United States Environmental Protection Agency
Office of Air Quality Planning and Standards Research Triangle Park, NC 27711
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Air

GUIDELINE FOR REPORTING OF DAILY AIR QUALITY - AIR QUALITY INDEX (AQI)

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Guideline for Reporting of Daily Air Quality
Air Quality Index (AQI)

This guidance is designed to aid local agencies in reporting the air quality using the AQI as required in Part 58.50 of 40 CFR and according to Part 58 of 40 CFR, Appendix G.

Do I have to report the AQI?

Part 58.50 states that Metropolitan Statistical Areas (MSAs) with a population of more than 350,000 are required to report the AQI daily to the general public. Table A-1 in the Appendix lists all the MSAs in the country that have a population of more than 350,000 according to the 1990 census. A complete list of MSAs may be found in the Statistical Abstract of the United States (1998).

How often do I report the AQI?

Appendix G states that MSAs must report the AQI on a daily basis. The appendix further defines daily as at least 5 times each week. This definition allows for days when personnel are not available to provide the AQI report or for equipment failures.

How do I provide the AQI report to the general public?

You must provide the report to the local media (newspapers, radio, television), and you must make the report available at one or more places of public access, provide a recorded telephone message, or publish the report on a publicly accessible web page on the Internet. Other programs, including real-time data reporting and community action programs (e.g., ozone action day programs) that provide timely air quality information to the public, may also be used to meet reporting requirements. When the AQI value is above 100, it is critical that the reporting be as extensive as possible. At a minimum, it should include notification to the media with the largest market coverages for your area.

What is in my AQI report?

Your AQI report must contain:

- The reporting area(s)
- The reporting period
- The critical pollutant
- The AQI

- The category descriptor and, if reported in a color format, the associated color.[1] Use only the following names and colors for the six AQI categories:

Table 1. AQI Categories, Descriptors, and Colors

for this AQI...	Use this descriptor...	and this color[2]
0 to 50	"Good"	Green
51 to 100	"Moderate"	Yellow
101 to 150	"Unhealthy for Sensitive Groups"	Orange
151 to 200	"Unhealthy"	Red
201 to 300	"Very Unhealthy"	Purple
301 and above	"Hazardous"	Maroon

- The groups most sensitive to the specific pollutant for any reported index greater than 100. Use the following sensitive group statements for each pollutant:

Table 2. Pollutant Specific Sensitive Groups

When this pollutant has an index above 100...	Report these Sensitive Groups...
Ozone	Children and people with asthma are the groups most at risk.
$PM_{2.5}$	People with respiratory or heart disease, the elderly and children are the groups most at risk.
PM_{10}	People with respiratory disease are the group most at risk.
CO	People with heart disease are the group most at risk.
SO_2	People with asthma are the group most at risk.

[1] A recorded phone message or a radio broadcast cannot show colors but can name a color in the report (e.g., this is a category "red" day).

[2] Suggested color formulations are given in Table 4.

NO_2	Children and people with respiratory disease are the groups most at risk.

An AQI report may also contain:

- The name and index value for other pollutants, particularly those with an index value greater than 100.
- The index for sub-areas of the reporting area.
- Actual pollutant concentrations.
- Causes for unusual AQI values.
- Health effects and cautionary language.
- Statements that "blend" the health effects statements or the cautionary statements for more than one pollutant, if there is more than one pollutant with an index value greater than 100.

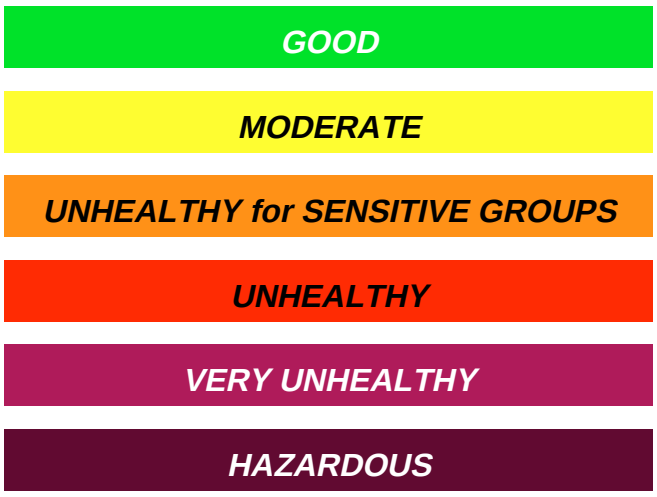
What does an AQI report look like?

The following examples of AQI reports present various methods of reporting the AQI which you can use.

Example 1. A short form for a newspaper.

