STATEMENT OF PROFESSOR GEORGE D. THURSTON

TO THE

SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT

OF THE

UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE SPACE AND TECHNOLOGY

RE: THE SCIENCE OF AIR POLLUTION HEALTH EFFECTS AND THE ROLE OIF CASAC IN EPA STANDARD SETTING

OCTOBER 4, 2011

I am George Thurston, a tenured Professor of Environmental Medicine at the New York University (NYU) School of Medicine. My scientific research involves investigations of the human health effects of air pollution. I have served on the U.S. EPA's Clean Air Science Advisory Committee (CASAC) Panel, and have been a contributing author to EPA's Integrated Science Assessment (ISA) documents.

I am also a member of the National Institute of Environmental Health Sciences' (NIEHS) Center at the NYU Institute of Environmental Medicine. One goal of this Center is to provide an impartial scientific resource on environmental health issues to the public and decision-makers, and that is my purpose in speaking to you at this hearing.

The adverse health consequences of breathing polluted air are well documented in the published medical and scientific literature. During the past decades, medical research examining air pollution and public health has shown that air pollution causes a host of serious adverse human health effects. The human evidence includes impacts revealed by epidemiologic studies, natural experiments and controlled chamber exposures, all showing consistent associations between air pollution and increases in adverse health impacts across a wide range of human health outcomes, including illness and death.

Epidemiological Evidence of Air Pollution Effects on Health

Observational epidemiology studies provide the most compelling and consistent evidence of the adverse effects of air pollution. "Epidemiology" is literally "the study of epidemics", but includes all statistical investigations of human health and potentially causal factors of good or ill health. In the case of air pollution, such studies follow people as they undergo varying real-life exposures to pollution over time, or from one place to another, and then statistically inter-compare the health impacts that occur in these populations when higher (versus lower) exposures to pollution are experienced. In such studies, risks are often reported in terms of a Relative Risk (RR) of illness, wherein a RR =1.0 is an indication of no change in risk after exposure, while a RR>1.0 indicates an increase in health problems after pollution exposure, and that such exposure is damaging to health.

These epidemiological investigations are of two types: 1) population-based studies, in which an entire city's population might be considered in the analysis; and 2) cohort studies, in which selected individuals, such as a group of asthmatics, are considered. Both of these types of epidemiologic studies have confirmed associations between air pollution exposures and increasing numbers of adverse impacts, including:

- decreased lung function (a measure of our ability to breathe freely);
- more frequent asthma symptoms;
- increased numbers of asthma and heart attacks;
- more frequent emergency department visits;
- additional hospital admissions; and
- increased numbers of premature deaths.

The fact that the effects of air pollution have been shown so consistently for so many health endpoints, and in so many places, indicates these associations to be causal.

Particulate Matter Air Pollution

One of the air pollutants most carefully studied is particulate matter (PM). Fine particles ($PM_{2.5}$), such as those that result from power plants and diesel trucks, defeat the defensive mechanisms of the lung, and can become lodged deep in the lung where they can cause a variety of health problems. New evidence indicates that short-term exposures to air pollution cause both respiratory and cardiac effects, including more heart attacks. In addition, my own research indicates that long-term exposure to fine particles increases premature mortality, and such exposures in the general population have been estimated to take years from the life expectancy of people living in our most polluted cities, relative to those living in cleaner cities (e.g., see Brunekreef, 1997).

$PM_{2.5}$ air pollution may be emitted directly from tailpipes and smokestacks (known as "primary" particulate matter), but much $PM_{2.5}$ that we breathe comes from the conversion of gaseous pollution emissions, such as sulfur dioxide, in the atmosphere to form "secondary" $PM_{2.5}$.

