mixing height computer program (EPA-450/4-81-022) can be used at rural as well as urban sites. The only information needed at the surface is the measured air temperature and an estimate or measurement of the surface air pressure (as explained in Appendix A). A problem occurs when a surface-based stable layer is found by this method. The 250 meter minimum value for an urban mixed layer at 0800 LCT is too deep for rural use. A rural "mixed" layer of 100 meters has been used by Schere and Demerjian (A Photochemical Box Model for Urban Air Quality Simulation. Proceedings, 4th Joint Conference on Sensing of Environmental Pollutants, published by American Chemical Society 1978) as an estimate of the vertical dispersion of surface-emitted pollutants due to wind turbulence and diffusion.

73. Question: How many areas were analyzed in regard to urban temperature profiles? (SF)

Reply: The work of Godowitch, et. al, (Dissipation of the Nocturnal Inversion Layer at an Urban and Rural Site in St. Louis, Missouri. Preprints, 4th Symposium on Turbulence, Diffusion and Air Pollution, January 15-18, 1976, Reno, NV. Published by American Meteorological Society) using St. Louis RAPS helicopter data was used along with an analysis of six helicopter temperature and pollutant soundings taken in Philadelphia on clear mornings around 0800 LDT. The limited data from Philadelphia show an urban mixed layer similar to the layer found by Godowitch, et. al, in St. Louis. Since the urban mixed layer is generally not detected by the recommended objective method described in Appendix A of the EKMA Guideline document or by sodar, we suggest using a 250 meter urban mixing height as a minimum value at 0800 LCT in EKMA/OZIPP. If low level sounding data (slow ascent radiosondes, helicopter soundings, etc.) are available in an urban center, we can work with a local or regional group to estimate the height of the urban mixed layer for a given day.

74. Question: Is it typical that urban areas will generally be unstable in the lowest 100 m? (SF)

Reply: A typical urban temperature sounding will have a less stable layer under the urban inversion layer due to heating from buildings and other urban surfaces and mechanical mixing due to greater surface roughness in the urban area. According to Godowitch, et. al, (1979), the urban mixed layer has an average minimum height of 160 meters.

75. Question: What does one have to do if there is no upwind surface measurements or direct measurements aloft? What about using 2/3 value of carryover from previous day? (SF)

Reply: The need for upwind measurements has been identified for several years. A city for which there are no upwind data should therefore constitute a special case which will need to be addressed on an individual basis with the appropriate EPA Regional Office. It is not possible to say whether or not the procedure proposed in this question is appropriate without being familiar with the particulars of the individual case.

76. Question: How constant are the ozone values aloft? Both spatial or time variation? Would it be more representative to use average ozone aloft instead of a value on a specific day? (SF)

Reply: Values of ozone aloft (above the mixed layer) vary slightly in time and space. The variation depends on the history of the air at various altitudes and locations. These differences are caused by changes in wind speed and direction with height and time. However, the average ozone above the mixed layer (i.e., not due to local precursors) on a given day can have a significant effect on the control requirement for that day (see Section 3.1.3 of the EKMA Guideline document) in some cases. Thus, using the average value for a set of days could result in violations of the ozone standard after the application of controls if the actual concentration of ozone aloft on the controlling day is greater than the average concentration of ozone aloft.

77. Question: Concerning sensitivity to ozone, if one says that ozone surface transport is not important and then one says OZIPP is sensitive to dilution and emissions, aren't these inconsistent? (SF)

Reply: No. The impact of ozone transported in the surface layer is to immediately convert initial NO to NO_2. However, this occurs in any event as the result of photochemistry. Sensitivity tests conducted thus far suggest that realistic concentrations of ozone transported in the surface layer in the early morning hours have little effect on peak ozone levels estimated with the model or on calculated control requirements.

78. Question: In severe control cases, would one expect ozone surface transport to be important? (SF)

Reply: After imposition of severe controls, boundary conditions become more important determinants of peak ozone. Therefore, it is conceivable that ozone surface transport could be more important after most of the city's emissions have been eliminated.

79. Question: Does one assume ozone aloft will be affected by control strategies? (SF)

Reply: Yes. A procedure for doing this is described on pages 52-57 of the March 1981 Guideline.

80. Question: EPA has used 1100-1300 estimate for surface ozone but not for precursors, what is the rationale for doing this? (SF)

Reply: We suggest that 1100-1300 Local Daylight Time surface ozone readings taken upwind of the city be used as an indicator of ozone transported aloft. It is also suggested that 6-9 a.m. LDT readings be used to estimate ozone and precursors transported in the surface layer. The difference in recommended times is a result of the presence of the nocturnal surface-based temperature inversion which causes stable stratification of the atmosphere. Generally, the atmosphere does not become well mixed until sometime after 9 a.m. Hence, 6-9 a.m. surface measurements would not necessarily be accurate indicators of ozone transported aloft. The 1100-1300 LDT suggestion is based on the supposition that this is shortly after the breakup of the nocturnal surface based inversion, but before a large amount of ozone is formed as the result of photochemistry. The 1100-1300 LDT recommendation is not a hard and fast rule. If an area has more locally specific information on when the nocturnal surface-based inversion disappears, this information may be used to select some other time for using surface data to estimate ozone transported aloft.

