FINE PARTICULATE MATTER IN THE ATMOSPHERE

• Health Impacts in NJ
• Need for Control Measures

New Jersey Clean Air Council
2004 Annual Public Hearing Report
CLEAN AIR COUNCIL

MEMBERS 2004

Mohammad "Ferdows" Ali
Richard Aicher
Jorge Berkowitz, Ph.D., Chairman
Leonard Bielory, M.D.
James Blando, Ph.D.
Joseph Constance
George Currier, P.E.
Michael Egenton, Vice-Chairman
Elease Evans
Gene Feyl
Marcelino Iglesias
Richard Lynch, Ph.D.
Raymond Manganelli, Ph.D.
John Maxwell
Stephen Papenberg
Gilberto Soto
Irwin Zonis

FINE PARTICULATE MATTER IN THE ATMOSPHERE
Public Hearing April 14, 2004

TABLE OF CONTENTS

NEW JERSEY CLEAN AIR COUNCIL

Public Hearing, Wednesday, April 14, 2004
Trenton, New Jersey

FINE PARTICULATE MATTER IN THE ATMOSPHERE

SCOPE

New Jersey has made great strides in controlling stationary and mobile sources of air pollution. However, diesel-powered mobile sources, a major contributor to the fine particulate pollution inventory, have not received the regulation or attention they warrant. Research concerning fine particulate matter has indicated greater health risks than first thought. Particulate matter is a serious health threat in New Jersey. The diesel engine is of particular interest to regulatory agencies because of its public health impact and because effective technologies exist to control diesel emissions.

Specific methods for dramatically decreasing particulate matter have been developed. New diesel engines pollute less and retrofits for many existing diesels are relatively inexpensive. Ultra low sulfur diesel fuel (ULSD) is also a significant help in reducing PM. Some engines built before 1990 may be difficult to retrofit and a program of retirement for these vehicles should be considered.

BACKGROUND

Particulate matter in the air consists of extremely small and practically invisible particles. Some types of particulate matter are directly emitted, including fuel particles, ash and unburned carbon. Other types of particulate matter are created when pollutants react with each other in the atmosphere. Particles can contain hundreds of different chemicals including cancer-causing agents like polycyclic aromatic hydrocarbons (PAH) and heavy metals like arsenic and cadmium. Particles differ in composition depending on their source. Locally produced particles are different from those formed during transport.

Fine particulate matter is measured in micrometers. Fine particulate matter described as PM_{10} contains particles smaller than 10 micrometers and $PM_{2.5}$, contains particles smaller than 2.5 micrometers. They are dangerous because they are tiny - several thousand could fit on the period at the end of this sentence. These fine particulates can remain suspended in the air for weeks. Ambient outdoor particles can penetrate into buildings and pass through conventional heating and air conditioning filters. When inhaled, they are able to penetrate and deposit deep in the lung, whereas larger particles travel shorter distances and are trapped in the upper airway.

Particulate matter adversely affects the health of all New Jerseyans. Only smoking and obesity outrank particulate matter in the estimated number of premature deaths they cause every year. Asthma and emphysema are caused and exacerbated by particulate matter in the atmosphere.

Diesel powered engines and equipment are responsible for most of the particulate matter from mobile sources in New Jersey. School buses, trucks and non road engines and equipment abound in our state and are built to last. Those built before 1990 are more difficult to retrofit.

RECOMMENDATIONS

1. The Clean Air Council is convinced that levels of fine particulate matter in excess of the new standard pose significant threats to the health of the public and especially to the health of children and the elderly, and that it is necessary to reduce the level of $PM_{2.5}$ in the air.

2. The Council recommends a series of requirements for diesel engines, in recognition of their significant contributions to fine particulate matter air pollution.

   (a) The State of New Jersey should require that proposals for State funded construction projects use clean diesel technology and/or ultra low-sulfur fuel (ULSD) for diesel-powered equipment on the job site, or to- and from- the job site.

   (b) The Council recognizes that one advantage of diesel engines is their long life. Nevertheless, New Jersey must meet the new $PM_{2.5}$ standard to be achieved by 2010. Accordingly, retrofit of existing engines is appropriate.

   (c) NJ Transit's capital budget for new buses should require clean diesel technology and the use of low-sulfur fuel. NJ Transit is currently using ultra low sulfur diesel (ULSD) fuel and the Council commends this early effort. In addition, New Jersey should institute a program of periodic retirement of those older buses, which emit high quantities of PM $_{2.5}$ even though they may not yet have reached their ultimate service life. Any such program would extend over a number of years, in order to prevent disruption of fleet capability and bus schedules. This program should also ensure that the ultimate disposition of those buses be done in an environmentally sound manner.

(d) Furthermore, NJ should institute a program whereby newer buses that are already part of the fleet are retrofitted with particulate traps at a cost compatible with NJ Transit's budget. It is hoped that given proper State funding, a multi-year contract with a selected supplier or suppliers would yield economies of purchase. Such a program should extend over a number of years. The Council cannot set a specific goal for the number of buses to be so retrofitted, but perhaps an attainable goal might be 50% of the present unequipped fleet, after subtracting the number of older buses which had been retired as per suggestion C.

(e) The Council recognizes that diesel-powered school buses must be considered as a category distinct from other diesel-powered vehicles. The Council understands that New Jersey school buses are replaced after twelve years, a life span considerably shorter than other diesels. Since cleaner school buses began to be manufactured in 1994, most high-emission buses are close to being phased out. Accordingly, the Council recommends that new school bus purchases be limited to models equipped with efficient PM controls, and that a program be implemented to retrofit existing school buses over a period of a few years. Low sulfur fuels should be used in school buses ASAP.

(f) Further, the Council recommends that the State seek partial funding from federal EPA to support the purchase of low-emission school buses, or retrofits to buses, and that the State supplement the federal funds with additional State funding. Such funding would provide monetary incentives to municipalities and private-sector operators.