The Air Quality in Durham yesterday

The AIR QUALITY in Durham yesterday was Moderate due to ozone. The air quality index was 57. ➡

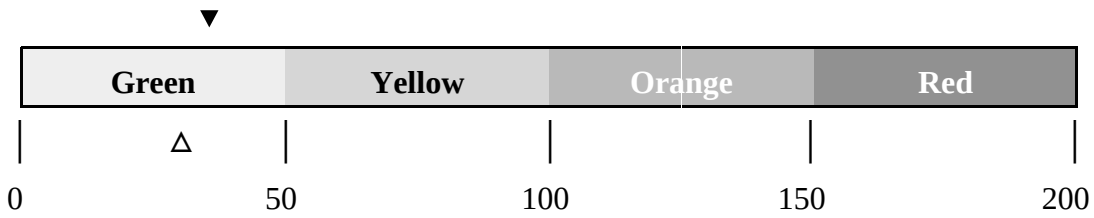


Example 2. A short form for a newspaper in black and white.

Air Quality for Washington, D.C.

▼ Today's forecast Δ Yesterday

Air Quality Index (AQI)



Yesterday's pollutant : **30, ozone**

Color codes:

Green = Good

Yellow = Moderate

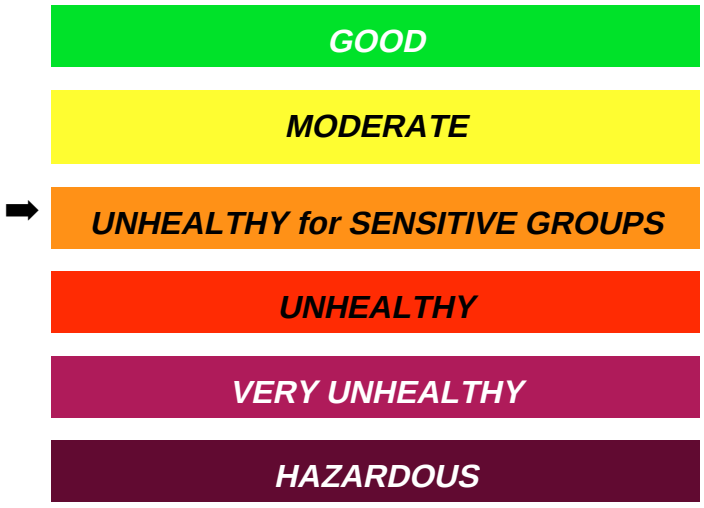
Orange = Unhealthy for Sensitive Groups

Red = Unhealthy

Example 3. A longer form for a newspaper.

The Air Quality in Baltimore yesterday

The AIR QUALITY yesterday in Northeast Baltimore was Unhealthy for Sensitive Groups due to ozone. Groups likely to be sensitive to ozone include active children and adults, and people with respiratory disease such as asthma. The air quality index was 110 resulting from an ozone concentration of 0.088 ppm. Elsewhere in Baltimore, the air quality index was 87 or Moderate. Since today's air quality is expected to be much the same, people in the sensitive groups should limit prolonged outdoor exertion. With outdoor exertion, these groups may experience respiratory symptoms and breathing discomfort.



The following is a short script that could be used for a television evening news/weather report. Graphics used for the report could be similar to the graphics used in newspaper reports. You must use the descriptors and, if a color format is used, colors for the categories that are listed in Table 1, above.

Example 4. A short form for television (evening).

"The air quality index today was 156, in the red category. Air stagnation caused a buildup of ozone to unhealthy levels. Children and people with asthma are the groups most at risk."

Example 5. A short form for television (morning).

"Yesterday the air quality was unhealthy due to ozone, and we expect similar air quality today – in the red range or around an index of 160 which is unhealthy. Children and people with asthma are the groups most at risk. Active children and adults and people with asthma or other respiratory diseases should avoid prolonged physical exertion outside today. In fact, everyone should consider limiting the time they spend on outdoor exercise or those outside jobs..."

Example 6. A long form for television (evening).

"Air quality today was unhealthy due to ozone, with an index value of 156. Children and people with asthma are the groups most at risk. The cool front we expected to come through here tomorrow and blow all this ozone away isn't going to make it, so the stagnant air will still be here, making air quality unhealthy. Active children and adults and people with asthma or other respiratory diseases should avoid prolonged exertion outside tomorrow. In fact, everyone should consider limiting the time they spend on outdoor exercise or those outside jobs..."

Recorded telephone messages can be used to give more up-to-date information on the air quality. The following example has been used.

Example 7. A script for telephone
"As of 10:00 AM the air quality index is 45 which is good or green. The responsible pollutant is ozone."

