UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: CO Monitoring Network Background and Review

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TO: Carbon Monoxide NAAQS Review Docket (EPA-HQ-OAR-2008-0015)

This document is intended to describe the history of the Carbon Monoxide (CO) monitoring network requirements and assess the objectives of the current network, particularly with regard to concerns raised by the Clean Air Scientific Advisory Committee (CASAC) Carbon Monoxide Review Panel regarding monitor locations and public health related objectives. This document was produced by reviewing the Code of Federal Regulations (CFR) prior to the October 2006 rule, the current CFR, interviewing U.S. Environmental Protection Agency (EPA) staff familiar with federal, State, local, and tribal monitoring efforts stretching back into the 1970s, interviewing select State and local air agency staff, and analyzing available CO network meta-data in EPA's Air Quality System (AQS).[1]

BACKGROUND

The May 1979 monitoring rule (44 FR 27571), that supported the CO National Ambient Air Quality Standards (NAAQS) promulgated in 1971, established minimum monitoring requirements for State and Local Ambient Monitoring Stations (SLAMS) and the subset of SLAMS called National Ambient Monitoring Stations (NAMS). Specifically, the minimum requirements presented below were established for NAMS. The 1979 rule introduced minimum monitoring requirements within 40 CFR Part 58, Appendix D, section 3.3, and stated:

> "Information is needed on ambient CO levels in major urbanized areas where CO levels have been shown or inferred to be a significant concern. At the national level, EPA will not routinely require data from as many stations as are required for PM_{10} and perhaps SO_2, since CO trend stations are principally needed to assess the overall air quality progress

[1] http://www.epa.gov/ttn/airs/airsaqs/.

resulting from the emissions controls required by the Federal Motor Vehicles Control Program (FMVCP) and other local controls.

Although State and local air programs may require extensive monitoring to document and measure the local impacts of CO emissions and emission controls, an adequate national perspective is possible with as few as two stations per major urban area. The two categories for which CO NAMS would be required are: (a) Peak concentration areas such as are found around major traffic arteries and near heavily traveled streets in downtown areas (microscale); and (b) neighborhoods where concentration exposures are significant (middle scale, neighborhood scale).

The peak concentration station (microscale) is usually found near heavily traveled downtown streets (street canyons), but could be found along major arterials (corridors), either near intersections or at low elevations which are influenced by downslope drainage patterns under low inversion conditions. The peak concentration station should be located so that it is representative of several similar source configurations in the urban area, where the general population has access. Thus, it should reflect one of many potential peak situations which occur throughout the urban area. It is recognized that this does not measure air quality which represents large geographical areas. Thus, a second type of station on the neighborhood scale is necessary to provide data representative of the high concentration levels which exist over the large geographical areas.

Because CO is generally associated with heavy traffic and population clusters, an urbanized area with a population greater than 500,000 is the principal criterion for identifying the urban areas for which pairs of NAMS for this pollutant will be required. The criterion is based on judgment that stations in urban areas with greater than 500,000 population would provide sufficient data for national analysis and national reporting to Congress and the public. Also, it has generally been shown that major CO problems are found in areas greater than 500,000 population."

The minimum monitoring requirements promulgated in 1979 were appropriately crafted to support the NAAQS at that time. One aspect of the requirements which we consider here is the reasoning behind the selection of the population threshold of 500,000 by which minimum monitoring was required. In the crafting of the 1979 monitoring rule, EPA staff reviewed data collected as far back as 1962. Although monitoring stations were sparse in the 1960s, by 1975 there were over 500 CO monitors in operation across the country providing data. Therefore, it was these data spanning back over a decade that allowed EPA staff to make the 'judgment' (the term used in CFR text) in 1979 that having monitors required in urban areas of 500,000 more persons would "provide sufficient data for national analysis and national reporting to Congress and the public."

In the October 2006 monitoring rule (71 FR 61236), the 40 CFR Part 58 Appendix D monitoring language referenced above was removed from the CFR. The rationale for removing the requirements was based on the fact that there were very few

(only one at that time) non-attainment areas anywhere in the US, and because reported ambient CO levels at nearly all monitors were well below the existing standards. This information is supported by data analysis presented in the latest (2008) EPA Trends report (http://www.epa.gov/airtrends/). As a result, in the 2006 monitoring rule revision, EPA chose to rewrite 40 CFR Part 58, Appendix D, section 4.2 to state that:

