Revising the Air Quality Index and Setting a Significant Harm Level for $PM_{2.5}$
February 12, 2007

Introduction

In October 2006, EPA revised the national ambient air quality standards for $PM_{2.5}$ by strengthening the 24-hour standard to protect public health against effects associated with short-term exposure to fine particles ($PM_{2.5}$). These effects include: premature death in people with heart and lung disease; non-fatal heart attacks; increased hospital admissions, emergency room visits and doctor's visits for respiratory diseases; increased hospital admission and ER visits for cardiovascular diseases; increased respiratory symptoms such as coughing, wheezing and shortness of breath; lung function changes, especially in children and people with lung diseases such as asthma; changes in heart rate variability; and irregular heartbeat.

The purpose of this issue paper is to provide our initial thoughts about possible revisions to the Air Quality Index (AQI) sub-index for $PM_{2.5}$, reflecting this strengthening of the 24-hour standard. We are also providing our initial thoughts about setting a Significant Harm Level (SHL) for $PM_{2.5}$, which historically is set at the same level as an AQI value of 500. We intend to encourage discussion and comment about these changes among the many agencies and partners that use the AQI on a daily basis to communicate with the public about daily air quality and any associated health risks. We expect these discussions to occur over the next few months, starting at the National Air Quality Conference in February, and to lead to the publication of a summer 2007 proposed rule to revise the AQI and to set an SHL for $PM_{2.5}$ with a final rule in the fall of 2007. To facilitate these discussions we have identified a few key questions which can be found in this paper. The responses to these questions will provide information useful to the rulemaking. At the end of this issue paper there is a list of key EPA contacts and links to supplemental information.

Possible revisions to the AQI value of 100 and the lower end of the range

In 1999, EPA adopted revisions to the uniform air quality index used by States for daily reporting to the general public in accordance with section 319 of the Clean Air Act.

The changes included, among others, the addition of a new sub-index for $PM_{2.5}$. The new sub-index for $PM_{2.5}$ was developed using an approach that was conceptually consistent with past practice for selecting the air quality concentrations associated with the AQI breakpoints. The Agency's historical approach to selecting index breakpoints had been to simply set the AQI value of 100 at the level of the short-term standard for a pollutant and the AQI value of 50 at the level of the annual standard, if there is one, or at one-half the level of the short-term standard if there is not. This method of structuring the index may be appropriate for a typical suite of air quality standards, which include a short-term standard designed to protect against the health effects associated with short-term exposures and an annual standard designed to protect against health effects associated with long-term exposures. In such cases the short-term standard in effect defines a level of health protection provided against short-term risks and thus can be a useful benchmark against which to compare daily air quality concentrations.

In the case of the 1997 $PM_{2.5}$ standards, we took a different approach to protecting against the health risks associated with short-term exposures. The intended level of protection against short-term risk was not defined by the 24-hour standard but by the combination of the 24-hour and the annual standards working in concert. In fact, the annual standard was intended to serve as the principal vehicle for protecting against short-term $PM_{2.5}$ exposures by lowering the entire day-by-day distribution of $PM_{2.5}$ concentrations in an area. Because the 24-hour standard served to provide additional protection against very high short-term concentrations, localized "hotspots" or risks arising from seasonal emissions that would not be well-controlled by a national annual standard, we consequently concluded that it would be appropriate to caution members of sensitive groups exposed to concentrations below the level of the 24-hour standard. We also concluded that it would be inappropriate to compare daily air quality concentrations directly with the level of the annual standard by setting an AQI value of 100 at that level. We wanted to set the AQI value of 100 to reflect the general level of health protection against short-term risks offered by the annual and 24-hour standards combined, consistent with the underlying logic of the historical approach. We concluded that it was appropriate to set the AQI value of 100 at the midpoint of the range between the annual and the 24-hour $PM_{2.5}$ standards (i.e., 40 $\mu g/m^3$) to reflect the dual role of the 24-hour and

the annual $PM_{2.5}$ standards in protecting against short-term risks. Given that decision, we also concluded that it was appropriate to retain the approach of using the level of the annual standard for an AQI value of 50 and of setting the AQI value of 150 at the level of the 24-hour $PM_{2.5}$ standard (see Table 1).