The newest way to report the AQI is via a publicly accessible Internet web site. Technology is available that can make these reports almost real-time. The Ozone Mapping Project (http://www.epa.gov/airnow) comes very close to real-time and uses much more involved analysis than is required for AQI reporting. Examples of web site reporting are given below.

Example 8. A short form for a Web site

Air Quality Index for St. Louis, MO for July 19,1999

Time of this report:	1:00PM	**AQI:**	110	**Color:**	Orange
Responsible pollutant:	Ozone	**Category:**	Unhealthy for Sensitive Groups		
Sensitive Groups	Children and people with asthma are the groups most at risk.				

Example 9. A long form for a Web site

Air Quality Index for Chicago, IL for August 1, 1999

Report as of:	2:00PM	**AQI:**	162	**Responsible pollutant:**	Ozone
Color:	Red	**Category:**	Unhealthy		
Sensitive groups:	Children and people with asthma are the groups most at risk.				
Health effects:	Greater likelihood of respiratory symptoms and breathing difficulty in sensitive groups, possible respiratory effects in the general population.				
HEALTH ADVISORY	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else (especially children) should limit prolonged outdoor exertion.				
Air Quality in South Chicago - Gary, IL		AQI:	122	(Unhealthy for Sensitive Groups)	
Tomorrow's air quality in Chicago is predicted to be:	Unhealthy for Sensitive Groups			Color:	Orange

What colors do I use in my AQI report?

If you report the air quality index in a color format, the colors you must use are specified in appendix G and Table 3, below:

Table 3. AQI Colors

For this category ...	... use this color
Good	Green
Moderate	Yellow
Unhealthy for Sensitive Groups	Orange
Unhealthy	Red
Very Unhealthy	Purple
Hazardous	Maroon

Suggested color formulations are defined in Table 4, below, for red, green, blue (RGB) and cyan, magenta, yellow, and black (CMYK) color formulas:[1]

Table 4. Suggested AQI Color Formulas

Color[2]	R	G	B	C	M	Y	K
Green	0	228	0	224	0	224	30
Yellow	255	255	0	0	0	255	0
Orange	255	126	0	0	132	255	0
Red	255	0	0	0	255	255	0
Purple	153	0	76	0	153	80	102
Maroon	76	0	38	0	76	38	179

[1] The RGB model is traditionally used for screen colors while CMYK is traditionally used for printing processes.
[2] The color models are based on a 0 - 255 scale (e.g. 50% is 127).

What health effects and cautionary statements should I use in my report?

The most recent health effects information used with the AQI is pollutant-specific. The following tables list the different health effects messages, sensitive groups, and cautionary statements for each pollutant in the AQI.

Table 5. Pollutant-Specific Health Effects Statements for the Air Quality Index (AQI)

AQI Category	Ozone (ppm)		Particulate Matter (µg/m^3)		Carbon Monoxide (ppm)	Sulfur Dioxide (ppm)	Nitrogen Dioxide (ppm)
	[8-hour]	[1-hour]	$PM_{2.5}$ [24-hour]	PM_{10} [24-hour]	[8-hour]	[24-hour]	[1-hour]
Good	None		None	None	None	None	None
Moderate	Unusually sensitive individuals may experience respiratory symptoms.		None	None	None	None	None
Unhealthy for Sensitive Groups	Increasing likelihood of respiratory symptoms and breathing discomfort in active children and adults and people with respiratory disease, such as asthma.	Increasing likelihood of respiratory symptoms and breathing discomfort in active children and adults and people with respiratory disease, such as asthma.	Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly.	Increasing likelihood of respiratory symptoms and aggravation of lung disease, such as asthma.	Increasing likelihood of reduced exercise tolerance due to increased cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.	Increasing likelihood of respiratory symptoms, such as chest tightness and breathing discomfort, in people with asthma.	None
Unhealthy	Greater likelihood of respiratory symptoms and breathing difficulty in active children and adults and people with respiratory disease, such as asthma; possible respiratory effects in general population.	Greater likelihood of respiratory symptoms and breathing difficulty in active children and adults and people with respiratory disease, such as asthma; possible respiratory effects in general population.	Increased aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population.	Increased respiratory symptoms and aggravation of lung disease, such as asthma; possible respiratory effects in general population.	Reduced exercise tolerance due to increased cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.	Increased respiratory symptoms, such as chest tightness and wheezing in people with asthma; possible aggravation of heart or lung disease.	None

Table 5. Pollutant-Specific Health Effects Statements for the Air Quality Index (AQI) (Cont.)