(g) The Council also recognizes the need to educate school administrators about the importance of reducing diesel emissions and to make clear to school administrators that technical assistance will be provided during school bus fleet conversions and purchases.

3. The Council believes that the regulation of diesel engines of non-road vehicles has not kept pace with that of on-road vehicles. Federal EPA's proposed tough emission rules for non-road vehicles, as announced on May 11, 2004, should make significant improvements in PM $_{2.5}$ emissions over the long term. New non-road engines will not be required to have particulate traps until 2012. NJ DEP should follow this area of activity

carefully and require retrofits of non-road diesels when technically possible to adequately protect New Jersey citizens.

4. The availability of low-sulfur fuel is a necessity for proper control of particulate emissions from diesel engines. Federal regulations require compliance for on-road diesel-powered vehicles by 2006, and State attention to this area should be continued.

5. The Council believes that truck-stop electrification, as is now available at a limited number of Turnpike rest areas, is a sound practice, and additional such truck stops should be constructed. Prevention of prolonged periods of truck idling will eliminate significant sources of $PM_{2.5}$. These programs would also be useful at New Jersey's port areas such as Port Newark, where a tremendous amount of truck traffic and idling occur.

6. The Council recognizes that there are many impediments to the total elimination of prolonged idling by diesel-powered trucks, as in queues at Port Newark. The state should develop a model program that addresses these impediments and will serve as an example for reducing truck idling in high use areas. Furthermore, the Council recommends that the State launch an anti-idling campaign for school buses and diesel-powered vehicles. Enforcement of current idling regulations is also recommended, and local police should be involved in controlling unnecessary idling.

7. It is well recognized that $PM_{2.5}$ is emitted locally but a significant portion of $PM_{2.5}$ in New Jersey is derived from out-of-state transport. The Council notes New Jersey's success in legal actions requiring compliance with federal regulations by out-of-state emitters, as exemplified by the current Dominion Power settlement. The Council strongly supports our State's activities in this area, as well as our State's opposition to EPA's weakening of New Source Review (NSR) regulations. The Council wants the State to continue to emphasize these legal actions to improve air quality.

8. The Council recognizes that a better understanding PM's health effects occurs through new particle measurement technology and the department should keep informed of these improvements. When the technology is sufficiently developed to routinely measure particle number concentrations (#particles/cc), the department should consider collecting this measurement at select sites chosen to help better understand the health impacts.

9. The Council recognizes that many scientific research questions still exist and that the State should encourage its scientists as well as their public health counterparts in NJDHSS to keep informed on $PM_{2.5}$ research. The department should work closely with epidemiologists in the New Jersey

Department of Health and Senior Services (NJDHSS) to understand the health impacts of $PM_{2.5}$ and to improve the predictive capabilities of air quality metrics to estimate potential public health impacts. The Department should work closely with the NJDHSS in evaluating $PM_{2.5}$ public health impacts. For example, utilization of the NJDHSS emergency room asthma data may be particularly useful.

10. The Council recognizes that Smart Growth is also linked to air quality and suggests that the Smart Growth plan continue to be mindful of air quality issues. This is particularly important as urban centers become redeveloped and mass transit projects are planned and implemented.

11. The State should promote the use of alternative fuels, which have the potential to reduce air pollution. The use of soy-diesel, which has been shown to reduce particulate emissions from diesel engines, should be promoted for use in farm equipment powered by diesel engines. Biodiesel blends should be monitored to insure that NOx emissions are not unwittingly increased.

12. The Council recommends that studies of nanoparticles (particles less than 0.1 micron in size) and their impact on health be more vigorously undertaken and that studies of PM short-term health effects be conducted to determine if conventional averaging of particle measurement is meaningful. Such studies could be coordinated with ongoing activities conducted in Paterson and Camden.

ORAL TESTIMONY

Commissioner Bradley Campbell, NJ Depart. of Environmental Protection

There is much at stake in New Jersey regarding public health and our economy when it comes to the issue of smog in our State.

New Jersey will need significant reductions in PM both in-state and out-of-state to meet tougher standards adopted by EPA and endorsed by the Bush Administration. We need to ask, what are the most cost-effective sources of reductions? How can we give fair notice to the regulated community in which the burdens of those reductions are felt?

It is also important to recognize that reductions have significant public health impacts. If we achieve the new federal standards on soot and smog, we would avoid more premature deaths than if we averted every homicide in the State of New Jersey and/or if we averted every traffic fatality in the State and that's at the low end of the estimates. We need to use our best efforts to reduce exposure to pollutants to avoid premature deaths. When we meet these standards in New Jersey, we will avoid many emergency room admissions for asthma and respiratory illnesses.

There will be significant economic benefits as well. All of these health impacts have an economic component in terms of health care costs, of workdays avoided and school days lost.

At the same time that New Jersey is struggling to meet stricter standards, the federal government is weakening the very tools we need, particularly with respect to upwind out-of-state sources with the rollback of New Source Review and other tools under the Clean Air Act. In New Jersey we get more than a third of our dirty air from upwind sources in Pennsylvania, Ohio and the Midwest. We rely heavily on federal enforcement to ensure that those sources are not saving money by shifting costs to New Jersey residents as they roll back New Source Review. The federal government is also placing many of our New Jersey businesses at an unfair competitive disadvantage by changing the rules and rewarding the lawbreakers. We need to identify what other leverage we have in those circumstances to force control of upwind plants.

It is the time to heed a long-standing call of our regulated community here in New Jersey to acknowledge and act on the fact that when we consider reductions to meet clean air standards, we look to stationary sources without considering mobile sources. We can no longer disregard at least some part of the mobile source inventory where we can find the most cost effective reductions. We should now try to target the dirtiest and longest running of our roughly 250,000 plus diesel engines in this state. We need to look at 11% of those for appropriate retrofits, to couple that with stricter enforcement of idling restrictions. Building more Truck Stop Electrification sites will help. Low sulfur diesel fuel requirements will also reduce PM.