81. Question: If one could eliminate local contribution and transport, could one use surface concentration to estimate ozone aloft? (SF)

Reply: As discussed in the response to Question 80, surface measurements can be used to estimate ozone transported aloft. However, the ground rules described in the previous response would still be necessary. Prior to breakup of the nocturnal inversion, ozone in the surface layer would be subject to surface deposition, whereas ozone transported aloft would not. Hence, use of early morning surface measurements would probably underestimate ozone concentrations transported aloft overnight.

82. Question: If one assumes a straight line trajectory with uniform speed, is this what actually happens in the real world? (SF)

Reply: Probably not. However, it is exceedingly difficult to precisely define individual trajectories, even with a data base suitable for use with Level I models. Indeed, the usual procedure with Level I models is to mathematically smooth trajectories. The trajectory used in city-specific EKMA assumes that highest observed ozone levels are, to an important degree, impacted upon by areas with the highest precursor concentrations. Such wind data as do exist should be used to establish that a monitoring site observing high ozone is downwind from the city on the days being modeled. Whether the exact trajectory assumed in the modeling exercise is followed is not so important unless the emission inventory is spatially and/or temporally resolved to great detail. If county wide emissions are used (as recommended on pages 28-31 in the March 1981 Guideline), failure to describe a trajectory accurately is mitigated.

83. Question: Is emission fraction always based on initial height of column? (SF)

Reply: The procedure described in Section 3.1.5 of EPA-450/4-80-027, Guideline for Use of City-specific EKMA in Preparing Ozone SIPs, requires use of the initial mixing height in calculating emission fractions. While other procedures are possible, the recommended approach is most consistent with the conceptual basis of city-specific EKMA.

84. Question: Is it valid to do back trajectory with surface wind data? (SF)

Reply: For the trajectory in EKMA/OZIPP, a column of air is assumed to move with the general wind flow downwind of the city. More sophisticated trajectory methods are not recommended because:

1) the methods attempt to track each parcel of air, while, in fact, many parcels of air from different locations in the urban area make up the column of air that has the maximum ozone concentration,

2) wind networks are often too sparse and sites unrepresentative of the general wind flow to make a true representation of the wind field possible,

3) during stagnation periods, local effects on wind monitors are accented due to the variable wind direction at low wind speeds,

4) influences such as sea or lake breezes are hard to model properly due to their changing extent in space and time, and because the model is not designed to explicitly handle vertical motions or recirculation cases.

Many of these problems occurred when trajectories were constructed from St. Louis RAPS data.

Approximate trajectories, using smoothed wind fields from highly resolved networks, can be used to provide an indication of whether a city is responsible for a peak ozone value.

85. Question: What does EPA define as low initial concentration? (SF)

Reply: A "low initial concentration" is one that results in peak ozone and control requirements being almost entirely determined by post 8 a.m. emissions. It is not possible to give a firm definition of "low," because it depends on a number of factors, including the amount of post 8 a.m. emissions and dilution. However, generally initial NMOC levels less than about 0.05-0.10 ppmC and NO_x levels less than about .005-.01 ppm may be regarded as "low" for most urban areas.

86. Question: If the post 8 a.m. emissions are assumed to be uniform, how can this be of any use in determining precise control strategies? (SF)

Reply: Fresh emissions may affect calculated control requirements in some instances. Thus, they are useful in helping to establish overall control targets for the city to meet. Precise impacts of a control strategy (e.g., what will happen at location j if emissions are reduced by x% at location i) can only be determined using Level I models. Level III modeling is most suitable for establishing urbanwide emission reduction targets.

87. Question: If one eliminates the post 8 a.m. emissions, is the analysis still considered to be a city-specific EKMA application that would be approved by EPA? Does it meet EPA's definition of what is required? (SF)

Reply: Ordinarily, post 8 a.m. emissions should be considered. However, there may be some occasions when this may not be necessary. Decisions of this nature would have to be made on a case by case basis in consultation with the appropriate EPA Regional Office. Generally, for cases in which very high initial precursor concentrations exist, high morning mixing heights prevail and peak ozone concentrations occur well downwind from a city in a county with low emission density, post 8 a.m. emissions may not be a key factor in determining control requirements.

88. Question: If post 8 a.m. emisions are derived from the emission inventory, shouldn't initial conditions also be derived from emission inventory instead of from measured air quality values? (SF)

Reply: Ambient concentrations of precursors are what react to form ozone. Whether or not initial ambient conditions are derived from an emission inventory depends on the degree of confidence one has in estimates of early morning emissions, trajectories, mixing heights, and the suitability of a trajectory model for simulating periods of the day where a large degree of windshear is often likely. Ordinarily, we believe it is more appropriate to base initial conditions on direct ambient air quality measurements. However, we recognize that there may be some cases in which derivation of initial conditions from emission inventories may be a more appropriate alternative. This is more likely to be the exception rather than the rule in our opinion, however.