The hazards of PM air pollution have become particularly clear in the past two decades of research. Two of the largest studies on air pollution and death, the Harvard Six Cities Study, published in 1993, followed by the American Cancer Society (ACS) Study report in 1995, have demonstrated greater risk of premature death in higher PM cities compared to cities with cleaner air. The Harvard Six Cities study monitored air pollution and tracked mortality in Six U.S. cities and discovered a 25 percent increased risk of death in the most polluted city (Dockery et al., 1993). Similarly, the ACS study examined half a million people in over 150 metropolitan areas throughout the United States and found a 17 percent increase in risk of mortality between the city with the least PM and the city with the highest levels of this pollution (Pope et al, 1995). The results of these two landmark studies were challenged by industry resulting in an independent reanalysis by the Health Effects Institute (HEI)—funded by industry and EPA. HEI found the results to be robust, and confirmed the relationships documented by the original investigators (Krewski et al, 2002).

More recent follow-up analyses of the Harvard and ACS studies have now considered longer records of time, and have confirmed and extended the conclusions from these two major studies. Indeed, a recent National Institute of Environmental Health Sciences (NIEHS)-funded extension of the ACS study, of which I was Principal Investigator, strengthens the original conclusions of the ACS study and, importantly, now links increased risk of lung cancer to long-term exposure to particulate matter (Pope et al, 2002), as shown in Figure 1.

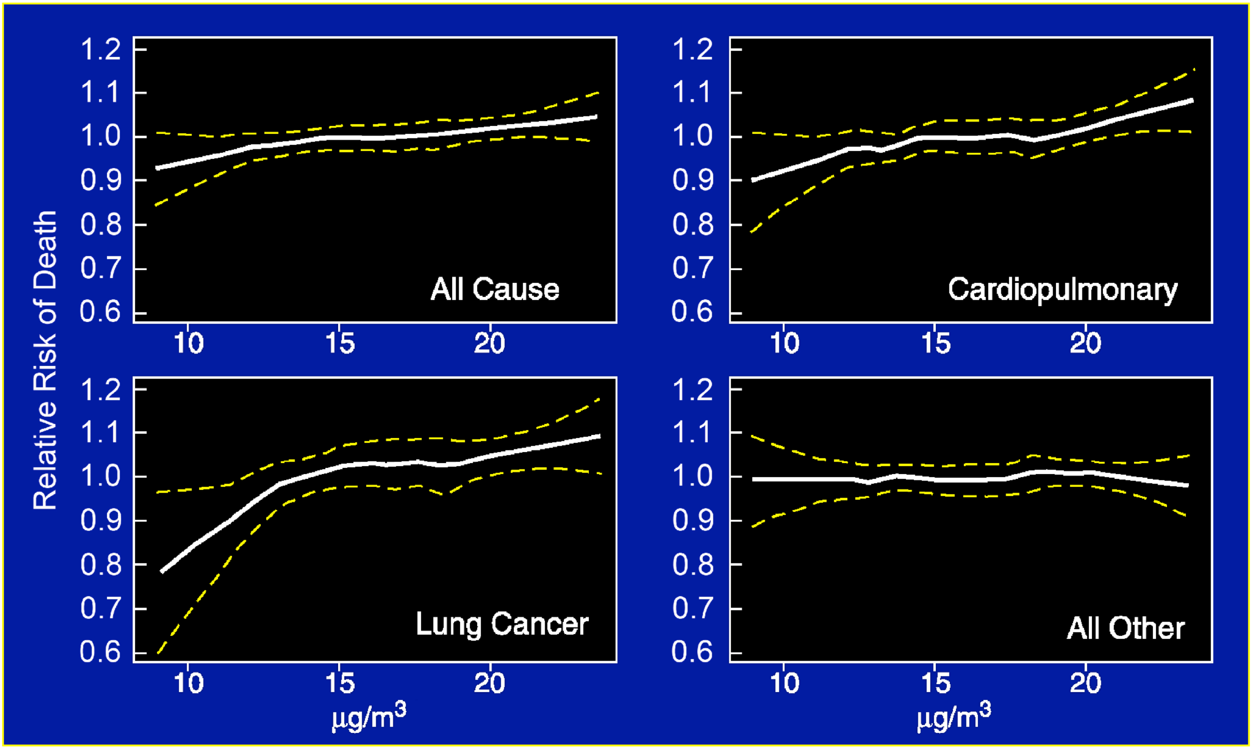

Figure 1. Results from the extended ACS *JAMA* Study showing increased risk of All Cause, Cardiopulmonary, and Lung Cancer Death with rising $PM_{2.5}$ air pollution. (adapted from Pope et al, 2002).

