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GUIDELINE SERIES

GUIDELINES FOR THE INTERPRETATION OF AIR QUALITY STANDARDS

(REVISED FEBRUARY 1977)

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OF AIR QUALITY STANDARDS

U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Air Quality Planning and Standards

Research Triangle Park, North Carolina

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Monitoring and Data Analysis Division
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INTRODUCTION

This revised guideline document discusses a series of issues concerning the interpretation of air quality data with respect to the National Ambient Air Quality Standards (NAAQS). This revision supersedes the original August 1974 version of this document. The issues presented deal with points of interpretation that have frequently resulted in requests for further clarification. Each issue is presented with a recommendation and a discussion indicating our current position. It is hoped that this document will continue to be useful in the evolutionary development of a uniform and consistent set of criteria for relating ambient air quality data to the NAAQS.

ISSUE 1: Given that there are a number of monitoring sites within an Air Quality Control Region (AQCR), does each of these sites have to meet the National Ambient Air Quality Standards (NAAQS)? In particular, if only one of these sites exceeds a standard, does that mean that the AQCR is in nonconformance with the standards even though all other sites meet the standard?

Recommendation

Each monitoring site within the AQCR must meet the standard or the AQCR is in nonconformance with that standard. This same reasoning may also be applied to other geographical subdivisions. such as counties or planning regions. It should be recognized that each monitoring site generally represents a much smaller spatial area than an entire AQCR. Therefore, a violation at a single site need not dictate an AQCR-wide SIP revision but may indicate that only a particular localize area within this region requires further control.

Discussion

The NAAQS' were defined to protect human health and welfare. The presence of one monitoring site within an AQCR violating any given standard indicates that receptors are being exposed to possibly harmful pollutant concentrations.

Concentrations in excess of standard values at a single monitoring station may result from the effect of a small, nearby source which is insignificant in terms of the total emission inventory, or the station in violation may be so located that the probability that individuals would be exposed for prolonged periods is negligible. Such circumstances do not mitigate the recommended interpretation of the question raised by this issue since NAAQS are generally interpreted as being set to protect health and welfare regardless of the population density. Although air quality improvement should be stressed in areas of maximum concentrations and areas of highest population exposure, the goal of ultimately achieving standards should apply to all locales.

Data from monitoring sites are the only available measure of air quality and must be accepted at face value assuming, of course, that data quality is maintained by use of an adequate quality assurance program. Attention is thus focused on the selection of monitoring sites in terms of the representativeness of the air they sample. This is discussed in more detail in the guideline series document entitled "Guidance for Air Quality Monitoring Network Design and Instrument Siting," (OAQPS No. 1.2-012). Consideration should be given to the relocation of monitoring stations not meeting the guideline criteria. Prior to any relocation, careful attention should be given to what extent the data from the monitor actually indicates a potential problem with respect to the standards.

Although the status of an AQCR with respect to the standards has several uses, it is often an inadequate indicator of air quality improvement. For example, there has been no change in the status of the N.Y.-N.J.Conn. AQCR with respect to the annual TSP standard, but fewer sites now exceed the standard and, therefore, it is estimated that 7 million fewer people in the area are now exposed to levels above this standard compared to 1971.

ISSUE 2: Should monitoring data be disqualified on the basis of non-conformance to siting criteria?

Recommendation

Any disqualification of monitoring data because of non-conformance to siting criteria should be treated on a case-by-case basis.

Discussion

The primary reason for requiring a case-by-case treatment of this issue is because improper siting may overestimate or underestimate the actual problem or, perhaps, make little difference. The central question is whether the data are adequate to ensure the protection of human health ant welfare. The answer to this question can vary from one situation to another. For example. improper siting that overestimates the problem but still meets the standard would be adequate to show compliance. On the other hand, improper siting that underestimates the problem and yet violates the standard would suffice to establish the need for control. In the event that the nature of the non-conformity would have no serious impact, the data could be taken at face value. These varying possibilities and the potential difficulties in determining the degree of control required make it highly advisable that all monitoring stations satisfy the siting criteria. However, it is recognized that in some cases practical constraints will make this difficult and exceptions may be required.

ISSUE 3: Short-term standards are specified as concentrations which are not to be exceeded more than once per year. How is this to be interpreted when analyzing data obtained from multiple monitoring sites?