89. Question: A statement was made that ozone production was not actually sensitive to HC composition changes in smog chamber studies. Was the change in composition and reactivity of HC considered? (SF)

Reply: The statement which was made was that the available smog chamber data suggest that peak ozone is less sensitive to changes in NMOC composition than implied by some models. Changes in the composition and reactivity of the NMOC composition were considered in these experiments.

90. Question: Why does one sometimes get a reversal in plotting? Is this due to double peaks? (SF)

Reply: In some rare instances, the algorithm for interpolating the ozone isopleths may lead to so-called reversals. The problems may sometimes be corrected by slightly altering some of the OZIPP inputs that control the generation of the diagram. Examples include changing the NMOC and/or NO_x scales, the isopleth lines which are generated, or the density of simulations as controlled by the ACCURACY option. If the reversal occurs for an isopleth which is not being used, it may simply be ignored.

IV. Application of Isopleths in EKMA Procedure

91. Question: How do you treat ratios greater than 30:1? (P)

Reply: The same as other ratios. However, a ratio of 30:1 is substantially higher than would be expected for an urban area. The appropriateness of the data should be carefully checked in such a case.

92. Question: Is it appropriate to develop an NO_x strategy for controlling O_3? (P)

Reply: It may be. This would depend on such factors as the prevailing NMOC/NO_x ratio, current ozone levels and the feasibility of reducing NO_x emissions in the city by the needed amount. Increasing NO_x to reduce local ozone levels is not an acceptable strategy, because it may aggravate multiday transport problems.

93. Question: If one has more than one monitor operating on the same day, how does one compute design ratios? (P)

Reply: See pages 42-43 of the March 1981 Guideline.

94. Question: How does one handle stagnation when developing isopleth diagrams? (P)

Reply: The same as other days. See page 25 of the Guideline for suggestions for estimating extent of transport on such a day.

95. Question: Do NMOC and NO_x monitors have to be collocated to generate design ratios? (P)

Reply: Generally, yes. There may be rare occasions where State statutes or regulations prevent this. Such cases will need to be considered on a case by case basis in concert with the appropriate EPA Regional Office.

96. Question: Is there a limit on the base point for NMOC and/or NO_x levels? (P)

Reply: The EKMA technique requires locating a base point on the isopleth diagram by finding the intersection of the measured NMOC/NO_x ratio line with the ozone isopleth corresponding to the observed peak. Because of the simplifying assumptions made in the EKMA technique, the NMOC and NO_x coordinates of the base point will most likely disagree with the 6-9 a.m. NMOC and NO_x levels measured in the urban area (i.e., the model will not predict O_3 perfectly). If the disagreement is large, the validity of using the technique may be questioned. As a guide to determining if the disagreemnt is extreme, the following procedure may be employed. The 6-9 a.m. NMOC and NO_x levels measured in the urban core may be used to predict an ozone level using either the isopleth diagram or the CALCULATE option in OZIPP. If the predicted ozone level differs from the observed level by more than ±50%, then the disagreement is significant (note that this disagreement is in ozone levels, not NMOC and/or NO_x levels). In such a case, the input data used to generate the isopleth diagram should be checked. Especially important are the inputs affecting dilution, post 0800 emissions and O_3 transported aloft. If no improvement can be made, a decision as to the feasibility of the EKMA technique in this individual case will have to be made in concert with EPA.

In the above procedure, an ozone prediction differing from an observed level by less than ±50% was used as the criterion for acceptable model performance. It must be emphasized that the control requirement calculations are made in the relative sense (i.e., it is the change in O_3 levels that is desired). The factors that affect the absolute predictions are the same as those that control the positioning of the isopleths on the diagram, i.e., dilution, post 0800 emissions, transport, sunlight, etc. Sensitivity studies have shown that the control calculations are relatively insensitive to changes in these parameters over the ranges normally encountered. Thus, if the ozone prediction agrees with the observed level within a ±50% range, then any further improvement may have little effect on control estimates.

97. Question: Should one take into account future emissions reductions from past controls, i.e., 1979 SIP control requirements? (P)

Reply: Yes.

98. Question: Must one always go through the 10-h simulation period when developing isopleths? (P)

Reply: The OZIPP program is designed to automatically perform a 10-hour simulation starting at 0800 LDT and ending at 1800 LDT even though, in many instances, the observed ozone peak may occur in the early afternoon. Simulations with city-specific EKMA and other more sophisticated models have shown that when VOC emissions are reduced, the peak ozone levels tend to occur later in the day. Therefore, to insure that the control strategy will reduce the peak 1-hour average O_3 level to .12 ppm throughout the day, the 10-hour simulation must be run.

99. Question: Are there any considerations for significant changes in emissions over the three year period? (P)

Reply: If major changes in emissions have been implemented during a three year base period, a shorter base period, reflecting previous large reductions in emissions, should be used.

100. Question: Is it true that the more monitors one has, the greater the control requirements? (P)

Reply: Not necessarily, however the likelihood is increased.