AQI Category	Ozone (ppm) [8-hour]	Ozone (ppm) [1-hour]	Particulate Matter (µg/m^3) $PM_{2.5}$ [24-hour]	Particulate Matter (µg/m^3) PM_{10} [24-hour]	Carbon Monoxide (ppm) [8-hour]	Sulfur Dioxide (ppm) [24-hour]	Nitrogen Dioxide (ppm) [1-hour]
Very Unhealthy	Increasingly severe symptoms and impaired breathing likely in active children and adults and people with respiratory disease, such as asthma; increasing likelihood of respiratory effects in general population.	Increasingly severe symptoms and impaired breathing likely in active children and adults and people with respiratory disease, such as asthma; increasing likelihood of respiratory effects in general population.	Significant aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; significant increase in respiratory effects in general population.	Significant increase in respiratory symptoms and aggravation of lung disease, such as asthma; increasing likelihood of respiratory effects in general population.	Significant aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease.	Significant increase in respiratory symptoms, such as wheezing and shortness of breath, in people with asthma; aggravation of heart or lung disease.	Increasing likelihood of respiratory symptoms and breathing discomfort in children and people with respiratory disease, such as asthma.
Hazardous	Severe respiratory effects and impaired breathing likely in active children and adults and people with respiratory disease, such as asthma; increasingly severe respiratory effects likely in general population.	Severe respiratory effects and impaired breathing likely in active children and adults and people with respiratory disease, such as asthma; increasingly severe respiratory effects likely in general population.	Serious aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; serious risk of respiratory effects in general population.	Serious risk of respiratory symptoms and aggravation of lung disease, such as asthma; respiratory effects likely in general population.	Serious aggravation of cardiovascular symptoms, such as chest pain, in people with cardiovascular disease; impairment of strenuous activities in general population.	Severe respiratory symptoms, such as wheezing and shortness of breath, in people with asthma; increased aggravation of heart or lung disease; possible respiratory effects in general population.	Greater likelihood of respiratory symptoms and breathing difficulty in children and people with respiratory disease, such as asthma.

Table 6. Pollutant-Specific Cautionary Statements for the Air Quality Index (AQI)

AQI Category	Ozone (ppm)		Particulate Matter (µg/m^3)		Carbon Monoxide (ppm) [8-hour]	Sulfur Dioxide (ppm) [24-hour]	Nitrogen Dioxide (ppm) [1-hour]
	[8-hour]	[1-hour]	$PM_{2.5}$ [24-hour]	PM_{10} [24-hour]			
Good	None		None	None	None	None	None
Moderate	Unusually sensitive people should consider limiting prolonged outdoor exertion.		None	None	None	None	None
Unhealthy for Sensitive Groups	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.	Active children and adults, and people with respiratory disease, such as asthma, should limit heavy outdoor exertion.	People with respiratory or heart disease, the elderly and children should limit prolonged exertion.	People with respiratory disease, such as asthma, should limit outdoor exertion.	People with cardiovascular disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.	People with asthma should consider limiting outdoor exertion.	None
Unhealthy	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.	Active children and adults, and people with respiratory disease, such as asthma, should avoid heavy outdoor exertion; everyone else, especially children, should limit heavy outdoor exertion.	People with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.		People with cardiovascular disease, such as angina, should limit moderate exertion and avoid sources of CO, such as heavy traffic.	Children, asthmatics, and people with heart or lung disease should limit outdoor exertion.	None

Table 6. Pollutant-Specific Cautionary Statements for the Air Quality Index (AQI) (Cont.)

AQI Category	Ozone (ppm)		Particulate Matter (µg/m^3)		Carbon Monoxide (ppm)	Sulfur Dioxide (ppm)	Nitrogen Dioxide (ppm)
	[8-hour]	[1-hour]	$PM_{2.5}$ [24-hour]	PM_{10} [24-hour]	[8-hour]	[24-hour]	[1-hour]
Very Unhealthy	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.	People with respiratory or heart disease, the elderly and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.	People with respiratory disease, such as asthma, should avoid any outdoor activity; everyone else, especially the elderly and children, should limit outdoor exertion.	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.	Children, asthmatics, and people with heart or lung disease should avoid outdoor exertion; everyone else should limit outdoor exertion.	Children and people with respiratory disease, such as asthma, should limit heavy outdoor exertion.
Hazardous	Everyone should avoid all outdoor exertion.	Everyone should avoid all outdoor exertion.	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly and children should remain indoors.	Everyone should avoid any outdoor exertion; people with respiratory disease, such as asthma, should remain indoors.	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic; everyone else should limit heavy exertion.	Children, asthmatics, and people with heart or lung disease should remain indoors; everyone else should avoid outdoor exertion.	Children and people with respiratory disease, such as asthma, should limit moderate or heavy outdoor exertion.

How do I calculate the AQI from pollutant concentration data?