Recommendation

Each site in an AQCR-wide monitoring network is allowed one excursion per year above a short-term standard. If any site exceeds the standard more than once per year, a violation has occurred. In the special case of Supplementary Control System (SCS) networks around a well-defined single source. it is recommended that the formal agreement between the source and the appropriate control agency allow only one excursion per year from the entire network around the source.

Discussion

A site-by-site interpretation leads to a clear indication of where the violation has occurred and minimizes potential ambiguities in developing control strategies. In contrast, a policy allowing combination of data from different monitoring sites would be potentially cumbersome (particularly for non-overlapping violations) and difficult to interpret. For example, combination of high values from separate sites could result in an AQCR being in violation even though each individual county (or state) is in compliance. In such instances where no one site is in violation, emission control strategies to achieve ambient standards would be difficult to define. This potential problem is more evident when noting that AQCR's in the west range up to 450 miles in length and 92,000 square miles in area larger than 39 of the 50 states.

In the case of SCS networks around a well-defined single source, the SCS agreement becomes the focal point. In these instances accountability is clear and the recommended interpretation is that only one excursion be allowed for the entire network. The reason for this distinction in the case of SCS networks is that the intended purpose of such networks is to prevent excursions by requiring emission reductions at the source on an intermittent basis. In keeping with this philosophy, this interpretation is intended to avoid indirectly allowing a source to selectively exceed the standard once in all directions. With SCS, the source operates within a framework giving more capability with respect to factors such as wind direction and to some extent can choose to control or not control based upon such information. This interpretation is consistent with EPA's approach where SCS networks are concerned, e.g., in each of the regulations we have proposed or promulgated which involve SCS at smelters (see Nevada S02 Control Strategy, February 6, l975, F.R. at p. 5508; Arizona SO2 Control Strategy, October 22, 1975, F.R. at p 49362; and New Mexico S02 control Strategy, May 2, 1975, F.R. at p. 19211). We also note that state agencies in Texas and Washington have successfully enforced against sources for causing air quality concentrations in excess of the NAAQS, allowing the standards to be exceeded one time per year for each source.

ISSUE 4: How many significant figures should be employed when making comparisons with the NAAQS and what system of units should be used?

Recommendation

Comparisons with the standards should be made after converting the raw data to micrograms (or milligrams) per cubic meter. All comparisons are made after rounding the air quality value to the nearest integer value in micrograms per cubic meter (or milligrams per cubic meter for carbon monoxide). The rounding convention to be employed is that values whose fractional part is greater than or equal to .50 should be rounded up and those less than 0.50 should be rounded down. The following examples should clarify these points.

Computed Value	Rounded Value
79.50	80
80.12	80
80.51	81
81.50	82

Discussion

By letting the standard itself dictate the number of significant figures to be used in comparisons, many computational details are minimized while Still~ll maintaining a level of protection that is consistent with the standard. It should be noted that the parenthetical expressions given in the NAAQS indicating parts per million (ppm) may be used as a guide but in some cases, such as the annual standard for sulfur dioxide, many require additional significant figures to be equivalent.

ISSUE 5: What period of record of air quality data is necessary to establish the status of an AQCR with respect to the NAAQS?

ISSUE 5:

Recommendation

Each AQCR should be treated is a separate case in establishing its status with respect to the NAAQS.

Discussion

Although each AQCR would be examined individually, the gradual establishment of precedents would eventually provide consistency. This option would consider differences in monitoring coverage, meteorology, the type and mix of sources, and unusual circumstances affecting emissions. Case-by-case treatment would allow greater flexibility in examining borderline cases, such as annual averages which fluctuate around the standard. or short-term excursions above the air quality standards. Use of this option is illustrated by the following examples: (1) S02 concentrations during one heating season in a northern AQCR are lower than the short-term standards. If it can be shown that the number of heating degree days, the industrial activity, and the dilution capacity of the atmosphere favored the occurrence of high S02 concentrations, then the status of the AQCR with respect to the NAAQS would be evaluated accordingly; (2) eight-hour average CO concentrations in an AQCR fluctuate about the standard. The period of record was unusually favorable for the dispersion of pollutants. Hence, a longer and more representative period of record is required to evaluate the status of this AQCR with respect to the NAAQS.

ISSUE 6: The NAAQS are defined in terms of a year, i.e., annual mean concentrations and short-term concentrations not to be exceeded more than once per year. What is meant by the term "year" and how frequently should air quality summaries be prepared to conform to that definition?