101. Question: When does one decide when transport is to be considered? (SL)

Reply: The transport of O_3 aloft should always be considered. Consideration of ozone transport in the surface layer is optional. In general, the consideration of precursor transport is not recommended, but may be considered if the necessary measurements are available. In such cases, some sensitivity testing may be performed to assess the importance of the precursor transport. Appendix B of EPA-450/4-80-027, Guidelines for Use of City-specific EKMA in Preparing Ozone SIPs, contains procedures along with some sensitivity results that serve as a guide in conducting the analysis.

102. Question: Should one use design value or peak value? (SL)

Reply: Model estimates should be utilized as described on pages 10-15 of the March 1981 Guideline rather than using a single peak or design value for ozone.

103. Question: When does one use mean ratio and when does one use median ratio? (SL)

Reply: Providing there is close agreement among ratios observed at all sites in a city on a given day, the mean 6-9 a.m. ratio from these sites is used to model that day. If there is only one NMOC, NO_x monitoring site, or if poor agreement results among the ratios at different sites, the median ratio from all days selected for modeling is used. The procedure for calculating NMOC/NO_x ratios is described in detail on pages 40-43 in the March 1981 Guideline.

104. Question: Why not use mean rather than median? (SL)

Reply: The median ratio is generally less influenced by widely divergent erroneous measurements.

105. Question: How does one calculate NMOC/NO_x ratio? (SL)

Reply: See pages 40-42 of the March 1981 Guideline.

106. Question: Why is CDT equal to zone 6? (SL)

Reply: It is necessary to specify "time zone" in order to accurately define solar zenith angles. Use of a "6" for CDT is consistent with the internal computer code for the model, as explained on page 39 of the OZIPP User's Manual (EPA-600/8-78-014a).

107. Question: Why doesn't one have a start or stop time for simulation? (SL)

Reply: The OZIPP program is set to begin all simulations at 0800 LDT and end them at 1800 LDT. The choice of these times is selected to correspond to the conceptual basis of the model and the data typically available for use with city-specific EKMA. If one were to consider a different starting time, the only option would be a time earlier than 0800 LDT since a simulation must be started before the photochemical reactions proceed to any appreciable extent. However, a time much earlier than 0800 LDT would require some idea of the early morning air parcel trajectory, the NMOC and NO_x ratio at the time and location of the trajectory starting point, and emissions along the trajectory. Such an approach is more consistent with a Level II or Level I modeling approach (i.e., detailed trajectory analyses), and requires far much more emissions, air quality, and meteorological data than are typically available for a city-specific EKMA analysis. With regard to the ending time, see Question/Response 98.

108. Question: Why did EPA use default values for isopleths? (SL)

Reply: Some values had to be chosen to illustrate the isopleth diagrams and the EKMA procedure.

109. Question: What is the applicable date of future diagram? (SL)

Reply: Generally, 1987.

110. Question: Why is 1987 used rather than some other year? (SL)

Reply: Because that is the year by which the 1982 SIPs are supposed to be trying to demonstrate attainment of the ozone NAAQS.

111. Question: Why doesn't one change emissions for the future? (SL)

Reply: See the responses to Questions 31 and 53. It is possible to change emission fractions in the future if one has reason to believe that the change in post 8 a.m. emissions will not be proportional to the change in initial precursor concentrations in the city. The procedure for doing this is described on pages 59 and 60 of the March 1981 Guideline.

112. Question: How does one arrive at changes in ozone aloft (.06-.08)? (SL)

Reply: The procedure for estimating changes in ozone transported aloft between the base and future periods is described on pages 53-55 of the March 1981 Guideline.

113. Question: How does one decide if areas upwind are attainment or nonattainment? (SL)

Reply: This is subjective and needs to be done in consultation with the appropriate EPA Regional Office. A good procedure would be to look at a map depicting upwind counties which are classified as nonattainment versus those which are unclassified. If the emissions in the "nonattainment counties" are much lower than those in the unclassified counties, it would be appropriate to assume that the upwind area is "nonattainment."

114. Question: If one has better data on upwind transport, should you adjust ozone transport curve? (SL)

Reply: The ozone transport curve (page 54 of the March 1981 Guideline) should not be regarded as immutable. If there is reason to believe that more locally applicable information exists, this should be discussed and agreed upon with the appropriate EPA Regional Office.

115. Question: Does one need to calculate a new NMOC/NO_x ratio for the future case? (SL)

Reply: No. This is done implicitly whenever one applies EKMA to an ozone isopleth diagram.

116. Question: How does one calculate NO_x levels for the future? (SL)

Reply: One should project future NO_x emissions considering such factors as national and local NO_x control programs, growth and retirement of older sources. Changes in ambient NO_x may be assumed to be proportional to the projected change in NO_x emissions. One exception to this general rule would be if a point source's effective plume height were above the estimated afternoon mixing height. Changes in emissions from such a source should be disregarded in the analysis.

117. Question: If two sites have high ozone concentrations on the same day, does one need to do two separate analyses? (SL)

Reply: As a rule, yes. It is necessary to demonstrate attainment at all operating sites. However, it may be possible to use the same isopleth diagram(s) for both sites if they are located in the same county and the peak O_3 levels occur at about the same time of day.