In 2006, EPA revised its national ambient air quality standards for $PM_{2.5}$ by strengthening the 24-hour standard to 35 $\mu g/m^3$. We used a significantly expanded and stronger body of evidence from short-term exposure $PM_{2.5}$ studies as the principal basis for selecting the level of this standard, which is aimed at protecting against health effects associated with short-term exposures to $PM_{2.5}$. Numerous U.S. and Canadian studies were available that provided evidence of associations between short-term exposure to $PM_{2.5}$ and serious health effects in areas with air quality at and above the level of the current annual $PM_{2.5}$ standard (15 $\mu g/m^3$). The standard level we established generally will require improvements in air quality in areas in which the distribution of daily short-term exposure to $PM_{2.5}$ can reasonably be expected to be associated with serious health effects. In setting the level of the 24-hour $PM_{2.5}$ standard at 35 $\mu g/m^3$, we noted that this standard would protect public health with an adequate margin of safety from serious health effects, including premature mortality and hospital admissions for cardiorespiratory causes that are associated with short-term exposure to $PM_{2.5}$.

With the promulgation of the 2006 24-hour $PM_{2.5}$ standard, the short-term standard defines a level of health protection provided against short-term risks that again serves as an appropriate benchmark against which to compare daily air quality concentrations. As a result, it is appropriate to consider setting an AQI value of 100 equal to the level of the 24-hour $PM_{2.5}$ standard (35 $\mu g/m^3$). We believe it is appropriate to consider reducing the AQI value of 150 (now 65 $\mu g/m^3$) in proportion to the reduction in the AQI value of 100 (to 55 $\mu g/m^3$ – rounded to the nearest 5 $\mu g/m^3$). This conclusion is based on the more extensive and stronger body of evidence linking 24-hour $PM_{2.5}$ concentrations with serious morbidity and mortality effects, including: premature death in people with heart and lung disease; non-fatal heart attacks; increased hospital admissions, emergency room visits and doctor's visits for respiratory diseases; increased hospital admission and ER visits for cardiovascular diseases; increased respiratory symptoms such as coughing, wheezing and shortness of breath; lung function changes,

especially in children and people with lung diseases such as asthma; changes in heart rate variability; and irregular heartbeat. We have also concluded that it is appropriate to retain the level of the annual standard for an AQI value of 50 (15 $\mu g/m^3$).

Possible revisions to the AQI value of 500 and the upper end of the range (including setting an SHL for $PM_{2.5}$)

Historically, the AQI value of 100 is set at the level of the short-term standard for a pollutant and the AQI value of 50 at the level of the annual standard, if there is one, or at one-half the level of the short-term standard if there is not. The upper bound index value of 500 corresponds to the Significant Harm Level (SHL), established in section 51.16 of the CFR under the Prevention of Air Pollution Emergency Episodes program. The SHL is set at a level that represents imminent and substantial endangerment to public health. We have not yet promulgated an SHL for $PM_{2.5}$. In 1999, we set an index value of 500 equal to 500 $\mu g/m^3 PM_{2.5}$, 24-hour average, and indicated that if we promulgated an SHL for $PM_{2.5}$ and it was different, we would revise the $PM_{2.5}$ sub-index accordingly (63 FR 67829). This level was established on the basis of increased mortality found during historical wintertime pollution episodes in London, where PM concentrations measured as British Smoke were in the 500 to 1000 $\mu g/m^3$ range. British Smoke provided an approximate measurement of fine particles, since it is considered to measure PM with a cut-point of approximately 4.5 microns. These measurements and health rationale are also the basis for the current SHL for PM_{10} (600 $\mu g/m^3$).

At that time, we considered using the proportion of the PM_{10} SHL (600 $\mu g/m^3$) that comprises $PM_{2.5}$ to set the 500 level of the AQI, but we did not have enough $PM_{2.5}$ monitoring data to establish a ratio ($PM_{2.5}$ to PM_{10}) for that purpose. Since then there has been a significant increase in $PM_{2.5}$ monitoring, and we now have sufficient $PM_{2.5}$ monitoring data to be able to estimate that in the United States, on average, 60 percent of PM_{10} consists of $PM_{2.5}$. This allows us to scale the SHL for $PM_{2.5}$ to the SHL for PM_{10}, rather than basing the $PM_{2.5}$ SHL on measurements of British Smoke, and to maintain the health-based rationale that we used for setting the 500 level of the AQI and the PM_{10} SHL. Using this approach results in a $PM_{2.5}$ SHL of 350 $\mu g/m^3$ (rounded to the nearest 50 $\mu g/m^3$).

For the intermediate breakpoints in the AQI between the values of 100 and 500, the $PM_{2.5}$ concentrations under consideration generally reflect a linear relationship between increasing index values and increasing $PM_{2.5}$ values (see Table 1). The available scientific evidence of health effects related to population exposures to $PM_{2.5}$ concentrations between the level of the 24-hour standard and the level of the SHL under consideration suggest a continuum of effects in this range, with increasing $PM_{2.5}$ concentrations being associated with increasingly large numbers of people likely to experience such effects. The generally linear relationship between AQI values and $PM_{2.5}$ concentrations in this range is consistent with the health evidence. This also is consistent with our practice of setting breakpoints in symmetrical fashion where health effects information does not suggest particular levels.