Recommendation

The term "year" means a calendar year and routine air quality summaries should be prepared for that period.

Discussion

While pollutant exposures may overlap calendar years, the use of a calendar year for air quality summaries remains a simple and conventional practice. Indeed, inquiries concerning air quality are most frequently expressed in terms of a calendar year. The data do not warrant quarterly evaluation of compliance or noncompliance with NAAQS, nor would it be reasonable to revise emission control requirements on a quarterly basis. This, of course, does not remove the need for continual appraisal of air quality on a quarterly or monthly basis to assess both status and progress with respect to the standards. Such efforts are obviously useful and sometimes necessary to ensure that standards are met on a calendar year basis. For example, when new stations begin monitoring a running 4-quarter or 12-month period may provide the most timely initial evaluation of compliance. This same flexibility may also be employed when developing control strategies, or considering possible variances, to ensure that the standards will be met.

ISSUE 7A: The NAAQS for CO and S02 include an eight-hourCO standard and three and twenty-four-hour S02 standards. For such standards, how is the time interval defined?

Recommendation

Compliance with these standards should be judged on the basis of running averages starting at each clock-hour. However, in determining violations of the standard the problem of overlap must be considered. This point can best be illustrated by cons~deration of the 8-hour CO average. In order to exceed the 8-hour CO standard twice, there must be two 8-hour averages above the standard and the time periods for these averages must not contain any common hourly data points. A simple counting procedure for this interpretation for 8-hour CO is to proceed sequentially through the data and each time a violation is recorded, the next seven clock hours are ignored and then the counting is resumed. In this way there is no problem with overlap. It should be noted that a clock-hour is the smallest time interval suggested for reporting data.

Discussion

This issue has generated considerable interest concerning the relative merits of fixed versus running averages. At the present time the computational advantages of the fixed interval approach are outweighed by the following properties of running averages: (1) running averages afford more protection than fixed averages and this additional margin appears warranted, (2) running averages more accurately reflect the dosage to receptors, and (3) running averages provide more equitable control from one region to another due to differences in diurnal patterns.

Recommending a running 24-average interpretation for S02 represents a change and, therefore, certain points should be mentioned. There has been a considerable increase in the use of continuous SO2 monitors and the promulgation of the equivalency regulations has provided the mechanism to establish that continuous methods are equivalent to the Federal Reference Method (24-hour bubbler). In some cases, particularly around large isolated point sources, the fixed midnight-to midnight interpretation can result in second high values 30 to 40 percent lower than the second highest non-overlapping 24-hour average. As a consequence, a site that appears to be in compliance using midnight -to-midnight values may actually have other 24-hour averages well above the standard. Therefore, to ensure adequate protection, the running 24 hour average interpretation is recommended. However, it is recognized that in many areas of the country SO_2 levels are sufficiently low and well behaved that the midnight-to-midnight computations are adequate to show compliance. Therefore, it is only necessary to compute running 24-hour averages for borderline situations. Because 24-hour bubblers are seldom the only monitors in areas where this problem arises (due to the 3-hour standard), such data continue to be generally adequate for demonstrating compliance.

The counting procedures for 3-hour- or 24-hour standards are similar to that described for 8-hour CO with the obvious change of ignoring the next two 3-hour averages or the next twenty-three 24-hour averages, respectively, when counting values above the corresponding standard.

It is worth noting that in applying this counting procedure, the maximum and second highest values could be ignored because they are overlapped by a counted value. Therefore, the sole function of this procedure is to count the number of non-overlapping violations. The identification of the maximum and second highest values is an independent procedure as described in the following discussion of Issue 7B.

ISSUE 7B: When using running averages for 24-, 8-, and 3-hour averages, how should the second highest value be determined?

Recommendation

The second highest value should be determined so that there is one other non-overlapping value that is at least as high as the second highest value. Although this seems relatively straight forward the following discussion indicates some of the subtleties involved.

Discussion

In using running average values to determine compliance with these multiple-hour air quality standards, the adopted convention is to determine violations on the basis of non-overlapping time periods. That is, any two values above the standard must be distinct and not share any common hours, as indicated in Issue 7A. This same consideration regarding overlap also applies in determining the second highest value.

