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PARTICULATE MATTER

AIR QUALITY: PARTICULATE MATTER

NOTE: This document was designed to assist public health officials in communicating specific air quality issues to the general public. Additional materials (e.g., fact sheets) will be supplied for public distribution.

Air Quality:

The Environmental Assessment Workgroup, comprised of members from the Agency for Toxic Substances and Disease Registry (ATSDR), Centers for Disease Control and Prevention (CDC), Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA), is recommending that people in New York City make an effort to reduce their exposure to air contaminants due to the fires, smoke, and dust (also known as particulate matter) created by the collapse of WTC and on-going response in Lower Manhattan. It is especially important for people with heart or respiratory disease, the elderly and young children to reduce their exposure to smoke and dust since they are likely to be more sensitive to the effects of particulate matter.

Health complaints from the area have been primarily irritant and respiratory in nature (such as coughing, irritation of the eyes, nose and throat, wheezing, difficulty in breathing and shortness of breath). Airborne particulate matter known to cause these types of acute health effects include smoke, fiberglass, and inhalable dust (e.g., cement and gypsum). Certain compounds in airborne particles may be present that may result in chronic health problems, including respirable silica and asbestos. Efforts to measure air quality are focusing on all these types of airborne particles.

Particulate Matter:

The term "particulate matter" (PM) includes both solid particles and liquid droplets found in air. Many human activities and natural events emit PM directly or emit other pollutants that react in the air to form PM. These solid and liquid particles come in a wide range of size. Particles less than 10 micrometers in aerodynamic diameter tend to pose the greatest health concern because they can pass through the nose and throat and be deposited in the lungs. Particles less than 2.5 micrometers in diameter are referred to as "fine" particles. Sources of fine particles include all types of combustion (motor vehicles, power plants, fires, etc.) and some industrial processes. Particles with diameters between 2.5 and 10 micrometers are referred to as "coarse" particles. Sources of coarse particles include crushing and grinding operations, and dust from paved and unpaved roads. The particle mix in most U.S. cities is dominated by fine particles generated by combustion with smaller amounts of coarse dust. The coarse dust resulting from the collapse of World Trade Center (WTC) buildings and the removal of rubble contains particles from building materials.

In order to address public health issues associated with PM in air, some characterization of airborne particulate matter is warranted to provide additional information. The likelihood for particles to produce certain health effects is also related to particle size. Larger particles are less likely to penetrate deeply into the lungs and can be deposited on mucous membranes of the eyes, nose and throat as part of the body's natural defense system. Particles deposited on these surfaces can cause irritation. As particle size decreases the likelihood for them to reach more deeply into the lungs increases. Particles depositing in the lower regions of the lungs can produce both short term effects, such as coughing and longer term effects such as changes in lung function. Specific characteristics (e.g. chemical composition) of these particles can also influence the types of health effects seen following exposure.

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Based upon their ability to cause adverse health effects, the EPA has set levels of concern for particulate matter, as part of EPA's Air Quality Index. Currently EPA has a set such levels for airborne particles that are 10 micrometers in diameter or smaller (PM₁₀), and for fine particles that are 2.5 micrometers or less in diameter (PM_{2.5}). It is important to note that even in environments where fine and coarse particles are below these levels of concern, some people may still experience eye, nose, and throat irritation due to the presence of other substances such as larger particles or irritating gases.

It is possible that PM from the WTC fire and collapse could have entered homes. Indoor air quality may have been affected by the WTC fire and collapse even if the windows and doors were closed since smaller particles can enter through very small openings and cracks. Additionally, settled dust can be re-suspended into the air during routine activities, and it can also be tracked inside from outdoors by people, pets, and other activities. Therefore, if dust is in the home (e.g., on the couch, floors, counter tops, etc...), people should pay particular attention to the recommendations regarding: 1) cleaning the home, 2) checking the air conditioning and heating system, and 3) ways to prevent tracking dust indoors.

Health Effects of Particulate Matter:

3. Dust and smoke may irritate healthy people's eyes, nose, throat, and lungs, and might cause more serious problems in sensitive populations. Because dust and smoke are mixtures of different chemicals with different sizes, not everyone will experience the same effects. Most healthy adults and children will recover quickly from the symptoms of short-term dust and smoke exposures and will not likely suffer long-term consequences.
4. Certain sensitive populations, listed below, are susceptible to more serious problems, including cough, phlegm, wheezing, shortness of breath, bronchitis, increased asthma attacks, and aggravation of respiratory or cardiovascular disease.
 - **Individuals with asthma and other respiratory diseases.** Levels of pollutants that might not affect healthy people might cause breathing difficulties for people with asthma or other chronic lung diseases, especially children. Individuals with emphysema and chronic bronchitis may also experience a worsening of their conditions because of exposure to dust and smoke. Studies have linked particulate matter pollution to increased risk of hospitalizations for respiratory disease, asthma attacks, and respiratory mortality.
 - **Individuals with cardiovascular disease.** People with heart disease might also experience symptoms such as shortness of breath or chest tightness. Studies have also linked particulate pollution to increased risk of hospitalizations for cardiovascular disease and heart attacks, and cardiovascular mortality.
 - **The elderly.** The elderly are more likely to have preexisting lung and heart diseases, and therefore are more susceptible to health effects from exposure to particle pollution.
 - **Children.** Healthy children are sensitive to air pollution and more susceptible to pollution than healthy adults. Studies have shown that in children, particulate pollution is associated with increased episodes of coughing and difficulty breathing, and decreased lung function.
3. In communicating to the public about levels of concern for concentrations of particulate matter in outdoor air, EPA uses the Air Quality Index (AQI). The AQI is composed of categories that represent different levels of air quality. EPA provides recommendations to the public about steps to reduce exposure above levels of concern for sensitive groups and the general public. When values are above these levels, it is recommended that members of sensitive groups reduce their exposure. Exposure to elevated concentrations of particles for periods of time less than a day are also of potential concern for sensitive groups.