You calculate the AQI by using your pollutant concentration data, the breakpoints in Table 7 on the next page, and the following equation (linear interpolation):

Equation 1

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{HI} - BP_{Lo}}(C_p - BP_{Lo}) + I_{Lo}.$$

Where I_p = the index for pollutant $_p$

C_p = the rounded concentration of pollutant $_p$

BP_{Hi} = the breakpoint that is greater than or equal to C_p

BP_{Lo} = the breakpoint that is less than or equal to C_p

I_{Hi} = the AQI value corresponding to BP_{Hi}

I_{lo} = the AQI value corresponding to BP_{Lo}.

Table 7. Breakpoints for the AQI

These Breakpoints						equal these AQIs...		Category
O_3 (ppm) 8-hour	O_3 (ppm) 1-hour[1]	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI	
0.000-0.064	-	0.0 - 15.4	0 - 54	0.0 - 4.4	0.000 - 0.034	([2])	0 - 50	Good
0.065-0.084	-	15.5 - 40.4	55 - 154	4.5 - 9.4	0.035 - 0.144	([2])	51 - 100	Moderate
0.085-0.104	0.125-0.164	40.5 - 65.4	155 - 254	9.5 - 12.4	0.145 - 0.224	([2])	101 - 150	Unhealthy for sensitive groups
0.105-0.124	0.165 - 0.204	65.5 - 150.4	255 - 354	12.5 - 15.4	0.225 - 0.304	([2])	151 - 200	Unhealthy
0.125-0.374	0.205- 0.404	150.5 - 250.4	355 - 424	15.5 - 30.4	0.305 - 0.604	0.65 - 1.24	201 - 300	Very unhealthy
([3])	0.405- 0.504	250.5 - 350.4	425 - 504	30.5 - 40.4	0.605 - 0.804	1.25 - 1.64	301 - 400	Hazardous
([3])	0.505- 0.604	350.5 - 500.4	505 - 604	40.5 - 50.4	0.805 - 1.004	1.65 - 2.04	401 - 500	

[1] Areas are generally required to report the AQI based on 8-hour ozone values. However, there are a small number of areas where an AQI based on 1-hour ozone values would be more precautionary. In these cases, in addition to calculating the 8-hour ozone index value, the 1-hour ozone index value may be calculated and the maximum of the two values is reported.

[2] NO_2 has no short-term NAAQS and can generate a AQI only above a AQI value of 200.

[3] When 8-hour O_3 concentrations exceed 0.374 ppm, AQI values of 301 or higher must be calculated with 1-hour O_3 concentrations.

Example 1. 8-hour Ozone.

Suppose you have an 8-hour ozone concentration of 0.0875125 ppm. First you truncate the concentration to 0.087 ppm. Then you look in Table 7 under 8-hour ozone for the range of concentrations that contain this concentration (0.085 - 0.104 ppm). This range in the table for 8-hour ozone corresponds to index values of 101 to 150. Now you have all the numbers needed to use the equation:

$$\frac{(101-150)}{(0.104-.085)}(0.087-0.085)+101=\frac{49}{0.019}0.002+101=106.157=106$$

So an 8-hour concentration of 0.0875125 corresponds to an index value of 106.

Example 2. Multiple pollutants.

Suppose you have an 8-hour ozone value of 0.077 ppm, a $PM_{2.5}$ value of 54.4 µg/m^3, and a CO value of 8.4 ppm. You apply the equation 3 times:

$$0_3: \frac{(100-51)}{(0.084-0.065)}(0.077-0.065)+51=82$$

$$PM_{2.5}: \frac{(150-101)}{(65.4-40.5)}(54.4-40.5)+101=128$$

$$CO: \frac{(100-51)}{(9.4-4.5)}(8.4-4.5)+51=90$$

The AQI is 128 with $PM_{2.5}$ as the responsible pollutant.

Example 3. Ozone 1-hour and Ozone 8-hour concentrations.

Suppose you had a 1-hour concentration of 0.162 ppm and an 8-hour concentration of 0.141125 ppm. Then you apply the equation twice:

$$1-hr: \frac{(150-101)}{0.164-0.125)}(0.162-0.125)+101=147$$

$$8-hr: \frac{(300-201)}{(0.374-0.125)}(0.141-0.125)+201=207$$

In this case, the index is 207 (the maximum of 147 and 207) and the responsible pollutant is ozone (8-hour).

Example 4. $PM_{2.5}$ and PM_{10} concentrations.

Suppose you had daily concentrations of $PM_{2.5}$ (48.7 µg/m^3) and PM_{10} (178 µg/m^3). Then you apply Equation 1 twice as if you had two pollutants instead of two indicators of the same pollutant:

$$PM_{2.5}: \frac{(150-101)}{(65.4-40.5)}(48.7-40.5)+101=117$$

$$PM_{10}: \frac{(150-101)}{(254-155)}(178-155)+101=112$$

In this case the AQI would be 117 (the maximum of 117 and 112) and the responsible pollutant would be PM ($PM_{2.5}$).