In order to reduce the contribution from our diesel inventory, we need to ensure an equitable distribution among sources. It is important to get ahead of the curve on this so that we are ready for new EPA incentives. This will avoid negative impact on the economy as well as address a vital public health issue.

Kenneth Fradkin, USEPA Region II, Air Programs Branch

In order to conform to EPA initiatives on fine particles, New Jersey has identified a ten county area where there is non-attainment for $PM_{2.5}$. We are currently evaluating the State's findings and will formally designate the non-attainment area in December 2004. The State will then have three years to develop an implementation plan.

EPA's proposed programs for controlling $PM_{2.5}$ will be released in June or July of 2004. The non-road Diesel Emissions rule, which was proposed last May will lead to a 90% reduction in emissions from non-road diesel. The Interstate Air Quality rule, which was released in December deals with the regional transport of precursors like NOx and SO_2.

The EPA diesel retrofit program is an example of a highly successful EPA program. In the past two years public and private partners have retrofitted over 87,000 diesel engines providing a reduction of approximately 26.000 tons of nitrogen oxide and 12,000 tons of particulate matter. The EPA is also poised to release a web-based catalog with information on over 500 innovative products.

EPA is also working on a guidance document for using non-traditional measures to reduce PM. Finally, there's an EPA Air Innovations conference scheduled this August on measures for reducing PM, as well as other pollutants.

EPA is in the process of reviewing the National Ambient Air Quality Act for PM. The PM criteria document will be released this summer. There may be a lowering of the annual standard from 15 micrograms per cubic meter to as low as 12 micrograms per cubic meter and a lowering of the 24-hour standard down to a range from 65 micrograms per cubic meter to 30 micrograms per cubic meter.

Barbara Turpin, Ph D – Associate Professor, Rutgers University, Department of Environmental Sciences

I will discuss the composition of particulate matter and what different kinds of control strategies can do for us. There are billions of particles in the air, particles which we cannot see. They are composed of many things. Some particles are small solid carbon particles, some are spherical liquid particles made up of ammonium sulfate and water or acids and water, some are metals. Organic particles are viscous and oily resulting from petroleum combustion processes. Sometimes particles condense and absorb into pre-exiting particles. They can be a coating on other particles. These are common particles found every day in New Jersey.

There are particles formed from wind-blown soil, dust, plant debris or cement dust. Particles are created through different mechanisms. They have different composition, different physical and chemical properties and different effects.

Most of the particulate matter in this State is formed in the atmosphere. So atmospheric processes dramatically change the concentration of fine particles, their size, distribution and composition. For example, SO_2, coming mostly from coal-fired power plants, is oxidized in the atmosphere with the help of sunlight to form sulfuric acid, which in the presence of ammonia eventually becomes ammonium sulfate.

Organic particulate matter is also formed in the atmosphere. It is formed because of NOx emissions and VOC. NOx is emitted from high temperature combustion in coal-fired power plants and diesel trucks. NOx, sunlight and organic compounds react in the atmosphere to form organic particulate matter, forming more readily when there's already acidic sulfate in the air. Sulfate, nitrate and organic matter dramatically change the composition of airborne particles.

Much of the particulate matter in New Jersey comes from upwind. Days in which particulate concentrations are high at the testing station in Brigantine proves this fact. Those particles and particle precursors, the SO_2s, the NOx, the VOCs enter the atmosphere, are processed through clouds with the aid of sunlight and end up in Brigantine.

It is interesting to note that Brigantine $PM_{2.5}$ mass is about 70% of Newark's $PM_{2.5}$. That additional 30 % in Newark comes from local sources. The composition of regional aerosol is different than local aerosol. Regional PM is comprised of water soluble compounds formed in the atmosphere. Local PM is very different, dominated by material that's emitted directly in particle form, usually from combustion processes. We don't know how that impacts health.

An average U.S. resident spends about 87 percent of his time indoors. Outdoor particles are the major source of indoor particles in non-smoking homes. There is some change in the bulk composition of the aerosol as it comes indoors because different types of particles have different properties. Exposures to particles of outdoor origin occur mostly indoors. The composition of outdoor PM can be altered with outdoor-to-indoor transport of primary combustion particles. Indoor transport is enhanced close to combustion sources, for example, 100 to 200 meters away from a major thoroughfare.

There is a difference between summer and winter aerosol composition. When it's hot, there is more photochemistry, so concentrations of all those secondary components formed in the atmosphere go up causing $PM_{2.5}$ concentrations to go up. But, in the winter temperature inversions put a cap on the atmosphere so primary emissions tend to have higher concentrations in the wintertime.

Indoor air pollution is different from the ambient air. The biggest problem is smoking. Cooking and housecleaning also produce particles. Limonene, from air fresheners can react with ozone to form aldehydes, serious air pollutants. For instance, coupling an ionizing air cleaner which generates ozone with a lemony plug-in deodorizer will create lots of particles.

Morton Lippmann, Ph.D., Professor of Environmental Medicine NYU School of Medicine

DEP regulations are based on health concern and epidemiology. This science is blunt tool, but one that can't be ignored. It looks at annual exposures to particulate matter and sees associations between fine particles and longevity. The latest data suggests a couple of year's difference in longevity between U.S. cities with the highest level of pollution versus the lowest.

Over the last four years there has been a 50 million dollar a year research program on PM and this research will continue for five more years. Some answers are being found about the specific health effects of PM. The problem is that our measures of pollution and the exposure inferences need to be based on a gravimetric assay which the EPA believes sufficiently simulates a gravimetric measurement used for regulatory purposes. The composition of the particles changes from season to season, from day-to-day, from place to place. All of New Jersey does not have particles of the same composition. For example, ammonium nitrate, which is only 10 percent here, can be a problem elsewhere. In New Jersey there is a lot of water in particle collection and we are paying a penalty in this gravimetric game because we are measuring water.