> "4.2 Carbon Monoxide (CO) Design Criteria. (a) There are no minimum requirements for the number of CO monitoring sites. Continued operation of existing SLAMS [State and Local Ambient Monitoring Station] CO sites using FRM [Federal Reference Method] or FEM [Federal Equivalent Method] is required until discontinuation is approved by the EPA Regional Administrator. Where SLAMS CO monitoring is ongoing, at least one site must be a maximum concentration site for that area under investigation.
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> (b) Microscale and middle scale measurements are useful site classifications for SLAMS sites since most people have potential for exposure on these scales. Carbon Monoxide maximum occur primarily in areas near major roadways and intersections with high traffic density and often poor atmospheric ventilation.
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> (1) *Microscale* – This scale applies when air quality measurements are to be used to represent distributions within street canyons, over sidewalks, and near major roadways. In the case with Carbon Monoxide, microscale measurements in one location can often be considered as representative of other similar locations in a city.
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> (2) *Middle scale* – Middle scale measurements are intended to represent areas with dimensions from 100 meters to 0.5 kilometer. In certain cases, middle scale measurements may apply to areas that have a total length of several kilometers, such as "line" emission source areas. This type of emission source area would include air quality along a commercially developed street or shopping plaza, freeway corridors, parking lots, and feeder streets.
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> (c) After the spatial scale and type of site has been determined to meet the monitoring objective for each location, the technical guidance in reference 2 of this appendix [Appendix D] should be used to evaluate the adequacy of each existing CO site and must be used to relocate and existing site or to locate and new sites."

Although the first requirements for CO monitoring did not appear until May 1979, tracking of CO monitoring sites in EPA's AQS stretches back into the 1960s. Upon review of the number of monitors reporting by year, we found that by 1975 the CO network had over 500 monitors in operation. From 1975 forward, the network generally maintained its size until 2003, with the maximum number of sites operating in a year being 569 in 1996. However, beginning in 2003, the network began to reduce in size each year. By 2009, the network had shrunk to approximately 345 monitors operating nationally. The reductions likely occurred, and may continue to occur, for reasons including: 1) ambient CO concentrations on a national level were well below the

NAAQS and monitoring conducted by States in excess of any minimum monitoring requirements may have been viewed as unnecessary; and 2) as an impact of the removal of CO monitoring requirements other than those required for the National Core (NCore) multi-pollutant monitoring stations in the 2006 monitoring rule.

REVIEW

To answer questions about the current circumstances of the CO network, what objectives the current CO network is addressing or characterizing, and the impact of the relatively recent (2006) removal of a specific CO monitoring requirement (except for those required at NCore multi-pollutant monitoring stations), EPA reviewed CO monitor meta-data stored in AQS. This review is only intended to broadly describe how the network addresses the varied monitoring objectives and how the network is situated with regard to measurement scale of the collective group of CO monitors. The data that were reviewed are those available from AQS for monitors reporting data in 2009. This includes data for any monitor that reported data for any length of time during the year. The meta-data fields for each monitor are typically created by State and locals whenever a monitor or site is opened, moved, or has a certain characteristic re-characterized. Often, EPA Regions consult with States and locals on some of these meta-data characteristics, but it is the responsibility of the State or local air agency to classify their own sites. With that, it should be noted that EPA must caveat this review due to the fact the AQS meta-data may have missing or 'old' meta-data field entries, as States and locals do not have a routine or enforced process by which they must update or correct meta-data fields.

Monitor Objective:

The monitor objective meta-data field describes what the data from an ambient air monitor are intended to characterize. The focus of the data presented is to show the nature of the network in terms of its attempt to generally characterize health effects, emission sources, photochemical activity, transport, background concentrations, or welfare effects. There are 11 categories of monitor objectives for a monitor within AQS, and it is noted that any particular monitor can have more than one monitor objective in AQS. The "other" category is for sites likely addressing a State or local need outside of the routine objectives, and the "unknown" category represents missing meta-data. The remaining categories stem directly from categorizations of site types within the CFR. In 40 CFR Part 58, Appendix D, there are six examples of CO site types:

1. Sites located to determine the highest concentration expected to occur in the area covered by the network (Highest Concentration).
2. Sites located to measure typical concentrations in areas of high population (Population Exposure).
3. Sites located to determine the impact of significant sources or source categories on air quality (Source Oriented).
4. Sites located to determine general background concentration levels (General Background).

5. Sites located to determine the extent of regional pollutant transport among populated areas, and in support of secondary standards (Regional Transport).
6. Sites located to measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts (Welfare Related Impacts).

The remaining four categories available are a result of an update of the AQS database. In a revision to AQS in early 2002, the data handlers inserted the available site types for Photochemical Assessment Monitoring Stations (PAMS) network. These PAMS site types are described in 40 CFR Part 58, Appendix D as follows:

1. Type 1 sites are established to characterize upwind background and transported ozone, and its precursor concentrations entering the area, and will identify those areas which are subjected to transport (Upwind Background).
2. Type 2 sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions are expected to impact and are suited for the monitoring of urban air toxic pollutants (Max. Precursor Impact).
3. Type 3 sites are intended to monitor maximum ozone concentrations occurring downwind from the area of maximum precursor emissions (Max. Ozone Concentration).
4. Type 4 sites are established to characterize the downwind transported ozone and its precursor concentrations exiting the area and will identify those areas which are potentially contributing to overwhelming transport in other areas (Extreme Downwind).

CO monitoring is not relevant to PAMS objectives. Although some CO sites could have these monitor objectives listed in AQS, such an occurrence would likely only be due to the CO monitor being co-located with instrumentation that are relevant to PAMS objectives, not because the CO monitor itself is relevant to PAMS objectives.

In 2009, there were 345 CO monitors reporting data, and of those 345 monitor records, five monitors had two monitor objectives (thus a total monitor objective count of 350). Table 1 presents the monitor objective distribution (not including the four additional PAMS related objectives) across all CO monitors reporting data to AQS in 2009.