Basically, there are two key points involved in selecting the appropriate second highest value: (I) consistency with the counting procedure, i.e., if a site has two or more non-overlapping values above the standard, then the second highest value should be above the standard and (2) the second highest value should accurately reflect the relative magnitude of the problem. Both of these characteristics can be achieved by using the maximum second highest non-overlapping value. This is relatively simple to determine and the method can perhaps best be illustrated in the following example using 8-hour CO averages.

List the 9 highest 8-hour averages for the year in order starting with the highest as shown in the table below:

Listing of the 9 Highest 8-Hour CO Averages in Order

Order	8-Hour average (mg/m3)	Date & time of occurrence	Does it overlap all of the higher values?
l	16	Dec. 8 10:01 am- 6:00 pm	--
2	l5	Dec. 8 9:01 am- 5:00 pm	yes
3	15	Dec. 8 11:01 am- 7:00 pm	yes
4	14	Dec. 8 3:01 am-ll:OO am	No (this is the second max)
5	13	Nov. 20 10:01 am- 6:00 pm	
6	13	Nov. 11 11:01 am- 7:00 pm	
7	13	Feb. 9 9:01 am- 5:00 pm	
8	12	Nov. ll 10:01 am- 6:00 pm	
9	12	Oct. 29 10:01 am- 6:00 pm	

For each of these 8-hour values include the time of occurrence. As indicated, the first value is the maximum 8-hour average for the year. For each of the remaining values, answer the question, "Does it overlap all of the higher values?" The first value for which the answer is "no" is the proper second highest value. A point of interest in this example is that 14 mg/m3 is the proper second highest value, even though it overlaps the maximum because there is one other non-overlapping value at least as high (namely, 15 mg/m3 from 11:01 a.m. to 7:00 p.m. on December 8). This particular example was constructed to illustrate this possibility, although it remains to be seen how often this would occur in actual practice. Nevertheless, it demonstrates that this particular algorithm for determining the second highest value will yield the proper value for use in control strategies.

It should be noted that with 9 values on the list, even the extreme case of 9 consecutive values must result in two disjoint 8-hour intervals. A similar procedure is used for 3-hour or 24-hour averages using a list of the 4 highest or 25 highest values, respectively.

ISSUE 8: The chances of detecting violations of 24-hour maximum standards depend considerably upon the frequency with which the air is monitored. In view of this, how should data obtained from intermittent monitoring be interpreted?

Recommendation

Sampling at monitoring sites which yields only partial annual coverage is not necessarily sufficient to show compliance with "once per year" standards. Although noncompliance will not generally be declared on the basis of predicted values, it is possible that predicted values in excess of the standard may necessitate more frequent sampling at a particular site.

Discussion

Ideally, continuous monitoring of all pollutants would be conducted. However, except for those pollutants specified in Federal regulations, EPA does not currently require continuous monitoring. Thus, one is left with either (1) predictive equations employing data from partial annual coverage, or (2) the data collected through partial annual coverage. Since the accuracy of predictive equations is not well estab~lished, the remaining alternative is to judge compliance on the basis of partial annual coverage; however, states, at their option, could sample more frequently than the required minimum. Partial annual coverage schedules make detection of short-term violations difficult. The entries in the following table are the probabilities OT choosing two or more days on which excursions have occurred for different numbers of actual excursions above the standard and different sampling frequencies. The underlying assumption in determining these probabilities is that excursions above the standard occur randomly over the days of the year. This is, of course, an oversimplification but is sufficient for the purposes of this discussion.

ISSUE 9: How should particulate matter, CO and other pollutant concentrations resulting from severe recurring dust storms, forest fires, volcanic activity any other natural sources be taken into account in determining compliance with NAAQS?

Recommendation

Regardless of the source, ambient pollutant concentrations exceeding a NAAQS constitute a violation.

Discussion

Ambient pollutant concentrations exceeding the NAAQS are considered to be violations regardless of the source. These standards are intended to protect human health and welfare and from this viewpoint the origin of the pollutant is irrelevant. However, as indicated in CFR 51.12(d), the source becomes relevant when considering control strategies. Detailed information establishing that violations are due to uncontrollable natural sources may be used in determining the feasibility of modifying control strategies. In general, reasonably available control technology would be expected for all existing sources and best available technology for new sources impacting the non-attainment monitor.