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- For fine particles (PM_{2.5}), the level of concern is 40 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$), for a 24-hour average exposure.
- For fine and coarse particles combined (PM₁₀), the level of concern is 150 $\mu\text{g}/\text{m}^3$, for a 24-hour average exposure.

Although total suspended particulate (TSP) is not included in the Air Quality Index, New York State estimates a screening level (i.e., a level requiring further evaluation) to be 250 $\mu\text{g}/\text{m}^3$, for a 24-hour average exposure.

While there are State and Federal standards for selected particles in outdoor air and workplace, there are no standards for particles in residential settings, nor do we have a good characterization of what a “background” or average concentration would be. This is because there are many human and household factors that can dramatically influence air concentrations of particles in the home. The range of activities that can introduce particles into the air (e.g. smoking, cooking with natural gas, candle and incense burning, and cleaning) coupled with a home’s ventilation status (which could remove or introduce particles) will determine airborne particle concentrations in a home at a specific time.

Recommendations:

The Environmental Assessment Workgroup is providing the following recommendations to help people reduce their exposure to particulate matter and make well-informed decisions about their health.

1. People with respiratory or heart disease, the elderly and young children, should avoid prolonged exposure to dust and suspended particles.
 - When dust and smoke are present outdoors, limit time outdoors.
 - Avoid physical exertion, indoors or outdoors, when dust or smoke levels are high.
 - Consult with your physician to determine if you should be cleaning up any dust from the WTC that may have entered your home.
 - If you have symptoms of heart or lung disease, including shortness of breath, chest tightness, chest pain, palpitations or unusual fatigue, contact your physician.
 - If you have asthma, bronchitis or other lung diseases, or cardiovascular disease make sure you have adequate medication on hand. In addition, if you have asthma, follow your asthma management plan.
2. People having symptoms (including those who have not been diagnosed with respiratory or heart disease), such as shortness of breath, wheezing, difficulty taking a full breath, painful breathing or persistent cough, should contact a physician. Be aware that onset of symptoms can appear even 24 to 48 hours after exposure.
3. In the home, car and workplace, keep windows and doors closed during hazy days or if dust is on the streets or entrances and/or smoke is in the air. If you are using your air conditioner or heater use the recycle/recirculate mode. Inspect and change air filters and air conditioning filters as needed. When the air quality improves, you should open up and air out your homes.
4. If your home has dust or suspended particles as a result of the WTC collapse, you should consider steps to minimize your exposure. If you decide to clean the dust yourself, the following suggestions can help to reduce the opportunities for dust to re-enter the air. Additional information can be obtained from EPA’s indoor air quality website at <http://www.epa.gov/iaq>.

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- A regular vacuum cleaner will clean dusty areas, furniture, and carpeting but small particles will pass through the vacuum and re-enter the air. Alternatively, using a High Efficiency Particulate Arresting (HEPA) vacuum without a beater bar is an effective method to clean and minimize resuspension of dust.
 - Moisten dusty and sooty, non-porous surfaces prior to wiping them. This will reduce the amount of particulate matter becoming airborne. Some porous materials may be damaged by water and may require specialized cleaning techniques. Avoid breathing the dust if any is stirred-up by wiping, and make sure surfaces are dry once the dust is removed.
 - Clean roof-top and building air conditioning and heating systems before use and assess duct work for signs of contamination.
 - Replace or clean dirty air conditioner filters and set air conditioners and heaters to re-circulate if indoor air is relatively dust-free.
 - Wash plants and furnishings prior to moving them indoors.
5. In dusty areas, minimize dust entering the home by leaving shoes outside, using a door mat and wiping pets feet at the doorway.