Ozone Air Pollution

Another major air pollution health threat, ozone (O_3), is a highly irritant gas that is formed in our atmosphere in the presence of sunlight from other "precursor" air pollutants, including nitrogen oxides and hydrocarbons. These precursor pollutants are emitted by pollution sources including automobiles, electric power plants, and industry.

In my own research, I have found that ozone air pollution is associated with increased numbers of respiratory hospital admissions in U.S. and Canadian cities. But these effects of ozone are only the "tip of the iceberg" of adverse effects associated with this pollutant, and they are best viewed as indicators of the much broader spectrum of adverse health effects being experienced by the public today as a result of air pollution exposures, such as more restricted activity days and doctors visits.

Airway inflammation induced by ozone is especially a problem for children and adults with asthma, as it makes them more susceptible to having asthma attacks. My own asthma camp results have shown that children have more asthma attacks on high ozone days in the summer (Thurston et al, 1997). In addition, recent controlled human studies have indicated that prior exposure to ozone enhances the reactivity of asthmatics to aeroallergens, such as pollens, which can trigger asthma attacks. In addition, the increased inflammation and diminished immune system ozone effects in the lung can make the elderly more susceptible to pneumonia, a major cause of illness and death in this age group.

Controlled Exposure Studies

The air pollution – health effects associations indicated by epidemiologic studies are supported by a large body of data from controlled exposure studies giving consistent and/or supportive results, and demonstrating pathways by which ozone can damage the human body when it is breathed. For example, clinical studies have demonstrated ozone-related decreases in lung function, increased frequencies of respiratory symptoms, heightened airway hyper-responsiveness, and cellular and biochemical evidence of lung inflammation in healthy exercising adults exposed to ozone. Similarly, animal exposures to combustion-related $PM_{2.5}$ have been shown to have significant adverse effects on the lung, including diminished respiratory defense mechanisms, opening the lung to illness from other causes.

The Benefits of Cleaner Air

Most published studies evaluate whether rising air pollution levels worsen health, but it has also been shown that reducing pollution in the air can result in health benefits to the public. For example, Pope (1989) conducted a compelling study clearly showing that, when pollution levels diminish, the health of the general public improves. He investigated a period during the winter of 1986-87 when the Geneva Steel mill in the Utah Valley shut down during a strike. The PM levels dropped dramatically in that strike-year winter, as opposed to the winters preceding and following when the steel mill was in operation. As shown in Figure 2 below, hospital admissions in the valley showed the same pattern as the PM air pollution, decreasing dramatically during the strike. As a control, Pope also examined the pollution and hospital admissions records in nearby Cache Valley, where the mill's pollution was not a factor, and no such drop in respiratory admissions was seen, showing that the drop in admissions in the Utah Valley was not due to some cause other than the reduction in the air pollution levels.