Example 5. Concentrations for pollutants that have blank places in Table 7

You disregard 8-hour ozone concentrations greater than 0.374 ppm, 1-hour ozone concentrations less than 0.125 ppm, and NO_2 concentrations less than 0.65 ppm. Suppose you had a 1-hour ozone concentration of 0.104 ppm, an 8-hour ozone concentration of 0.087 ppm and an NO_2 concentration of 0.54 ppm. First you disregard the 1-hour ozone concentration because it is less than 0.125 ppm and the NO_2 concentration because it is less than 0.65 ppm. Then you calculate the index for the 8-hour ozone concentration as before:

$$\frac{(150-101)}{(0.104-0.085)}(0.087-0.085)+101=106.158$$

which rounds to an AQI value of 106.

Are there exceptions to these reporting requirements?

Yes. When you have low index values that meet the following criteria, you do not have to meet all the requirements:

- If the index for a specific pollutant remains below 50 for a season or a year, then you are not required to include this pollutant in the calculation of the AQI.
- If your calculated AQI remains below 50 for more than a year, then you are not required to report the AQI.

- However, if any of these conditions are not met in subsequent years, then you must resume reporting the index according to Appendix G to Part 58 of 40 CFR.

Where do I get the pollutant concentrations for the AQI?

The pollutant concentration data is from the State and Local Air Monitoring Stations (SLAMS) operating under the rules set forth in Part 58 of 40 CFR. You are not required to have any special monitors in your area for the purpose of reporting the AQI. In the case of PM, many areas use non-Federal Reference Method monitors (continuous PM monitors such as TEOM monitors) for the purpose of reporting the AQI. The EPA encourages you to do this for the sake of timely reporting of the AQI. It is only necessary for you to establish a linear relationship between concentrations from a Federal Reference or Equivalent Method and a non-reference method monitor for the purpose of reporting PM values in the AQI.

Where do I find more information about reporting the AQI?

There are several publications, guidance documents, and a computer program to help you report the AQI. These may be found on the AIRNOW web site (**http://www.epa.gov/airnow)** or from the AIR QUALITY TRENDS ANALYSIS GROUP, US EPA (MD-14), RTP, NC 27711.

- Ozone health effects booklet and pamphlet
- AQI brochure
- AQI calculator program
- Forecasting guidance

Do I have to forecast pollutant concentrations for the AQI report?

You are not required to forecast, but if you choose to do so, we encourage you to forecast values 24 hours in advance. The AQI is designed to inform the public about air quality so that individuals may choose to avoid exposure to certain levels and types of air pollution. This choice is unavailable if the information is not timely. Forecasts caution people in advance. However, good forecasts require data, computational resources and expertise that may be unavailable to you. The EPA provides guidance if you are interested in starting a forecasting program for your MSA.

Since ozone is often the critical pollutant in AQI reporting and the averaging period is 8 hours, informing the public before the end of the maximum 8-hour period is important even if you are not able to forecast 24 hours in advance. In order for individuals to take advantage of this information, it is necessary to consider at least a short term forecast or prediction of 8-hour ozone levels for the purposes of reporting the AQI. You can do this with very little additional resources. You can rely on the high correlation between daily maximum values of 8-hour and 1-hour ozone concentrations. A simple linear regression can be calculated on daily maximum data at any site. From this regression, you can predict that the 8-hour ozone maximum for a day will be at least as high as the 8-hour value corresponding to the present 1-hour value. From this information you can predict the AQI hours earlier than if you wait for

the full 8-hour maximum to be observed.

What if the correlation at my site is low?

The lowest observed correlation between 1-hour and 8-hour maximum ozone concentrations at any site reporting to AIRS data was 0.86. This correlation is adequate to predict the maximum 8-hour values from the maximum 1-hour values for reporting the AQI. However, if you feel uncomfortable due to the imprecision from lower correlations, you may want to predict the AQI from the confidence interval for the 8-hour maximum predicted from the 1-hour maximum. In other words, if your are more concerned about "false negatives," for example, not predicting unhealthy air quality when the concentrations later in the day might reach unhealthy levels, then predict unhealthy air quality as soon as the upper bound of the confidence interval is greater than the AQI breakpoint for the unhealthy category. If you are more concerned about "false positives," for example, predicting unhealthy air quality when the concentrations later in the day might indicate that air quality did not reach unhealthy levels, then you should consider predicting unhealthy air quality only when the lower bound of the confidence interval is above the breakpoint for the unhealthy category.