Air Quality Index:

Health Comparison Guideline Table for Ambient PM*

24 Hour Levels ($\mu\text{g}/\text{m}^3$) PM_{2.5}**	24 Hour Levels ($\mu\text{g}/\text{m}^3$) PM₁₀**	Air Quality	Cautionary Statements
0-15	0-55	Good	None
>15-40	>55-155	Moderate	None
>40-65	>155-255	Unhealthy for Sensitive Groups	People with respiratory or heart disease, the elderly, and children; should limit prolonged exertion.
>65-150	>255-355	Unhealthy Sensitive groups may experience more serious health effects.	People with respiratory or heart disease, the elderly and children, should avoid prolonged exertion; everyone else should limit prolonged exertion.

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>150-250	>355-425	Very Unhealthy Everyone may experience more serious health effects.	People with respiratory or heart disease, the elderly and children, should avoid any outdoor activity; everyone else should avoid prolonged exertion.
>250	>425	Hazardous The entire population is more likely to be affected.	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly and children, should remain indoors.

* Developed from EPA's Air Quality Index: A Guide to Air Quality and Your Health, EPA-454/R-00-005, June 2000 and EPA Guideline for Reporting of Daily Air Quality - Air Quality Index (AQI), EPA-454/R-99-010, July 1999 (at: <http://www.epa.gov/airnow/publications.html>).

** These comparison levels are guidelines to make public health decisions. Detected concentrations of PM above specific guideline levels does not mean that adverse health effects will occur.

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DRAFT (October 17, 2001, 2 p.m.)		ATSDR, CDC, EPA, OSHA Environmental Assessment Workgroup Levels for World Trade Center Response		PM Action
Respirable Particulate 24 hour PM _{2.5} Ambient Action Level (µg/m ³)	Thoracic Particulate 24 hour PM ₁₀ Ambient Action Level (µg/m ³)	General Public/Recommendations	Comments	
0-40	0-155	No restriction	Air quality is good to moderate.	
>40-56	>155-255	People with respiratory or heart disease, the elderly and children, should limit prolonged exertion.	Air quality is unhealthy for sensitive groups.	
>65-150	>255-355	People with respiratory or heart disease, the elderly and children, should avoid prolonged exertion; everyone else should limit prolonged exertion.	- Air quality is unhealthy for all persons. - Sensitive groups may experience more serious health effects.	
>150-250	>355-425	People with respiratory or heart disease, the elderly and children, should avoid any outdoor activity; everyone else should avoid prolonged exertion.	- Air quality is very unhealthy for all persons. - Everyone may experience more serious health effects.	
>250	>425	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly and children, should remain indoors.	- Air quality is hazardous for all persons. - The entire population is more likely to be affected.	
Inhalable Particulate 24 hour TSP Screening Level (µg/m ³)		General Public/Recommendations	Comments	
250		- Further characterization of particulate is warranted. - Dust suppression procedures may be warranted. - Respiratory protection while in the area may be warranted.	- Based on NY State Ambient Air Quality Standard. - Screening level for the general public that requires further evaluation.	

1. Developed from EPA Air Quality Index at: <http://www.epa.gov/airnow/publications.html> and the NY State at:

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pH Guidelines

The pH of a substance represents the hydrogen ion concentration of the substance. The range of pH values is generally from 0 to 14 with 7 being considered a neutral pH. Substances with a pH of less than 7 are considered to be acidic and will yield hydrogen ions when they are in solution. Acids will change litmus paper red. A base is a substance with a pH greater than 7 and will yield hydroxyl ions in solution. Bases will react with acids to form salts and water. In the body, a normal balance between acids and bases is maintained that keeps the extracellular fluids in the body with a pH between 7.35 and 7.45. A pH out of this range indicates a state of acidosis or alkalosis. Regulation of the pH in the body depends on the function of the lungs and the kidneys.

Guidelines for the interpretation of the pH values of the dust samples being proposed are included in this plan to assist in defining what role if any that the pH may be in the irritant properties of the dust. An irritant effect is one where the tissue has been stimulated and responds with a reversible inflammatory response. Common symptoms from exposure to an irritant are cough, burning of eyes, nose, & throat, tearing, dyspnea, and wheezing.

There are very few standards for the regulation of the pH of a substance. The national Secondary Drinking water standards set the pH range at 6.5 - 8.5. EPA has established guidelines for the testing of the acute dermal irritation and the acute eye irritation properties of substances. Those guidelines state that it is not necessary to test substances with a pH of less than 2.0 or greater than 11.5 as they are known to be corrosive. A corrosive is a highly reactive substance that causes irreversible damage to living tissue after less than 4 hours of exposure. Using this information as a basis, the following guide is proposed:

pH	Acid/base	Properties
0 - 2.0	Strongly acidic	Corrosive
>2.0 - 6.5	Weakly acidic	Irritant
>6.5 - 8.5	Neutral	
>8.5 - 11.5	Weakly basic	Irritant
>11.5	Strongly basic	Corrosive

To put these levels into perspective, the pH of some common substances is included below.

Substance	pH
Gastric Juice	1.4
Lemon Juice	2.4
Vinegar	3.0
Tomatoes	4.2
Rain	5.5

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Blood or Tears	7.0
Household Ammonia	11.5
Household Bleach	12.5