Each of the six criteria pollutants has different time standards and different chemical forms. The standards for NOx, are indexed by NO_2. The standard for sulfur oxide is indexed by SO_2. Lead is indexed in many compounds of varying toxicity. For particulates, there are different size cuts on a health-based standard. We used to use a big vacuum cleaner, basically an Electrolux with a 8 by 10 filter attached. That was the selection for a health-based standard because we believed that the health effects were due to particles getting into the thorax. In 1987 we made an advance by letting only the particles under PM_{10} reach the filter to be weighed. That was epidemiologically more conclusive. We were measuring PM_{10}, but were not addressing $PM_{2.5}$, which is where most of the health effects are. These health effects include premature mortality, emphysema, COPD and asthma. Since emphysema is a disease of the lower airways, fine particles have an impact. For bronchitis it may be 2.5 to10.

$PM_{2.5}$ was selected for the fine mode rather than $PM_{1.5}$ because they dominate the mass concentration. These nanoparticles are a new health concern and meeting the new $PM_{2.5}$ criteria of 15 micrograms per cubic meter as an annual average will be difficult. Some communities will have to reduce fine particles by 20 percent in the presence of continuing economic growth and increased miles traveled. This will not be easy, but not as difficult as meeting the ozone standards. In my view, the PM standard is more intimately related to the human health and something that really affects New Jersey.

Critical to meeting the PM standard will be enforcement of the New Source Review. Plants that have been in operation for 25 years without a major overhaul produce the bulk of SO_2. It is important that the State Attorney General enforce the emissions rule.

Central site monitors are not good measures of what each individual in the community is breathing because they only measure what the average person is breathing. A better appreciation of the plausibility of effects is coming from studies looking at concentrated PM. By using a virtual impactor, it reduces the particles to a smaller fraction. The only way to do controlled exposures is to enhance it. This shows that the exposure to CAPs, Concentrated Air Particles, not only cause reactions that can be measured with a bio-marker in the lung, but in the heart as well. Epidemiology has been moving towards cardiac effects. We did the first study with mice wearing implanted cardiac monitors. We used a normal mouse and a genetically altered mouse, which is prone to develop cardiac aortic plaque spontaneously. This represents a model for the human cardiac patient. We found significant changes in heart rate in the mouse model that varied on a daily basis with concentration10 times the ambient air. Over a five month period we saw a 10% shift in the heart rate that accumulated with continuing exposure.

Both acute and chronic effects can come from the particles in the ambient air in a susceptible model. The most recent analysis of the ACS cohort showed one cancer in excess of cardiovascular mortality on an annual basis. And a second paper on that same 16-year follow-up documented more specific cardiac association.

Charles Pietarinen, Chief, Bureau of Air Quality Monitoring, Division of Air Quality, NJ DEP

An older piece of instrumentation called a smoke shade analyzer has been used in New Jersey for over 30 years as a surrogate measure of particulates and we have a 30-year history of using this instrument, which represents consistent measurement back to the early 1970s. The smoke shade measurement is not a direct measurement of the particles but we can correlate the mass. Correlations were developed over the years relating smoke shade to total suspended particulates or correlations for PM_{10} when that was the standard in 1987 and when $PM_{2.5}$, was promulgated in 1997. Since the PM_{10} standard went into effect, we have been in compliance across the state. Today, the ambient standard is 15 micrograms per cubic meter and the 24-hour standard is 65 micrograms per cubic meter.

We began new monitoring in 1998, the first full year of data was 1999. $PM_{2.5}$ is different. AQI in value of 150 is actually set to short term standards of 55 micrograms per cubic meter; 100 level is 40 milligrams per cubic meter. That was selected as halfway between the annual standard of 15 and the 24-hour average standard of 65.

It is clear that pollutants are influenced by motor vehicles because the early morning peak is at rush hour. There is an afternoon peak that may coincide with the afternoon rush hour. In the summer concentrations from the morning peak continue through the day.

There are four sites in New Jersey for compositional data. These are dominated by organic carbon, sulfates, nitrates and ammonium nitrate. New Brunswick, Chester, Elizabeth and Atlantic City are all different. Organic carbon and elemental carbon are significantly higher in Elizabeth than the other locations.

In terms of changes, the Canadian forest fires a few years back dramatically indicated transport and how quickly unhealthy air can impact an area. During this particular event there were concentrations as high as a 125 micrograms per cubic meter in a 24-hour average in Atlantic City. Again, those are the highest levels that we recorded and that was before the Atlantic City sampler shut down because it got clogged up with particles.

Reporting air quality to the public is complex. It involves the air quality index, which is color-coded. Green is good, yellow is moderate and orange is unhealthy. In order to report in real-time, we can't use the Federal Reference Method because it takes several days to get data back. So we use the Tapered Element Oscillating Microbalance, TEOM, which is a continuous method. We are trying to find a surrogate for what we think the 24-hour average would be.

In New Jersey there is a class one area in Brigantine, a wildlife preserve, which means that visibility is protected by a federal standard. We are working with an IMPROVE program (Inter-agency Monitoring Protected Visual Environments) to monitor visibility in Brigantine. Questions arise as to why New Brunswick's average sulfate concentration is 33% of the total concentration whereas Brigantine’s is 52 %. The reason is that sulfate is reported differently in the IMPROVE program. Ammonia is included so there are higher percentages. Sulfate drives the visibility issue in New Jersey.

To conclude, we are not exceeding the 24-hour average standard at every site, just occasionally and most sites are meeting the annual health standard. Concentrations usually peak in the summer from secondary aerosol compounded by locally generated particles. On average the carbon, sulfate and nitrate tend to predominate. However, fine particulates are the primary cause of visibility degradation. Ozone may be lower in the morning but there appears to be no diurnal pattern with fine particles.