How do I calculate the upper and lower bounds for the confidence interval for the predicted maximum 8-hour ozone value?

Most computer regression programs include the error variance or the residual variance or the variance of "Y given X" as part of the output. Call this S_e^2. Then you calculate the upper an lower bounds of the predicted value as:

$$upper: \quad \hat{Y} + t_{1-\alpha/2,n-2}\sqrt{S_e^2\left(1+\frac{1}{n}+\frac{(x'-\bar{x})^2}{(n-1)S_x^2}\right)}$$

$$lower: \quad \hat{Y} - t_{1-\alpha/2,n-2}\sqrt{S_e^2\left(1+\frac{1}{n}+\frac{(x'-\bar{x})^2}{(n-1)S_x^2}\right)}$$

Where:

$\hat{Y}$ is the predicted 8-hour ozone maximum,
$t_{1-\alpha/2,n-2}$ is a tabulated Student's-T value corresponding to a two sided (1- α)100% confidence interval with n-2 degrees of freedom,
S_e^2 is the error variance described above,
x' is the 1-hour value used to predict the 8-hour value,
$\bar{x}$ is the average of the 1-hour values, and
S_x^2 is the variance of the 1-hour values.

The value α is arbitrary, but conventionally it is usually set to 0.05 corresponding to a 95% confidence

interval.

APPENDIX

Table A-1. Metropolitan Statistical Areas with over 350,000 population (1990 Census)

MSA	NAME	POPULATION
80	AKRON, OH	657,575
160	ALBANY-SCHENECTADY-TROY, NY	861,424
200	ALBUQUERQUE, NM	589,131
240	ALLENTOWN-BETHLEHEM-EASTON, PA	595,081
440	ANN ARBOR, MI	490,058
520	ATLANTA, GA	2,959,950
600	AUGUSTA-AIKEN, GA-SC	415,184
620	AURORA-ELGIN, IL	356,884
640	AUSTIN-SAN MARCOS, TX	846,227
680	BAKERSFIELD, CA	543,477
720	BALTIMORE, MD	2,382,172
760	BATON ROUGE, LA	528,264
840	BEAUMONT-PORT ARTHUR, TX	361,226
875	BERGEN-PASSAIC, NJ	1,278,440
1000	BIRMINGHAM, AL	840,140
1120	BOSTON, MA-NH	3,227,707
1160	BRIDGEPORT, CT	443,722
1280	BUFFALO-NIAGARA FALLS, NY	1,189,288
1320	CANTON-MASSILLON, OH	394,106
1440	CHARLESTON-NORTH CHARLESTON, SC	506,875
1520	CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	1,162,093
1560	CHATTANOOGA, TN-GA	424,347
1600	CHICAGO, IL	7,410,858

MSA	NAME	POPULATION
1640	CINCINNATI, OH-KY-IN	1,526,092
1680	CLEVELAND-LORAIN-ELYRIA, OH	2,202,069
1720	COLORADO SPRINGS, CO	397,014
1760	COLUMBIA, SC	453,331
1840	COLUMBUS, OH	1,345,450
1920	DALLAS, TX	2,676,248
1960	DAVENPORT-MOLINE-ROCK ISLAND, IA-IL	350,861
2000	DAYTON-SPRINGFIELD, OH	951,270
2020	DAYTONA BEACH, FL	399,413
2080	DENVER, CO	1,622,980
2120	DES MOINES, IA	392,928
2160	DETROIT, MI	4,266,654
2320	EL PASO, TX	591,610
2640	FLINT, MI	430,459
2680	FORT LAUDERDALE, FL	1,255,488
2760	FORT WAYNE, IN	456,281
2800	FORT WORTH-ARLINGTON, TX	1,361,034
2840	FRESNO, CA	755,580
2960	GARY, IN	604,526
3000	GRAND RAPIDS-MUSKEGON-HOLLAND, MI	937,891
3120	GREENSBORO--WINSTON-SALEM--HIGH POINT, NC	1,050,304
3160	GREENVILLE-SPARTANBURG-ANDERSON, SC	830,563
3240	HARRISBURG-LEBANON-CARLISLE, PA	587,986
3280	HARTFORD, CT	1,157,585
3320	HONOLULU, HI	836,231
3360	HOUSTON, TX	3,322,025