118. Question: Are States supposed to model all the highest days at all sites? (SL)

Reply: Yes. However, as indicated in the response to Question 117, it is not always necessary to generate separate isopleth diagrams for each site-day. For example, if two sites observed a high ozone concentration on the same day and the other inputs (e.g., post 8 a.m. emissions) to the OZIPP program were similar, the same diagram(s) could be used for both sites.

119. Question: How does EPA know that the control requirement is correct? (SL)

Reply: There is no guarantee of this. However, as discussed in the response to Question 144, the impact of control strategies calculated with city-specific EKMA is generally similar to that estimated with more sophisticated Level I models.

120. Question: Why do emissions factors drop for the last three hours assuming example on page 130 of the workbook is realistic? (SF)

Reply: The emission factors for the last three hours decrease to reflect the movement of the air parcel from the high emission density urban core to a lower emission density suburban area downwind of the city.

121. Question: On the base diagram in the workbook, only two curves are shown, in practice how many curves would one construct? (SF)

Reply: In practice, the number of curves to be constructed would be dictated by the purpose for which the diagram is to be used. For example, if control estimates are needed, then only two isopleths would actually be used - one corresponding to the observed peak ozone level and one corresponding to the standard (i.e., .12 ppm). In some instances, however, it may be desirable to estimate the effectiveness of potential control strategies. For example, the following question may be asked: "What will be the future ozone peak if VOC emissions are reduced by 30%, 40%, and 50%, respectively?" For this situation, it would be desirable to construct enough isopleths to allow reasonable interpolation between the observed level and the standard. Note also, that in some situations, a single diagram may be used for more than one measured ozone peak (e.g., two sites experiencing high ozone levels on the same day). In such a case, ozone isopleths for each observed level being modeled would be constructed.

122. Question: Is a 10% increase in NO_x in the diagram in the workbook (page 132) representative and how was it derived? (SF)

Reply: The 10% NO_x increase was assumed for illustrative purposes only. In actual analysis, the change in NO_x must be projected on a case by case basis. The second paragraph on page 47 of

EPA-450/4-80-027, Guideline for Use of City-specific EKMA in Preparing Ozone SIPs, provides some general considerations in making such projections.

123. Question: If one has specified VOC reductions (i.e., 55%) how would one estimate NO_x reduction, wouldn't one get two values? (SF)

Reply: If the VOC reduction were to be specified initially, the change in NO_x emissions that would be needed to meet the ozone standard could be found. The procedure would be to locate the base point on the isopleth diagram as always. The the NMOC base level would be reduced by pre-specified VOC reduction (i.e., by 55% in the example). The change in NO_x emissions needed to meet the ozone standard would then be found on the .12 ppm isopleth at the reduced NMOC level. For example, if the base NMOC level were 1.0 ppmC and a 55% reduction in VOC emissions were specified, the reduced NMOC level would be 0.45 ppmC. Using the isopleth diagram, the NO_x level(s) on the .12 ppm ozone isopleth would be found at the point(s) at which NMOC was .45 ppmC (i.e., the point at which NMOC equals .45 ppmC and ozone equals .12 ppm). The NO_x change would be computed as the % difference between the new NO_x and the base point NO_x.

Theoretically, two possible NO_x solutions could exist. One in which NO_x was increased and one in which NO_x was decreased. More than likely, technical limitations will be associated with each. Large reductions in NO_x emissions may not be technologically possible. On the other hand, large increases in NO_x emissions would not be permissable due to the NO_2 standard, and because the increased NO_x emission would likely result in ozone problems further downwind. Consequently, the opposite approach is recommended for control strategy development: (i.e., relatively small anticipated changes in NO_x should be estimated first and then the change in VOC emissions needed to achieve the standard should be calculated).

124. Question: The calculations only relate to peak ozone, how would one relate an NO_2 standard to diagram? How could one relate the annual NO_2 standard to changes in NO_x levels to meet the ozone NAAQS? (SF)

Reply: The standard OZIPP program is not designed to generate peak hourly NO_2 isopleths. Under most circumstances, proportional rollback is a suitable means for estimating the impact of NO_x control strategies on peak short term and annual average NO_2, providing the impacts of certain source categories are discounted. A detailed description of suitable simplified modeling procedures for NO_2 is contained in Technical Basis for Developing Control Strategies for High Ambient Concentrations of Nitrogen Dioxide, EPA-450/4-80-017.

125. Question: If one has an NO_x problem, couldn't one run the program for the winter case since NO_x levels are higher then and therefore consider seasonal control of HC? (SF)

Reply: See the response to Question 124.

126. Question: Wouldn't the impact of the Federal Motor Vehicle Control Program affect the average NO_x conditions? (SF)

Reply: Yes. This should be factored in to the projections for NO_x when using the EKMA isopleth procedure.

127. Question: Should one expect much reduction from the control strategy by reducing ozone aloft? (SF)

Reply: An assumed reduction in the levels of ozone aloft will lower estimates of controls necessary to meet the ozone standards. The degree of that reduction can only be determined on a case by case basis.

128. Question: Is there an assumption in example 1, page 142 of the Workbook, that sites are far enough apart that input variables vary? Why can't one just choose a design value? Can an example be provided where one just uses a design value? (SF)

Reply: In the example problem, percent reduction estimates are assumed to have been determined on a site by site basis. That is, isopleth diagrams were developed for each site for each day.