David Brown, Sc.D., Northeast States for Coordinated Air Use Management (NESCAUM)

I am a toxicologist with NESCAUM. I have been attempting to merge health data with environmental data. The question arises on how to assess long-term risk with short-term risk. What is the impact in the short term?

Three short-term effects from air pollution are asthma, heart attacks and COPD. With children it's important to look at three-hour exposures because it is a significant amount of air that a child breathes in a day. We performed an experiment in Connecticut sponsored by Environment & Human Health. We discovered that the rate of children carrying inhalers in Connecticut is 8 percent. We even found a school located under Interstate 95 with 24% rates. There is a severe asthma problem in Connecticut.

To study the problem, students were given a monitor, which they carried on their lapels all day. It measured $PM_{2.5}$ every minute and the highest exposure these children experienced during the day occurred when they got on the school bus. We then compiled a Connecticut school bus report, which resulted in bus retrofits and laws reducing bus idling.

Although safety standards are build into the Federal Clean air Act standards, it is difficult to protect people against short-term health impacts.

Particles are toxic because they absorb water and gases forming an acid gas, which is carried deep into the lungs damaging tissue. Two very important studies occurred in the last four years. The Peters study showed that $PM_{2.5}$ was associated with myocardial infarctions in Jamaica Plains. Two hours after an increase in PM, the heart attack rate went up. The second study by Dr. Gent tracked severe asthmatics in New Haven, Hartford and Springfield, Massachusetts. They found that 35 % of those studied had increased wheezing one hour after 50 parts per million of ozone and 47% had increased chest tightness. At no time during the study was the standard exceeded.

There is a paradox between good science and public health. We didn't have good data soon enough on smoking, dioxin, asbestos, chlordane and mercury. With particulate matter we have an asthma epidemic at the end of the twentieth century. Discovering this epidemic 25 years into it suggests that we're not doing a good job. Asthma is now a major disease in our schools. We now know that asthma is related to 6 to 12 pollutants found in outside air especially ozone and PM. There are four things we need to know, the health effects, the sources, the movement of air and how to reduce potential exposures.

Although EPA has revised the standard, they are not placing enough emphasis on short-term health effects and there are plausible health risks from short-term exposures. An investigation of quantitative health risks from localized short-term air exposure is needed.

There were PM levels collected in New Haven over a three-month period to determine whether an area meets the EPA particulate matter standards. The hourly data was collapsed to a single value of 9.2, totally obscuring any content or structure within the data. When we look at the data from the hourly exposures, we see that it needs to be examined. We need to look at micro-scale exposures.

Six ways to reduce pollution for school children includes identifying sources, restricting emissions, reducing idling engines, increasing make-up air during the clean period and preventing stagnation of air in the school.

Kevin Fennelly, M.D. Associate Professor, Pulmonary Care Medicine UMDNJ

I will focus on aerosols and particles in the air and how we breathe them. I have done research on particulate air pollution at the National Jewish Medical and Research Center in Denver.

I am now primarily involved in research on aerosols that are created by human beings who are infected with tuberculosis. As part of this work we measure particle sizes. This is critically important in relation to toxicity. As a pulmonologist and occupational environmentalist physician, there is very compelling data indicating multiple health effects from particulate pollution.

In the 50s there were a number of disasters that woke everybody up to the fact that air pollution can be a problem. One was the London Air Pollution Disaster in 1952. This resulted in many deaths due to a severe air inversion that sent sulfur dioxides soaring. The morgues were overrun with bodies during this disaster and in about 500 of the autopsies that were done, 300 of the individuals had co-existing heart and lung diseases.

In Denver, particulate matter and carbon monoxide soar up in winter inversions. There is a brown cloud in the Denver region as a result of wintertime inversions which hold the particles in suspension and result in cardiovascular hospitalizations and deaths associated with particulate air pollution, both PM 10 and PM 2.5. Also, there are hospitalizations for pulmonary diseases and deaths, cancer and asthma exacerbations. At first I concluded that carbon monoxide was causing the heart deaths and particles were causing the pulmonary deaths, then I realized that many patients that have both lung and heart disease. The most prevalent particulate air pollution in the world is cigarettes and patients who inhale cigarettes get both lung and heart disease. They get emphysema, chronic bronchitis and COPD and heart disease.

Particulate matter is made up of many different things. For instance, in Denver, it is common to find crustal elements such as silicone and various components of the earth's crust. Combustion products are a central concern. The data also point toward metals. Depending on how active we are, we may breathe up to 15,000 liters a day and the body has a mechanism to remove the particles we breathe in. When we exhale and especially when we cough, particles go out and drift. There's a phenomenal amount of stuff in the air. Water-soluble particles tend to cause more toxicity in the upper airways because of the water there. Whereas lipid soluble compounds will be more of a problem in the deeper reaches of the lung or the alveoli. Initially, it was believed that ultrafine particles, less than a micron, were not deposited. But now we know that there are two main areas of deposition within the lung in the bronchii and in the aveoli. Particles of about .01 tend to be deposited very well. There are even nanoparticles, about 200 nanometers, that can be a very efficient mechanism for delivering drugs.

The clearance mechanisms for particles are critical and mucociliary are the most important. The other major mechanism of clearance is cough, which can move things northward. But there's also some clearance directly in the lymph node tissue near the airways. Once the particles get into the alveolar where the gas exchange takes place, there are even more efficient clearance mechanisms to move that into the lymph and into the bloodstream. These deposition and clearance mechanisms are important in understanding PM toxicology.

In the Mt. St. Helen's eruptions we learned that even fairly benign particles become toxic if they are small enough. An easy way to understand the importance of particle size is to look at what happens with a bronchodilator. If particles 5 to 15 microns in size are used, the benefits are small, but when the size is decreased to a micron, the drug is distributed to more airways for a much better effect.

