No. 10-997

IN THE

# Supreme Court of the United States

STATE OF NORTH CAROLINA EX REL. ROY COOPER,
ATTORNEY GENERAL,

*Petitioner*,

v.

TENNESSEE VALLEY AUTHORITY
AND STATE OF ALABAMA,

*Respondents.*

On Petition For A Writ of Certiorari
To The United States Court of Appeals
For The Fourth Circuit

## BRIEF OF *AMICI CURIAE* AMERICAN LUNG ASSOCIATON AND AMERICAN THORACIC SOCIETY IN SUPPORT OF PETITIONER

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## INTEREST OF THE *AMICI CURIAE*[1]

Founded in 1904, the American Lung Association (ALA) is the nation's oldest voluntary health organization. ALA's mission is to prevent lung disease and promote lung health through education, advocacy, and research on air pollution and its accompanying threats to lung health. ALA publishes reports on air pollution, including the annual *American Lung Association State of the Air* report. Through its advocacy programs, ALA also participates at the national, state, and local levels in the development and enforcement of laws and regulations related to lung health.

The American Thoracic Society (ATS) is an international educational and scientific organization founded in 1905 that represents approximately 15,000 health care professionals. ATS works to prevent and fight respiratory disease around the globe through research, education, patient care, and advocacy. ATS publishes three peer-reviewed scientific journals that disseminate groundbreaking research, including studies on air pollution and health.

*Amici curiae* support Petitioner North Carolina's position because the emissions from Respondent Tennessee Valley Authority's (TVA) coal-fired power plants harm public health and

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[1] Pursuant to Supreme Court Rule 37, the parties were notified ten days prior to the due date of this brief of *amici's* intention to file. All parties have consented to the filing of this brief. No counsel for any party in this case authored this brief in whole or in part, and no person or entity other than *amici* and their counsel have made a monetary contribution to the preparation or submission of this brief.

welfare. Given the extraordinary importance of the issues presented in this case, *amici* urge that this Court grant North Carolina's petition for *certiorari* to review and reverse the decision of the U.S. Court of Appeals for the Fourth Circuit.

## SUMMARY OF ARGUMENT

*Amici curiae* submit this brief to assist the Court in understanding the extraordinary importance of the public health and welfare effects of air pollution from power plants, like those TVA operates within 100 miles of North Carolina. Air pollution is deadly. If the Fourth Circuit's decision stands, North Carolinians will suffer from preventable harm while TVA continues to release hundreds of thousands of pounds of pollution into the air each year. Limiting emissions from TVA's plants is thus an action in the public interest.

Coal-fired power plants emit many dangerous air pollutants, notably nitrogen oxide ($NO_x$) and sulfur dioxide ($SO_2$), which are precursors to fine particulate matter (PM) and ground-level ozone. Exposure to these pollutants can have serious impacts on human health, including premature death, asthma exacerbations, and increased hospitalizations for cardiovascular and respiratory illnesses. Air pollution from power plants is especially harmful to children and their developing respiratory systems, and to other vulnerable subpopulations. It is also responsible for significant social and economic harms, such as increased health care costs from hospitalization and medicine use, lost productivity from job absences, and educational disruptions from missed school days.

Following a twelve-day bench trial, the U.S. District Court for the Western District of North Carolina correctly concluded that TVA's emissions are a public nuisance because they endanger human health and inconvenience the lives of North Carolina's citizens.[2] Common law remedies are a powerful means of protecting people from the injurious effects of air pollution because adverse health effects occur even when emission levels are below the National Ambient Air Quality Standards (NAAQS) set by the U.S. Environmental Protection Agency (EPA). Numerous scientific studies demonstrate that improving air quality beyond current regulatory requirements benefits human health and welfare.

The Fourth Circuit's rejection of the District Court's conclusions allows TVA's power plants to continue to emit harmful pollutants to the surrounding communities, despite the availability of effective pollution control technology. Unless TVA is required to significantly reduce emissions from its power plants, its activities will further degrade air quality and continue to endanger the citizens of North Carolina.

*Amici curiae* support North Carolina's efforts to protect its citizens from unnecessary health risks caused by emissions from TVA's power plants. Common law nuisance actions are a critical tool for states seeking to reduce pollution-related harms that occur below regulatory limits. Accordingly, *amici*

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[2] *See North Carolina ex rel. Cooper v. Tennessee Valley Authority*, 593 F. Supp. 2d 812, 830-31 (W.D.N.C. 2009); (Pet. App. 88a-91a).

urge this Court to review and reverse the Fourth Circuit's decision.

## ARGUMENT

### I. AIR POLLUTION FROM TVA'S COAL-FIRED POWER PLANTS ENDANGERS THE LIVES AND HEALTH OF NORTH CAROLINA'S CITIZENS.

This case presents issues of extraordinary importance because air pollution from TVA's power plants in Tennessee and Alabama threatens lives and health in downwind communities in North Carolina. Coal-fired power plants are major sources of $NO_x$ and $SO_2$, which react in the atmosphere to form other dangerous pollutants, such as PM and ground-level ozone. Plumes from power plants spread emissions great distances and affect PM and ozone levels in areas well beyond their place of origin, compromising public health in downwind regions. Exposure to these pollutants has significant and severe health impacts, even when they are present at levels below the NAAQS.[3]

An extensive body of scientific and medical research documents the link between power plant emissions and human health.[4] PM emissions are

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[3] *See* Staff of Senate Committee on the Environment and Public Works, 95th Cong., *A Legislative History of the Clean Air Act Amendments of 1977*, 6634-55 (1978).