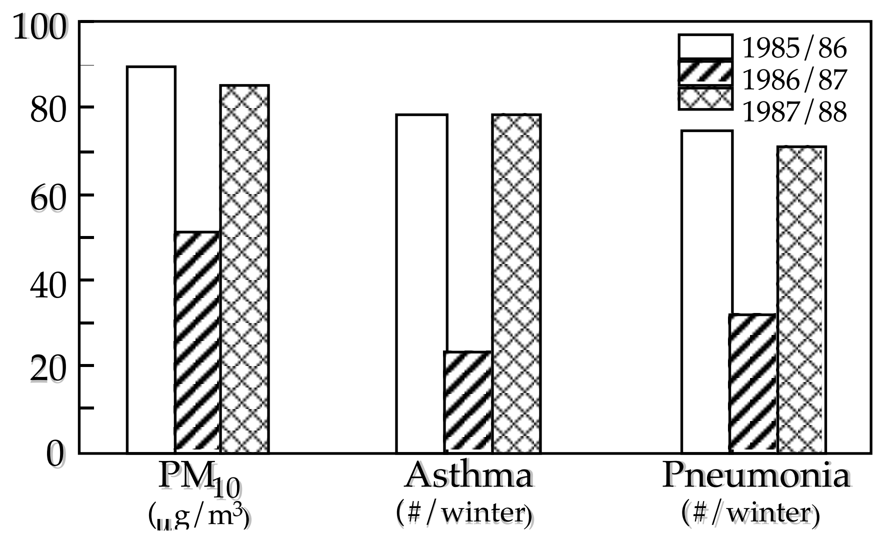

Figure 2. Decreasing PM pollution lowered the number of children's hospital admissions (Source: Pope, 1989).

A more recent study considers a broadly relevant case showing the benefits of cleaner air. During the Atlanta Summer Olympics of 1996, traffic-related ozone and PM declined significantly as a result of the alternative mass transportation strategy implemented to reduce road traffic during the Games (Friedman *et al.*, 2001). These improvements were correlated with changes in the rate of children's hospital admissions. Compared to a baseline period, traffic related ozone and PM levels declined by 28% and 16%, respectively. Concentrations of both PM and ozone also rose noticeably after the end of the Olympics. The study showed a significant reduction in asthma events associated with these pollution improvements. This study indicates that improvements in acute air pollution can provide immediate public health benefits.

Furthermore, a recent follow-up analysis of the Harvard 6-Cities Study discussed earlier (Dockery *et al.*, 1993) has shown that mortality was decreased by lowering pollution (Laden et al, 2006). An extended analysis of the Harvard Six Cities Study (to include follow-up through 1990) has now shown that reductions in long-term ambient PM pollution results in concomitant reductions in the health risks associated with PM. As shown in Figure 3, large reductions in PM at Harvard study cities have resulted in likewise large reductions in the relative risk (RR) of mortality in those cities: Steubenville, OH (S), Harriman, TN (H), St. Louis, MO (L), and Watertown, MA (W). The authors found that, for each decrease of 1 *u*g/m^3 in averge $PM_{2.5}$, the overall death rate from causes such as cardiovascular disease, respiratory illness and lung cancer decreased by some 3 percent, while also extending the lives of study subjects. Thus, although we still carry very large health risks in the United States from our present levels of air pollution, amounting to tens of thousands of premature deaths per year, recent research shows that the lowering of air pollution levels in the air is an effective way to improve public health.