Is it important to do more research on fine particulates before we act? I don't think so. We still don't understand exactly how smoking cigarettes causes arteriosclerosis or cancer, but I think most of you would agree the data is pretty conclusive. Transportation is a public health problem. We need to take as much action as possible to get people out of automobiles.

Joseph Suchecki, Director of Public Affairs, Engine Manufacturers Association (EMG)

EMA is a trade association representing the major manufacturers of internal combustion engines. We represent our members on emissions issues and regulatory matters with the USEPA, as well as state and local governments. EMA represents 27 member companies who manufacture and market engines for everything from lawn mowers and garden equipment to heavy-duty trucks and buses, construction, farm equipment and locomotives and marine vessels. In addition to mobile source products, our members' engines are also used in stationary sources such as power generation.

The issue of PM health effects will be impacted by significant engine improvements to reduce emissions. On the health effects issue, especially with PM., some scientific evidence portrays current ambient PM levels as a major public health issue. We do not know the level of ambient concentration that actually contributes to health concerns. There's a recent report by the Health Effects Institute which at the request of EPA looked at the statistical problems of short-term studies and that there was an issue with model selection. Depending on the model, the answers were different.

There is also a recent paper from England by Koop and Tole indicating that this modeling uncertainty overwhelms any of the small associations found in many epidemiological studies. Refinements in data analysis techniques have generally lowered estimates of health risks from PM.

Finally, in some respects the epidemiological evidence available today is actually weaker than it was when the $PM_{2.5}$ standards were first proposed. That's not to say there are no health effects from PM, but new research raises questions as to the magnitude of those health risks.

Although there are numerous PM sources, I would like to focus on diesel engines. Diesels are an important source of power and the primarily engine choice in trucks and buses, non-road equipment, small stationary power generation, locomotives and large marine vessels. Diesel's share of the market has grown since the 1950s because of its efficiency, reliability and durability. Moreover, diesels are very cost-effective. Like other combustion sources, diesels produce emissions, which include PM. The amount of PM depends on the efficiency and temperature of the combustion process, the quality of the fuel and the need to trade-off between the production of NO_2 and PM.

Today, diesel engines are very different and virtually all studies of their health effects derive from epidemiological studies done in 50s and 70s. PM emissions from diesel have been declining and make up only a small percentage of annual PM emissions. PM emissions from on-road trucks and buses have declined by more than 90%. On the non-road side, PM emissions have also been reduced. EPA will soon publish new non-road rule and we will comply.

PM reductions are accomplished through improvements to the engine, the introduction of ultra-low sulfur diesel fuel and the addition of catalyzed PM filters. These systems and control technologies essentially take PM levels to undetectable levels. While this solves the PM issue for new engines, there are still large numbers of vehicles that are powered by older diesels. Unfortunately, these engines will continue to operate for some time, however, retrofits are available. Generally, engines manufactured before the 1990s with inherently high PM emissions cannot be fitted with catalyzed filters to meet the new engine standards. Retrofits come down to economics.

EMA believes that a number of reasonable and viable PM reduction efforts can be implemented. For mobile sources the US EPA, Engine Manufacturers and the Petroleum Industry have solved the problem for new engines. New federal standards for heavy-duty engines will reduce PM emissions to near zero levels. For existing fleets, EMA supports the adoption of voluntary retrofit programs with incentives as the best option, state programs that encourage a more rapid fleet turnover and provide owners with money to replace or retrofit engines

In terms of the existing fleets, one option is to enhance inspection and maintenance programs for heavy-duty vehicles and equipment. On the stationary side, EMA recommends that all new stationary standby engines be required to meet the US EPA non-road Tier 2 or 3 engine standards. We also recommend that existing standby engines not be retrofitted since critical performance measures will suffer.

There are two types of diesel fuel, on-road diesel and non-road diesel. The on-road is about 350 parts per million sulfur and the non-road, used in farm equipment and construction, can be up to 2000 parts per million. The new on-road standard for 2006, will be as little to 15 parts per million. Ultra low sulfur diesel fuel for non-road equipment will probably start in 2008. PM reductions are great for ultra low sulfur fuel. The new fuel will work just as well in existing equipment as it does in new equipment.

In addition to the low sulfur fuel, PM is reduced through the catalyzed PM filter. Retirement of the fleet will also be critical. Large companies turn over every five to six years, but sell their old trucks to smaller companies. School buses are notoriously old. In California school buses from the 1960s are still running.

EMA has been working with the Union of Concerned Scientists and the Natural Gas Coalition in congress to get federal monies for retrofits. We have also been working on retrofitting school buses, trying to get $60,000 a year in federal funding. Retrofits cost between $2,000 and $10,000. Diesels can last for 350,000, 400,000 miles before any major overhauls. So a diesel engine's life will be over a million miles. The filters last for 250,000 miles so the treatment devices will need to be replaced 4 times during the life of the engine.

Bart Chezar, M.S. Transportation Consultant

We have been studying emissions from school buses. Funding was provided by the New York Power Authority because when they built and installed 10 combustion turbines in New York City, they made a commitment to offset those emissions. They did this in two ways, one was the installation of stationary fuel cells at sewage treatment plants, the other was reducing pollution from school buses. The latter was a six million dollar program installing diesel particulate filters on 1,000 school buses in New York City and providing ultra-low sulfur diesel fuel to those buses. The New York City Department of Education has about 5000 buses in service. About 3000 of these buses are operated by 30 outside contractors. On an average these buses are kept from 12 to15 years. They get about 8 miles per gallon and travel about 9000 miles per year.

The only buses for which diesel particulate filters are appropriate are those built after 1990. A particulate filter is a ceramic mesh that forces the exhaust air through a ceramic brick containing catalyst that reacts with the particulate matter and enables it to burn up at a lower temperature. It is important to have ultra low sulfur diesel fuel for these filters to work.