Pre-1982 SIP procedures for estimating VOC emission reductions involved the concept of a design value. Pages 8 and 9 of EPA-450/4-80-027, Guideline for Use of City-specific EKMA in Preparing Ozone SIPs, contain the rationale for replacing the design value concept with the specific site/day modeling approach.

129. Question: Suppose one had two HC measurements and two ozone monitoring stations downwind, shouldn't one look at the meteorology and establish if there are source-receptor relationships before one develops a control strategy? (SF)

Reply: As suggested on page 10 of the March 1981 Guideline, one should review the wind data to ensure that only those cases in which the city impacts the ozone monitor (i.e., the monitor is not upwind of the city) are modeled. If a monitor is clearly not impacted by the city on a given day, that siteday should not be modeled, even if the observed ozone level is very high.

130. Question: If one has numerous ozone, HC and NO_x stations, wouldn't it be necessary to go through more extensive trajectory analysis? (SF)

Reply: Not for a Level III analysis.

131. Question: What is the purpose of going through procedures for determining design values? (SF)

Reply: To determine whether or not an area is currently in compliance with the NAAQS and to provide one means for tracking trends.

132. Question: Why does one pick control requirements on a site specific basis as opposed to lumping all sites together and picking third highest control value? Is more control needed with the third highest approach? (SF)

Reply: The NAAQS for ozone implies that it should be met at all sites. Therefore, demonstrations are needed at individual sites. Lumping calculated controls together for all sites and then choosing the third highest control requirement (assuming two years of data) could produce an estimated requirement which is too high under some circumstances.

V. Efforts to Validate EKMA

133. Question: Does uncertainty grow with time? (P)

Reply: The uncertainty bands shown in the comparisons of EKMA with historical trends do not necessarily grow with time.

134. Question: What was the basis for selecting the 95th percentile? (P)

Reply: The 95th percentile daily maximum ozone concentration was selected as a trend parameter in the comparison of EKMA with trends for two reasons. First, because it is at the high end of the frequency distribution for ozone, it should be affected by control programs. Second, it is not so subject to fluctuations in meteorological conditions as the maximum peak daily ozone value.

135. Question: When comparing the SAI model, does one assume the same chemistry? (P)

Reply: In the comparisons between the SAI grid and trajectory models and EKMA, the SAI models utilized the carbon bond II chemical mechanism, whereas the EKMA isopleths were generated using the Dodge propylene-butane mechanism. In other words, there was no effort to ensure identical chemistry in the models.

136. Question: Is there any kind of trend between EKMA and SAI in St. Louis? (P)

Reply: For strategies in which NMOC is reduced by less than about 60-70%, there is no apparent trend or systematic difference between city-specific EKMA and the SAI Urban Airshed Model in the St. Louis studies. For strategies in which NMOC is reduced by more than about 70%, there is a tendency for EKMA to predict greater reductions in peak ozone values than the Airshed Model.

137. Question: Were there any comparisons conducted between EKMA and Rollback? (P)

Reply: Yes. Comparisons between city-specific EKMA, rollback and the Urban Airshed Model have been conducted for various strategies on three days in St. Louis. Although there are some exceptions, the general tendency in these comparisons is for rollback to predict greater changes in peak ozone levels than either of the other two models for NMOC reductions less than about 60-70%. This difference is more pronounced if the prevailing $NMOC/NO_x$ ratio is high. For large NMOC reductions (e.g., greater than about 60-70%), the difference between EKMA and the Airshed Model versus Rollback in the St. Louis studies becomes less. For very large reductions (e.g., greater than 70%), agreeement between the Airshed Model and rollback is better than between the Airshed Model and EKMA. For these very high reductions, EKMA suggests a greater impact on peak O_3 than either of the other two models. It is not clear whether the preceding relationship would hold for cities in which base level peak O_3 and $NMOC/NO_x$ ratios are far outside the ranges observed in St. Louis.

138. Question: In looking at urban areas, does one take into account reductions between counties? (P)

Reply: Yes. This can be done by altering post 8 a.m. emissions and generating a second isopleth diagram as described on pages 59-60 of the March 1981 Guideline. This need not be done however if the analyst believes the differences in emission trends among counties to be trivial. See responses to Questions 118 and 119.

139. Question: Are isopleths reproductions of smog chamber data? (SL)

Reply: No. Smog chamber data were used as the basis for the model's assumptions about reactivity. However, cityspecific isopleths reflect the impact of dilution, fresh emissions, transport and sunlight intensity characteristics of the city being modeled.

140. Question: How does one account for variability in meteorology? (SL)

Reply: A given isopleth diagram reflects a constant set of assumptions about meteorology. This is appropriate, since one is interested in assessing the impact of precursor controls without confounding differences in meteorology. However, it is also important to consider several different sets of meteorological conditions/ transport, etc. This is done by generating isopleth diagrams using day-specific inputs for several different days as recommended on pages 10-15 of the March 1981 Guideline.