CO Monitor Objective	Number of Monitor Objective Records	Percent Distribution
Population Exposure	165	47.8%
Highest Concentration	75	21.7%
General Background	19	19.7%
Other	11	5.5%
Regional Transport	7	3.2%
Source Oriented	4	1.2%
Welfare Related Impacts	1	0.3%
Unknown	68	19.7%
Totals:	**350**	

Table 1. CO Monitoring Network: Monitor Objective Distribution. Table 1 lists monitor objective records (not including the four additional PAMS related objectives) in AQS for monitors reporting data in 2009, and is intended to show characterization of the CO network in terms of the distribution of those monitors addressing a given monitor objective. Five of the 345 sites had two monitor objectives; thus, the total monitor objective count is 350.

Measurement Scales

The spatial (measurement) scales are used to allow for an understanding of what an ambient air monitor represents in terms of a surrounding, relatively homogeneous parcel of air. These measurement scales are spelled out in 40 CFR Part 58, Appendix D, Section 1 "Monitoring Objectives and Spatial Scales." These spatial scales assign a name to an actual area dimension, where:

Microscale	=	0 to 100 meters
Middle Scale	=	100 to 500 meters
Neighborhood Scale	=	500 meters to 4 kilometers
Urban Scale	=	4 to 50 kilometers
Regional Scale	=	50 kilometers up to 1000km

There are meta-data records for the CO network to indicate what the measurement scale of a particular monitor represents. There are 345 CO monitor records in AQS for which measurement scale information may be supplied. It is also important to note that a monitor can only have one measurement scale, as opposed to the possibility of a single monitor having multiple monitor objectives as noted above. Table 2 shows the measurement scale distribution across all CO sites from the available data in AQS of monitors reporting data in 2009.

Measurement Scale	Number of Measurement Scale Records	Percent Distribution
Microscale	56	16.2%
Middle Scale	33	9.6%
Neighborhood	148	42.9%
Urban Scale	18	5.2%
Regional Scale	7	2.0%
Unknown	83	24.0%
Totals:	**345**	

Table 2. CO Monitoring Network: Measurement Scale Distribution. Table 2 lists all measurement scale records in AQS and is intended to show characterization of the CO network in terms of the distribution of those CO monitors characterizing a given geographic area.

Review Summary

Upon review of the 345 monitors known to be reporting CO data to AQS in 2009 and the distribution of the available data from the categories of monitor objective and measurement scale, we believe the CO network is primarily targeting public health related needs through monitoring objectives to assess population exposure (~47.8% of the network) and highest concentration (~21.7% of the network). It is reasonable to suggest that many of these sites are holdovers from the early monitoring rules promulgated in 1979 for areas with populations of 500,000 people or more. In particular, a majority of the remaining microscale sites, and possibly some middle-scale sites, may be left over from the "peak concentration" sites required in the old monitoring requirements that targeted characterization of mobile sources in "heavily traveled downtown streets" or near "major arterial" roads. Regarding the sites assigned larger spatial scales, we again may reasonably suggest that many of the existing neighborhood scale sites are in place due to the "neighborhood stations" that were required in the old monitoring rule.

Using 2009 U.S. Census Bureau estimates (www.census.gov), there are 103 urban areas (specifically, Core Based Statistical Areas) with populations of 500,000 or more. Therefore, under the old rule language, that would translate to only 206 required sites nationwide, or more specifically, 103 microscale sites and 103 neighborhood sites. However, there were 345 sites operating during 2009. This invokes the question of why there are significantly more monitoring sites than what would have been required. EPA believes that the increased number of sites in operation above what would have been the minimum number under the old monitoring requirement is likely a result of State or local (and possibly federal) interests to further characterize CO concentrations in certain areas on a case-by-case basis. Such cases could include interests in broadened spatial coverage, increased background monitoring, stationary source characterizations, and special purpose monitoring. These interests in many cases are served by a limited duration of monitoring. However, EPA has discovered through engagement with State and local agencies that once a monitor is established, it is often difficult to cease monitor operations due various reasons. These reasons include internal or public desire to

maintain its operation for continued public information purposes, data use in ongoing public health or scientific studies, or in some cases, a lack of EPA Regional Administrator approval to shut down a monitor.

Even before the promulgation of the 2006 monitoring rule that removed the minimum monitoring requirements introduced in 1979, there has been a steady decrease in the total CO monitor count year-to-year starting in the early 2000s through the present. In 2000, there were approximately 535 CO monitors in operation. Since then, there has been an average of 20 CO sites shut down annually through 2009. EPA anticipates that in the absence of any new minimum monitoring requirements that may come as part of the CO NAAQS review (circa 2010/2011), the CO network will continue to shrink in size. Considering the budget shortfalls in many States at the current time (2010), which impact staffing and general operations, increased reduction in network size would not be unexpected. Therefore, any site having design value concentrations well below the NAAQS and that meets criteria laid out in 40 CFR 58.14 regarding system modification, could be subject to consideration for shutdown, except for CO monitors required at NCore multi-pollutant monitoring stations.