Cost is a factor. We had six million dollars. The oxidation catalysts are about $1500 per unit. Diesel particulate filters are $5,000 per unit and ultra-low sulfur diesel fuel is about 12 cents above the typical diesel used in commercial applications. Emission reduction for NOx is about 10% to 20% just using the fuel. The oxidation catalysts cannot be used without the fuel yielding a 40 percent reduction in particulate. Ultra low diesel fuel reduces particulates 95% in all particulate sizes. There is a 90% reduction in hydrocarbons and carbon monoxides and a 95% reduction in PAH, polycyclic aromatic hydrocarbons, toxics that are in very low concentration in all combustion fuels, a category that includes formaldehyde.

The Power Authority is fueling 2500 buses with ultra low sulfur diesel fuel. There are 250 buses with the diesel oxidation catalysts. They have plans for purchasing a combination of 1000 diesel oxidation catalysts and particulate filters. Beginning in June 2006, all diesel fuel will be ultra low sulfur diesel fuel. In 2007 all heavy-duty diesel engines will have to meet much more strict emissions criteria.

There are three strategies I would recommend; retiring pre-1995 school buses, retrofitting remaining buses with diesel oxidation catalysts and accelerating the introduction of ultra low diesel fuel. Three general suggestions involve zoning to prevent sprawl, reinstituting HOV lanes in NJ and electrifying diesel stations to cut down on emissions.

In the technology arena, hybrid technology in the form of hydroelectric transit buses is happening. New York City Transit is getting 350 buses. They get twice the fuel efficiency, very low emissions and a quieter ride.

Peg Hanna, Team Leader, Diesel Risk Reduction Team, NJDEP

Controlling diesel emissions is a chance for the Department to do something that has very tangible environmental benefits. It is important that DEP look at the mobile source structure. Our first project will involve idling reduction with an anti-idling campaign starting with school buses. Controlling Idling costs nothing, but the health benefits are huge. The level of particulate matter that children are exposed to when they get on the bus needs to be reduced. We need to educate the school bus drivers, the teachers, the boards, the PTAs, the school administrator and the children.

We're also going to look at charter buses and short-haul delivery trucks. There are problems in Atlantic City with charter buses dropping off customers and idling for long periods of time. We have taken some action and intend to couple that with education in the form of a compliance alert.

Long-haul truckers idling at truck stops cause pollution and truck stop electrification should help. It is currently installed in Paulsboro and Bordentown with 170 spaces electrified. The money came from a federal grant along with penalty money that a violator donated toward this project. The cost was approximately $1.6 million, each truck space costs approximately $10,000.

After outreach and education there will be an enforcement campaign using existing inspectors and new staff to prioritize the urban areas. We also hope to make statutory and regulatory changes to increase the penalties for idling violations. Currently, it is $100 to $200 for first offense. The existing violation is a three-minute standard. We'd like to eliminate some of the exemptions and extend the enforcement authority to other agencies.

The most important change will be a state-wide retrofit program. The federal engine standards will take effect in 2006 coupled with the ultra-low sulfur fuel. This means analyzing horsepower of engines, the model years, the types of equipment with the biggest emissions. A lot has been done to demonstrate the application of retrofits to on-road and non-road sources. This is new ground in terms of a state-wide mandatory program for retrofits.

Another program involves roadside inspection. We'll be tightening up some of those standards.

The last component pertains to school buses, which will not be a state-wide mandatory program. Initially, it will involve some voluntary efforts to retrofit school buses. We don’t believe that it is cost effective to retrofit school buses because they can only operate in New Jersey for 12 years. There is funding from EPA through the Clean School Bus U.S.A. Program and we have applied in the past and will apply again. Another source of money for retrofits is penalty money.

Jeff Tittle, Director, New Jersey Sierra Club

When we look at air quality in New Jersey, we've made a lot of progress. However, as we fix one problem, we find that we're driving farther or moving further away and not getting the benefits of our progress. We also have serious problems in our urban areas with particulates.

Diesel emissions have become critical to the state. We have a tremendous amount of old diesel equipment, 20 to 30 years old, and this is a huge source of PM. I think the biggest culprits are construction vehicles and buses. New Jersey Transit is also culpable. We also need to retire older school buses and replace them with cleaner buses. The state is looking at legislation to try and retire the 20% of the dirtiest diesels in the state. I think it's critical to find funding for that legislation. We need to find funding mechanisms whether it's through taxing fuels or increasing licensing fees.

The next tier is to look at trip reduction. We made a major step in cleaning the air with the passage of California car, but New Jersey is still too auto dependent. We need people to car pool, van pool and drive less. Some states limit the number of parking spaces and give tax credits and money to take out parking spaces to encourage people to van pool and car pool. Computer Commuting, which was a Jitney system based on the computer was a great idea. In many of our suburbs we have good transit but we build these giant parking decks for those who drive to the train station even though they live a mile away. A jitney system could work. We need to develop programs to reduce commuting since about 50 percent of New Jerseyans live within five miles of their employers.

We can reduce PM by examining what California and other states are doing with vehicles like ATVs and jet skis. We need to force them into four-cycle engines.

Alternative fuels are another area where we can realize emissions reduction. We need this new technology for automobiles and generating facilities. We need less reliance on coal and fossil fuels. An innovation like wind power could eliminate tons of air pollution from New Jersey air.

Emily Rusch – New Jersey Public Interest Research Group (NJPIRG)

PIRG recently published a report called the Public Health Impact of Air Pollution in New Jersey. We used air pollution monitoring data from the USEPA as well as scientific literature and health statistics from the New Jersey Department of Health and Senior Services. It is estimated that fine particulate pollution in New

Jersey leads to between 2300 and 5400 premature deaths every year. There are also between 5100 and 7800 respiratory hospital admissions, at least 460,000 missed worked days and between 330,000 and 1.4 million asthma attacks.