141. Question: How well does the model do at predicting levels at or near 0.12 ppm? (SL)

Reply: Only a limited number of cases in which observed ozone concentrations are low have been examined. These include one day in San Francisco, one day in St. Louis and three days in Tulsa in which peak observed ozone levels were 0.11-0.15 ppm. For four of the five days tested with Level II version of OZIPP, predictions agreed with observations within ±30%. For all four tests conducted with Level III OZIPP (i.e., used as the underlying basis for city-specific EKMA), agreement between observations and predictions were within ±30%. One caveat should be kept in mind in interpreting these results. In at least some of the cases, the ozone concentrations are low because the meteorological conditions are unfavorable for buildup of high concentrations. Good model performance under these conditions does not necessarily guarantee good performance in the case with poor meteorology after completion of major control programs.

142. Question: Has final Tulsa, Oklahoma report been sent to the planning agency? (SL)

Reply: The report on applying city-specific EKMA to Tulsa is currently undergoing review. It should be available for general distribution in September as EPA-450/4-81-005b. See the response to Question 28 for procedures to obtain this document.

143. Question: Were cityspecific EKMA comparisons made only for St. Louis? (SL)

Reply: No. Comparisons between city-specific EKMA and more sophisticated models have been made in St. Louis, Los Angeles, San Francisco, Sacramento, and Tulsa. Comparisons between OZIPP predictions and observed peak ozone concentrations using a Level III data base have been made in St. Louis and Tulsa.

144. Question: If an elected official asks how good the model is, what should be the response? (SL)

Reply: The results to date suggest generally good agreement between the impact of controls predicted with city-specific EKMA and with Level I models, particularly photochemical grid models. These results suggest that the likelihood of underestimating the impact of controls by more than 10% is only about 10%. The OZIPP model's predictions of peak O_3 has been compared with observed peak ozone in St. Louis and Tulsa. Twelve of 14 available comparisons agree within $\pm 30\%$. Comparisons with historical trends present more ambiguous results. About 60-70% of the available comparisons made in the Los Angeles basin appear to agree. For most cases where there is disagreement, the model underpredicts the observed change in ozone. The bulk of available comparisons suggests the model performs reasonably well. However, individual comparisons exist where the model has done poorly. Therefore, several days and control scenarios are simulated in the SIPs to enable better recognition of such outliers.

145. Question: Were comparisons made using new data validation techniques or did EPA use data as it was recorded? When was this completed? (SF)

Reply: Four approaches have been used to evaluate EKMA:

(1) comparison of predicted changes in ozone concentrations with observed changes in peak and 95th percentile daily maximum ozone concentrations;

(2) comparison of predicted changes in peak ozone concentrations obtained with EKMA against changes in peak ozone predicted with sophisticated (Level I) photochemical grid and trajectory models;

(3) comparison of peak ozone values predicted with a modified version of OZIPP in a Level II analysis with observed peak ozone concentrations; and

(4) comparison of peak ozone values predicted with OZIPP in a Level III analysis with observed peak ozone concentrations.

Work is continuing with the St. Louis data base. However, work with the Los Angeles, San Francisco, and Sacramento data bases has been completed. There may be some additional tests with the Tulsa data during FY-82. In addition, extensive studies of Philadelphia will begin in FY-82.

146. Question: Was comparison between EKMA and other models done with actual monitoring values or just the predicted values from each model? (SF)

Reply: See the response to Question 145.

147. Question: Would city specific EKMA provide the most promising results for Los Angeles, i.e., less controls as comparied to trajectory or airshed models? (SF)

Reply: No.

148. Question: If one characterizes a day as being stagnant, should one attempt to construct trajectories with light variable winds? (SF)

Reply: See #84.

149. Question: How does one treat ozone aloft on stagnation days? (SF)

Reply: To estimate ozone transported aloft during stagnations, one chooses a monitor which is not likely to be impacted upon by the city and notes the ozone concentration observed shortly after the breakup of the nocturnal inversion. The procedure and suitable monitoring sites for this purpose are described in greater detail on pages 23-25 of the March 1981 Guideline.

150. Question: Typical trajectory in Salt Lake City shows flow reversal and land sea breezes, will the trajectory method work in this situation? (SF)

Reply: See #84.

VI. General Modeling Questions

151. Question: What thought has been given to the level of modeling applications used for regulatory control and those used for scientific analysis? (P)

Reply: In an ideal world, the same level of sophistication would be applied to both. However, it is recognized by the EPA that the data base, computational facilities and scientific expertise needed in a scientific analysis of photochemical pollution are extensive. Therefore, detailed scientific analyses can be performed by relatively few groups. One role of such analyses is to identify acceptable simplifications of potential use in regulatory applications. For regulatory applications, recognition must be given to resource and budgetary constraints on the part of those responsible for prescribing or implementing controls. This means that, in many cases, a compromise needs to be struck between the possible and the ideal. Use of city-specific EKMA by many cities in the 1982 SIPs is the result of one such compromise. Scientific analyses need to continue to, among other things, identify further improvements which can be made to models suitable for widespread use in regulatory applications.