Probability of selecting two or more days when site is above standard

Actual Number of excursions-	**Sampling Frequency** - days per year 61/365	122/365	183/365
2	0.03	0.11	0.25
4	0.13	0.41	0.69
6	0.26	0.65	0.89
8	0.40	0.81	0.96
10	0.52	0.90	0.99
12	0.62	0.95	0.99
14	0.71	0.97	0.99
16	0.78	0.98	0.99
18	0.83	0 99	0.99
20	0.87	0.99	0.99
22	0.91	0.99	0.99
24	0.93	0.99	0.99
26	0.95	0.99	0.99

From this table it is clear that the frequency of sampling must be considered in judging compliance with "once per year" standards. For example, if an every-sixth-day schedule is used and an area actually has eight days per year above the standard, there is only a 40 percent chance that the data will indicate a violation. Although this may appear unacceptably low, it applies to one particular year and the probability that the site would appear to meet the standard two years in a row is less than 30 percent.

The present recommendation was selected so that more frequent monitoring does not inherently penalize a given area. At the same time a certain degree of flexibility in the use of predictive equations such as the one discussed by Larsen ("A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards," EPA Publication No. AP-89) is left to those who evaluate compliance. For example, if the results of a predictive equation indicate a violation, more frequent monitoring might be advisable. At the present time it is difficult to suggest a predictive equation that has equal validity at all sites. In cases where existing monitoring data are not adequate for judging air quality status with respect to the standards, two options are possible: (1) additional (or more frequent) monitoring and/or (2) the use of predictive equations. The decision as to which approach will be used in a particular application depends on the degree of urgency associated with the decision, the validity of any predictive models proposed, and the availability of resources to conduct additional monitoring.

ISSUE lO: Should all available air quality data or only those derived from air quality surveillance systems, as specified in a state implementation plan (SIP), be used to determine com pliance with NAAQS.

Recommendation

All available valid air quality data can be used to determine compliance with the NAAQS. This includes data obtained from the air quality surveillance system specified tn the applicable SIP, data obtained from the National Air Surveillance Network (NASN), data obtained by industry monitoring stations, data obtained from monitoring stations installed and operated by concerned citizens, etc.

Discussion

NAAQS have been established to protect the health and welfare of the population. If the NAAQS have validity, the violation of a standard at any point ln the AQCR is significant. Even though a station is not part of the established surveillance network, if acceptable methods, procedures, calibrations, and recordings have been used and can be verified, and the station is located in accordance with applicable criteria for representativeness, the data from that station should be used for the determination of conformity with NAAQS.

ISSUE 11: May monitoring for certain pollutants be restricted to only a portion of the day or year?

Recommendation

Partial daily monitoring of pollutants subject to short-term NAAQS is not recommended (except non-methane hydrocarbons where 6-9 a.m. is specified in the NAAQS). All hours of the tay must be monitored except perhaps for one hour missed dur~following instrument calibration and this should be in a non-peak period. Partial annual monitoring during only certain seasons is not recommended in general, but it is recognized that in certain limited cases such a scheme may be adequate for highly seasonal pollutants.

Discussion

While specific pollutants show rather consistent diurnal patterns of concentration, particularly when mean hourly values are considered, the concentration patterns are subject to modification with both seasonal and short period changes of meteorological conditions. This is most noticeable when a region is subjected to episode conditions. In addition, the actual local time of occurrence of periods of high concentrations will vary from AQCR to AQCR and perhaps from monitoring station to monitoring station within an AQCR. Extensive study of patterns and trends exhibited by pollutant concentrations within each AQCR would be required to select the portion of the day to be monitored if partial monitoring were allowed. Further, monitoring data for the full twenty-four hour period will help determine the extent and duration of episodes and contribute to the determination of the need for emergency control measures. It should be noted that automatic monitoring devices used to obtain sequential hourly data are seldom amenable to shut-down and subsequent start-up without a warm-up and stabilization period.

With respect to partial annual monitoring, a better argument can be made that such schemes can result in significant resource savings. If this can be accomplished with little or no loss of information, then such monitoring is adequate. Obviously, this depends upon the degree of seasonality of the pollutant and the intended purpose of the data. If the primary purpose of the monitor is to assess compliance, then it is only necessary to show that the data will be sufficient to document status with respect to standards. However, if the monitor is intended to assess trends, it becomes much more difficult to justify partial annual monitoring and this would seldom be acceptable unless all values in the omitted season are near the minimum detectable limit.