In addition, children are especially vulnerable. Dr. Tracy Woodruff at the U.S. EPA linked pollution levels and neonatal deaths by studying 86 metropolitan areas. She found that normal-weight infants less than one year old who were born at high soot areas were 40 percent more likely to die of respiratory illnesses, 26 percent more likely to die from SIDS than in infants who were born in low soot areas. In another study, the National Bureau of Economic Research found that levels of particles fell during the recession in the 1980's, so did death rates in newborn children. In Pennsylvania the researchers found that when total fine particulate levels dropped 25 percent, newborn infant death rates from cardio pulmonary dropped 14 percent.

In Atlanta during the 1996 Olympic games, the city developed a mass transit plan just for that summer. As fewer people commuted into the city, there was a reduction in pollution. It was estimated that morning traffic declined by 22.7 percent and the maximum ozone levels decreased 28 percent that summer. Asthma-related emergency room visits for children decreased by 41.6 percent. These studies show that air pollution does affect public health.

Diesel trucks, buses and construction equipment account for at least 70 percent of total airborne cancers and New Jersey has higher cancer rates than the rest of the country.

New Jersey did take a strong step in January by passing the Clean Cars Bill, which will help reduce ozone pollution. Regulating diesel is the next logical step.

Written Testimony

Daniel Coranoto – Deputy Mayor of Hampton, NJ

Although there have been many improvements in cars and in fuels to improve air quality, the cost to the consumer has not been considered. Alternative fuels might be an answer. Oil companies need incentives to produce alternative fuels. Power companies need incentives to produce alternative power supply for our homes.

Biodiesel fuels have been produced for some time and should be more available. It would reduce cancer rates and other health issues. Better home construction would also reduce health problems with the home.

Gwen Farley – Co-chair Montgomery Township Environmental Commission

The 3M Company owns and operates a quarry and mining facility in Belle Mead, New Jersey, which is part of Montgomery Township. This plant produces excessive dust and mineral fines which become airborne and runoff the site into our waterways causing degradation of the air and water quality. The EC requests that the NJDEP oversee monitoring of the periphery of this facility.

The 3M plant manufactures granules for roofing shingles from the diabase rock that is mined from the quarry. There is a crushing and screening facility on the site as well as a coloring plant. Mineral fines are a byproduct of the manufacturing process and have been stored on site for 50 years in a mineral fines pile. The pile is a 40-acre mountain 80 feet in height. According to 3M's own air testing, traces of actinolinte, a known carcinogen, was identified in the dust from the plant. Pursuant to an Administrative Consent Order with NJDEP, 3M has begun to reshape, regrade and vegetate the pile in order to reduce the release of dust.

Even though some steps have been taken to contain this particulate matter release, the EC requests that NJDEP and the Clean Air Council monitor and enforce air permits.

Editor: Eileen Hogan, M.A

Glossary of Acronyms

CAA – Clean Air Act

CAPS – Concentrated Air Particles

CEHA – County Environmental Health Act

CEP - Cumulative Exposure Project

DOT – Department of Transportation

HOV – High Occupancy Vehicle

IMPROVE - Inter-agency Monitoring Protected Visual Environments

NJDEP – New Jersey Department of Environmental Protection

NJDHSS - New Jersey Department of Health and Senior Services

NOx – Nitrous Oxides

PAH - Polycyclic Aromatic Hydrocarbons

PM – Particulate Matter

RFG – Reformulated Gasoline

TEOM - Tapered Element Oscillating Microbalance

ULSD – Ultra Low Sufur Diesel fuel

USEPA – United States Environmental Protection Agency

VOC – Volatile Organic Compound

VTM – Vehicle Miles Traveled

CAC PUBLIC HEARING HISTORY

2004	Fine Particulate Matter in the Atmosphere • Health Impacts in NJ • Need for Control Measures
2003	Moving Transportation in the Right Direction
2002	Innovative Solutions for Clean Air
2001	Air Quality Needs Beyond 2000
2000	Air Toxics in New Jersey
1999	The Impact of Electric Utility Deregulation on New Jersey's Environment
1998	CLEAN AIR Complying with the Clean Air Act: Status, Problems, Impacts, and Strategies
1997	Particulate Matter: The proposed Standard and How it May Affect NJ
1996	Clearing the Air Communicating with the Public
1995	Strategies for Meeting Clean Air Goals
1994	Air Pollution in NJ: State Appropriations vs. Fees & Fines
1993	Enhanced Automobile Inspection and Maintenance Procedures
1992	Impact on the Public of the New Clean Air Act Requirements
1991	Air Pollution Emergencies
1990	Trucks, Buses, and Cars: Emissions and Inspections
1989	Risk Assessment - The Future of Environmental Quality
1988	The Waste Crisis, Disposal Without Air Pollution
1987	Ozone: New Jersey's Health Dilemma
1986	Indoor Air Pollution

1985	Fifteen Years of Air Pollution Control in NJ: Unanswered Questions
1984	The Effects of Resource Recovery on Air Quality
1983	The Effects of Acid Rain in NJ
1981	How Can NJ Stimulate Car and Van Pooling to Improve Air Quality
1980	(October) Ride Sharing, Car – and Van-Pooling
1979	What Are the Roles of Municipal, County, and Regional Agencies in the New Jersey Air Pollution Program?
1978	How Can NJ meet its Energy Needs While Attaining and Maintaining Air Quality Standards
1977	How Can NJ Grow While Attaining and Maintaining Air Quality Standards?
1976	Should NJ Change its Air Pollution Regulations?
1974	Photochemical Oxidants
1973	Clean Air and Transportation Alternatives to the Automobile and Will the Environmental Impact Statement Serve to Improve Air Quality in NJ?
1972	The Environmental Impact on Air Pollution: The Relationship between Air Quality, Public Health, and Economic Growth in NJ
1971	How Citizens of NJ Can Fight Air Pollution Most Effectively with Recommendations for Action
1970	Status of Air Pollution From Mobile Sources with Recommendations for Further Action
1969	Status of Air Pollution Control in NJ, with Recommendations for Further Actions