We have used the historical wintertime pollution episodes in London because there is little available information about similar, more recent, air pollution episodes and associated impacts on community health upon which to base a decision about an SHL for $PM_{2.5}$. *In light of this, we are encouraging state and local air agencies to send us information about air quality measurements and associated public health impacts, if available, related to episodes of high $PM_{2.5}$ levels.* We have compared the level of the SHL for $PM_{2.5}$ under consideration with air quality data (October 2003 to October 2006) in the AQS database. We looked at all appropriate data for this analysis. AIRNow data collected using non-reference method technologies were used to fill in for missing FRM data as necessary. Individual site analysis required 75 percent data completeness resulting in 845 observations out of 1137 possible. During these three years, only one monitor exceeded the level of the $PM_{2.5}$ SHL (350 $\mu g/m^3$) now under consideration, and that episode was related to wildfires.

As a related matter, we recognize that it would be quite useful to have a public advisory system based on a shorter averaging period (i.e., 1-hour $PM_{2.5}$ levels) for use during $PM_{2.5}$ episodes (such as wildfires), when there can be extremely high short-term peaks of $PM_{2.5}$ that aren't well communicated by advisories based on 24-hour average $PM_{2.5}$ concentrations. We intend to issue guidance that air agencies can use during $PM_{2.5}$ episodes. There is a growing body of studies that provide additional evidence of effects associated with exposure periods shorter than 24 hours (e.g., one to several hours)

(OAQPS PM Staff Paper, December 2005, section 3.5.5.1). While the PM Staff Paper concluded that this information remains too limited to serve as a basis for establishing a shorter-than-24-hour $PM_{2.5}$ primary standard, this information will be useful in helping develop guidance that can be used during $PM_{2.5}$ episodes. Some agencies already issue advisories based on 1-hour $PM_{2.5}$ levels. *We are requesting that agencies using such advisories send us information about the approach used and including associated strengths and weaknesses.*

Possible Implications for Air Quality Forecasting

For many areas around the country, lowering the AQI thresholds will result in more days reaching an AQI equal to 100 which is considered Unhealthy for Sensitive Groups (USG). In addition, areas that currently do not reach USG levels may do so once the threshold is lowered. Therefore, a lower threshold could impact existing forecasting programs and may necessitate that additional cities develop forecasting programs. It is EPA's goal to conduct analyses to quantify these impacts. Most, if not all, of the following questions will be answered by EPA to serve as information for state and local forecast programs as well as a basis for discussion:

- How will the frequency distribution of AQI levels change by season with the lowering of thresholds?

- Which cities may want to consider implementing a forecasting program? For existing forecast programs, will PM2.5 forecasts need to be extended into additional seasons and/or made at a greater frequency (e.g. daily versus weekly).

- How much time will be required to forecast with additional action days and additional "close-call" days?

A report will be available during the 2nd quarter of 2007 with answers to the above questions along with conclusions and recommendations.

Table 1. Current breakpoints and possible revisions to $PM_{2.5}$ sub-index

AQI Category	Index Values	$PM_{2.5}$ 24-hour ($\mu g/m^3$)	
		Current	Under Consideration
Good	0 - 50	0.0 - 15.4	0.0 - 15.4
Moderate	51 - 100	15.5 - 40.4	15.5 - 35.4
Unhealthy for Sensitive Groups	101 - 150	40.5 - 65.4	35.5 - 55.4
Unhealthy	151 - 200	65.5 - 150.4	55.5 - 140.4
Very Unhealthy	201 - 300	150.5 - 250.4	140.5 - 210.4
Hazardous	301 - 400	250.5 - 350.4	210.5 - 280.4
	401 - 500	350.5 - 500	280.5 - 350.4

Contacts

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Supplemental Information

Air Quality Index Reporting Proposed Rule (December 9, 1998):
http://epa.gov/airnow/health/aqi_proposal_1998.pdf

Air Quality Index Reporting Final Rule (August 4, 1999):
http://www.epa.gov/ttn/oarpg/t1/fr_notices/airqual.pdf

National Ambient Air Quality Standards for Particulate Matter Proposed Rule (January 17, 2006):

http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-177.pdf

National Ambient Air Quality Standards for Particulate Matter Final Rule (October 17, 2006): http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf

Review of the National Ambient Air Quality Standards for Particulate Matter: OAQPS Staff Paper (December 2005): http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20051221.pdf

Particle Pollution and Your Health: http://www.epa.gov/airnow//particle/pm-color.pdf