152. Question: Does a critical point exist between sensitivity and design values? (P)

Reply: The peak ozone level significantly affects the degree of VOC controls needed to achieve the standard. The most sensitive region is at ozone levels near the standard.

153. Question: Should EKMA be treated as other models, that is first, make a test run of the OZIPP curves, calibrate the model, then design the control strategy? (P)

Reply: Yes. And, in actuality, this is what is done. As indicated in the response to Question 96, one should first check to see whether the model is able to predict ozone within $\pm$ 50% of the observed value. If such agreement is obtained, one should proceed with the EKMA procedure. In effect, by using observed peak ozone values in identifying the base point on the ozone isopleth diagram, one is calibrating the model prior to its use in calculating control needs for each site-day.

154. Question: May ozone isopleth diagrams be applied to post-8:00 a.m. emissions? (P)

Reply: Yes. The procedure for estimating control requirements applies to post 8 a.m. emissions, as well as to pre-8 a.m. emissions. The impact of solely reducing post-8 a.m. emissions can be estimated using the procedures described on pages 59-60 of the March 1981 Guideline.

155. Question: Why is it necessary to reduce emissions over a fairly large area (county) when it may only be necessary to reduce emissions in the urban core? (P)

Reply: As described on Pages 31-32 of the March 1981 Guideline, it is ordinarily not recommended that spatial resolution finer than a county be used in the emission inventory for city-specific EKMA. However, the model is capable of considering grid squares as small as 10 km x 10 km. Given model predictions, whether or not a particular strategy is necessary or desirable is an economic, political and institutional issue which needs to be addressed on an individual basis.

156. Question: Is there an updated videotape of the models? (SL)

Reply: No.

157. Question: How good is the original EKMA for training purposes? (SL)

Reply: We do not recommend that past training material on EKMA be used. We suggest using the March 1981 Guideline, the workbook entitled "Workshop on Procedures (sic) to Demonstrate Attainment of the NAAQS for Ozone in the 1982 SIPs," and these questions and answers to prepare training materials.

158. Question: Explain procedures for upwind monitoring to obtain ozone data aloft. (SL)

Reply: These procedures are explained on pages 23-24 of the March 1981 Guideline.

159. Question: How does one account for unusual growth upwind in ozone future transport? (SL)

Reply: By using procedures described on pages 52-53 of the March 1981 Guideline. The only difference would be that one would assume a higher value for transported ozone in generating the second isopleth diagram.

160. Question: What is the regression equation for Level II EKMA vs. air quality? (SL)

Reply: A regression equation has not been derived for these comparisons.

161. Question: Is there any explanation as to why the St. Louis data result in underprediction as compared to other cities? (SL)

Reply: We believe that the major reason for poor model performance on the days with underprediction in St. Louis is uncertainty in the air parcel trajectories. Generally, on these days, calculated trajectories skirted or avoided the city altogether. We are currently examining other procedures for estimating trajectories.

162. Question: Have any attempts been made to validate the standard EKMA model? (SL)

Reply: Yes. Generally, it does not perform as well as city-specific EKMA.

163. Question: What is the error band around the model predictions? (SL)

Reply: This is difficult to say, because we do not know what the "correct" answer is with certainty. One must be willing to assume that state-of-the-art Level I photochemical models, which perform well in predicting ozone and precursor concentrations during the base case, yield the correct answer. If this assumption is made, results of our studies thus far (including the Tulsa studies) could be interpreted to mean that the likelihood is greater than 90% that the estimated impact of a control strategy estimated with EKMA is within 15% of the "correct" value. That is, if the "correct" reduction in peak ozone were 50%, $p(\Delta O_3 = 50 \pm 15) > .90$. If one is primarily concerned about EKMA being used to prescribe controls which are too stringent, the results suggest that the likelihood of underestimating the impact of controls by more than 10% is only .10. Thus, if the "correct" reduction in peak ozone were 50%, $p(\Delta O_3 \geq 60\%) = .10$.

164. Question: Can the resulting error band be used to determine the error band on the control point? (SL)

Reply: See the response to Question 163.

165. Question: Is there any reduction in cost possible by reducing the number of isopleths in OZIPP? (SL)

Reply: No cost reductions will be realized by reducing the number of isopleths to be drawn. However, other procedures can be used to accomplish some savings in computer time. These are described in Section 3.2.3 (page 46) of EPA 600/8-78-014a, User's Manual for Kinetics Model and Ozone Ispoleth Plotting Package.

166. Question: What is the cost difference between a one point run versus an isopleth run?

Reply: With the standard OZIPP procedures, approximately 65 single simulations are performed to generate an isopleth diagram. Thus, one would expect a significant difference between isopleth runs and single point runs. Example costs and times on EPA's UNIVAC computer are shown below:

	Computer Time/min.	Cost
One Point Run	0:15	$ 1.00
Isopleth Run	3:00	14.00

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16. ABSTRACT

Report presents responses to 166 questions asked at three 1981 workshops describing the basis and application of city-specific EKMA. Subject matter discussed includes the conceptual basis for EKMA, implications of the statistical form of the ozone NAAQS, monitoring support needed for EKMA analyses, generation and application of ozone isopleth diagrams and results of efforts to validate EKMA.

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