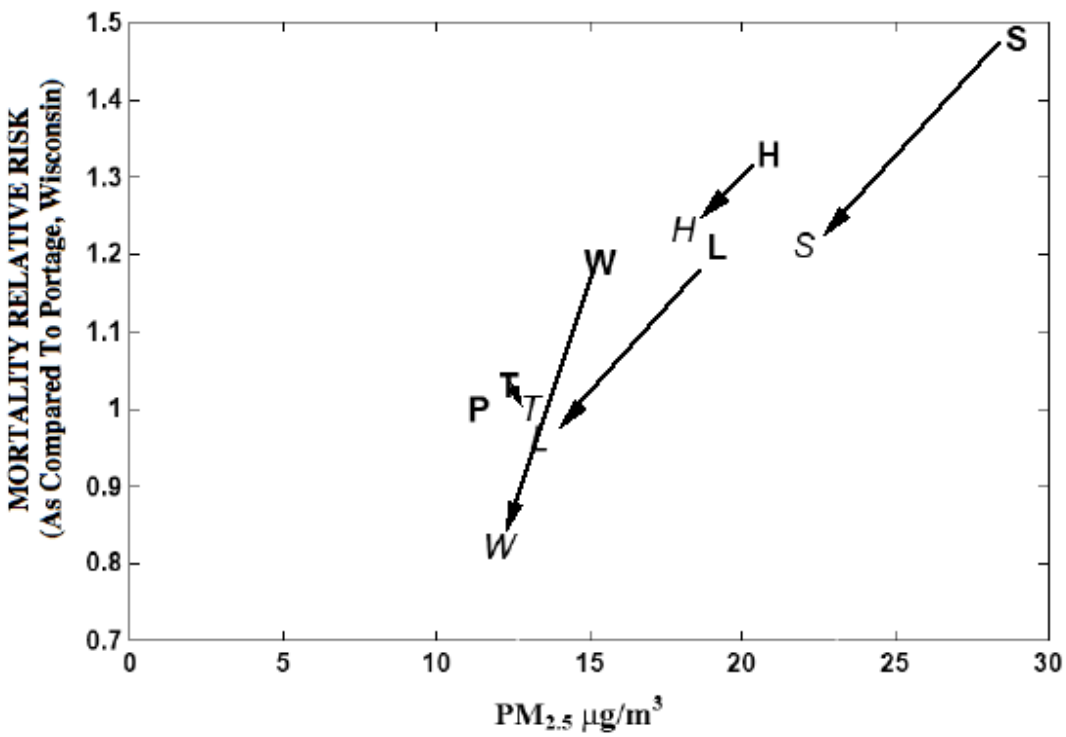

Figure 3. Reducing long-term PM exposure reduces mortality risk
(adapted from Laden et al., 2006)

The evidence is clear and consistent: air pollution is adversely affecting the health and lives of Americans across our nation. There is a coherence between the epidemiologic study associations and experimental study results, validating that there is indeed a cause-effect relationship between air pollution and adverse human health effects. The importance of these health effects relationships is made all the more imperative by the fact that virtually every American is directly impacted by this pollution. Cleaning the air causes improvements in public health, saving lives and improving the quality of life of all Americans.

The Role of CASAC

The setting of the National Ambient Air Quality Standards (NAAQS) is an essential mandate of the Clean Air Act. These NAAQS apply to "criteria" air pollutants that, in the words of the legislation, "endanger public health or welfare". At present, six pollutants are designated as criteria pollutants. The Clean Air Science Advisory Committee (CASAC) was authorized by the Congress in 1977 to aid the EPA Administrator in the setting of these NAAQS. Its members are derived largely from academia and from private sector research institutes, and are appointed by the EPA Administrator. CASAC's role is primarily to review the agency's work in the process of setting each NAAQS, which are each reviewed on an every-five-year schedule, and then to provide the EPA Administrator with independent advice on the interpretation of agency documents for the setting of the NAAQS. Most notably, CASAC reviews the agency's Integrated Science Assessment (ISA) and the Risk and Exposure Assessment (REA) that summarize the science and the policy analyses, respectively. The assessment of these pollutants individually during the CAAA approach, potentially missing effects of synergisms among the various air pollutants, combined with the fact that not all potential health impacts can be quantified in the REA process, has likely caused the EPA to underestimate the total benefits of pollution reductions when viewed on an individual pollutant by pollutant basis. Despite these facts, the EPA's REA and RIA (Regulatory Impact Analysis) analyses have consistently indicated that the valuation of the health benefits of cleaner air, such as fewer hospital admissions and deaths, far outweigh the costs of applying emission controls to reduce air pollution.

Based upon the EPA ISA's, REA's, and CASAC independent expert advice on the setting of the NAAQS (usually provided as a range of possible standards), the EPA Administrator proposes an updated standard for each pollutant that can be the same, more stringent, or less stringent than the existing NAAQS standard for a Criteria air pollutant. This process has generally worked well in the past, and has led to the application of sound science to the setting of the U.S. NAAQS standards to protect the health of the American public.

Conclusions

- The science is sound and the results are clear: cleaning our air reduces air pollution health impacts, lowers our health care costs, and saves lives.
- With the independent advice of CASAC, as stipulated by the Congress, the EPA's regulatory control of ambient air pollutants has led to reductions in both air pollutant exposures and health risks to the American people. This has caused the public to enjoy associated health benefits, including decreased asthma attacks, fewer hospital admissions, fewer heart attacks, and increased length and quality of life.

Thank you for the opportunity to testify on this important issue.

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