MSA	NAME	POPULATION
3480	INDIANAPOLIS, IN	1,380,491
3560	JACKSON, MS	395,396
3600	JACKSONVILLE, FL	906,727
3640	JERSEY CITY, NJ	553,099
3660	JOHNSON CITY-KINGSPORT-BRISTOL, TN-VA	436,047
3720	KALAMAZOO-BATTLE CREEK, MI	429,453
3760	KANSAS CITY, MO-KS	1,582,875
3840	KNOXVILLE, TN	585,960
3980	LAKELAND-WINTER HAVEN, FL	405,382
4000	LANCASTER, PA	422,822
4040	LANSING-EAST LANSING, MI	432,674
4120	LAS VEGAS, NV-AZ	852,737
4160	LAWRENCE, MA-NH	353,232
4280	LEXINGTON, KY	405,936
4400	LITTLE ROCK-NORTH LITTLE ROCK, AR	513,117
4480	LOS ANGELES-LONG BEACH, CA	8,863,164
4520	LOUISVILLE, KY-IN	948,829
4720	MADISON, WI	367,085
4880	MCALLEN-EDINBURG-MISSION, TX	383,545
4900	MELBOURNE-TITUSVILLE-PALM BAY, FL	398,978
4920	MEMPHIS, TN-AR-MS	1,007,306
5000	MIAMI, FL	1,937,094
5015	MIDDLESEX-SOMERSET-HUNTERDON, NJ	1,019,835
5080	MILWAUKEE-WAUKESHA, WI	1,432,149
5120	MINNEAPOLIS-ST. PAUL, MN-WI	2,538,834
5160	MOBILE, AL	476,923

MSA	NAME	POPULATION
5170	MODESTO, CA	370,522
5190	MONMOUTH-OCEAN, NJ	986,327
5360	NASHVILLE, TN	985,026
5380	NASSAU-SUFFOLK, NY	2,609,212
5480	NEW HAVEN-MERIDEN, CT	530,180
5560	NEW ORLEANS, LA	1,285,270
5600	NEW YORK, NY	8,546,846
5640	NEWARK, NJ	1,915,928
5720	NORFOLK-VIRGINIA BEACH-NEWPORT NEWS,VA-NC	1,443,244
5775	OAKLAND, CA	2,082,914
5880	OKLAHOMA CITY, OK	958,839
5920	OMAHA, NE-IA	639,580
5945	ORANGE COUNTY, CA	2,410,556
5960	ORLANDO, FL	1,224,852
6160	PHILADELPHIA, PA-NJ	4,922,175
6200	PHOENIX-MESA, AZ	2,238,480
6280	PITTSBURGH, PA	2,384,811
6360	PONCE, PR	3,442,660
6440	PORTLAND-VANCOUVER, OR-WA	1,515,452
6480	PROVIDENCE-FALL RIVER-WARWICK, RI-MA	1,134,350
6640	RALEIGH-DURHAM-CHAPEL HILL, NC	855,545
6760	RICHMOND-PETERSBURG, VA	865,640
6780	RIVERSIDE-SAN BERNARDINO, CA	2,588,793
6840	ROCHESTER, NY	1,062,470
6920	SACRAMENTO, CA	1,340,010
6960	SAGINAW-BAY CITY-MIDLAND, MI	399,320

MSA	NAME	POPULATION
7040	ST. LOUIS, MO-IL	1,836,302
7120	SALINAS, CA	355,660
7160	SALT LAKE CITY-OGDEN, UT	1,072,227
7240	SAN ANTONIO, TX	1,324,749
7320	SAN DIEGO, CA	2,498,016
7360	SAN FRANCISCO, CA	1,603,678
7400	SAN JOSE, CA	1,497,577
7440	SAN JUAN-BAYAMON, PR	1,836,302
7480	SANTA BARBARA-SANTA MARIA-LOMPOC, CA	369,608
7500	SANTA ROSA, CA	388,222
7510	SARASOTA-BRADENTON, FL	489,483
7560	SCRANTON--WILKES-BARRE--HAZLETON, PA	638,466
7600	SEATTLE-BELLEVUE-EVERETT, WA	2,033,156
7680	SHREVEPORT-BOSSIER CITY, LA	376,330
7840	SPOKANE, WA	361,364
8000	SPRINGFIELD, MA	587,884
8120	STOCKTON-LODI, CA	480,628
8160	SYRACUSE, NY	742,177
8200	TACOMA, WA	586,203
8280	TAMPA-ST. PETERSBURG-CLEARWATER, FL	2,067,959
8400	TOLEDO, OH	614,128
8520	TUSCON, AZ	666,880
8560	TULSA, OK	708,954
8720	VALLEJO-FAIRFIELD-NAPA, CA	451,186
8735	VENTURA, CA	669,016
8840	WASHINGTON, DC-MD-VA-WV	4,223,485

MSA	NAME	POPULATION
8960	WEST PALM BEACH-BOCA RATON, FL	863,518
9040	WICHITA, KS	485,270
9160	WILMINGTON-NEWARK, DE-MD	513,293
9240	WORCESTER, MA-CT	478,384
9320	YOUNGSTOWN-WARREN, OH	600,859