[4] *See generally* U.S. ENVTL. PROT. AGENCY, EPA/600/R-08/139F, INTEGRATED SCIENCE ASSESSMENT FOR PARTICULATE MATTER (FINAL REPORT) (2009) [hereinafter INTEGRATED SCIENCE

especially dangerous because they can bypass the body's defensive mechanisms and become lodged deep in the smaller airways of the human lung; their small size also allows them to enter the blood stream and travel throughout the body.[5] These interactions increase the risk of premature death and cause or contribute to a host of respiratory and cardiopulmonary ailments, including asthma. Children and the elderly are particularly susceptible to the adverse health effects of air pollution.

**a. Air Pollution Causes Premature Mortality.**

Exposure to air pollution can kill.[6] In 2008, the EPA elicited an assessment from twelve of the world's leading experts on the health effects of air pollution, which revealed substantial agreement on the likelihood of a causal connection between exposure and premature death.[7] A recent analysis estimated that emissions from existing coal-fired power plants caused nearly 13,200 premature deaths

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ASSESSMENT] (reviewing and summarizing body of scientific literature on air pollution and human health).

[5] Gunter Oberdorster et al., *Nanotoxicology: An Emerging Discipline Evolving from Studies of Ultrafine Particles*, 113 ENVTL. HEALTH PERSPS. 823, 823 (2005).

[6] U.S. ENVTL. PROT. AGENCY, EXPANDED EXPERT JUDGMENT ASSESSMENT OF THE CONCENTRATION-RESPONSE RELATIONSHIP BETWEEN $PM_{2.5}$ EXPOSURE AND MORTALITY: FINAL REPORT, vii, 3-20-3-24 (2006).

[7] Henry A. Roman et al., *Expert Judgment Assessment of the Mortality Impact of Changes in Ambient Fine Particulate Matter in the U.S.*, 42 ENVTL. SCI. TECH. 2268, 2270 (2008).

in 2010.[8] Other studies suggest premature mortality from exposure to these emissions may range from 8,158 to 24,475 deaths per year.[9]

When air pollution levels are high, deaths can occur immediately, or within months, by inducing heart attacks and strokes.[10] Daily PM exposure, even at low levels, can lead to premature mortality by causing life-threatening diseases.[11] Acute PM exposure increases the risk of death from respiratory and cardiovascular causes;[12] chronic exposure increases the risk of death from lung cancer and

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[8] *See* CLEAN AIR TASK FORCE, THE TOLL FROM COAL: AN UPDATED ASSESSMENT OF DEATH AND DISEASE FROM AMERICA'S DIRTIEST ENERGY SOURCE 4 (2010).

[9] *See* Paul R. Epstein et al., *Full Cost Accounting for the Life Cycle of Coal*, 1219 ANNALS N.Y. ACAD. SCI. 73, 86 (2011).

[10] Yun-Chul Hong et al., *Effects of Air Pollutants on Acute Stroke Mortality*, 110 ENVTL. HEALTH PERSPS. 187, 188 (2002); Shang-Shyue Tsai et al., *Evidence for an Association Between Air Pollution and Daily Stroke Admissions in Kaohsiung, Taiwan*, 34 STROKE 2612 (2003).

[11] *See* Douglas W. Dockery et al., *An Association Between Air Pollution and Mortality in Six U.S. Cities*, 329 NEW ENG. J. MED. 1753, 1753 (1993); C. Arden Pope III et al., *Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U.S. Adults*, 151 AM. J. RESPIRATORY & CRITICAL CARE MED. 669 (1995); Daniel Krewski et al., *Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality* 275 (Health Effects Inst. 2000).

[12] Meredith Franklin et al., *Association Between $PM_{2.5}$ and All-Cause and Specific-Cause Mortality in 27 U.S. Communities*, 17 J. EXPOSURE SCI. & ENVTL. EPIDEMIOLOGY 279, 279, 285 (2007); Cathryn Tonne et al., *A Case Control Analysis of Exposure to Traffic and Acute Myocardial Infarction*, 115 ENVTL. HEALTH PERSPS. 53, 53 (2007).

cardiovascular disease.[13] Numerous studies also demonstrate that short-term exposure to ozone can shorten life.[14]

Recent assessments indicate that the risk of premature mortality from air pollution is greater than previously believed.[15] In 2007, a groundbreaking study of 66,000 women in thirty-six U.S. cities found that an increase in ten micrograms per cubic meter[16] of $PM_{2.5}$ correlated with a seventy-

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[13] C. Arden Pope III et al., *Cardiovascular Mortality and Year-Round Exposure to Particulate Air Pollution: Epidemiological Evidence of General Pathophysiological Pathways of Disease*, 109 CIRCULATION 71 (2004) (finding $10\mu g/m^3$ increase in $PM_{2.5}$ increased mortality risk by 8-18%); C. Arden Pope III et al., *Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution*, 287 J. AM. MED. ASS'N 1132 (2002).

[14] *See, e.g.*, Michelle L. Bell et al., *A Meta-Analysis of Time-Series Studies of Ozone and Mortality with Comparison to the National Morbidity, Mortality, and Air Pollution Study*, 16 EPIDEMIOLOGY 436, 442 (2005); Jonathan I. Levy et al., *Ozone Exposure and Mortality: An Empiric Bayes Metaregression Analysis*, 16 EPIDEMIOLOGY 458 (2005); Kazuhiko Ito et al., *Associations Between Ozone and Daily Mortality: Analysis and Meta-Analysis*, 16 EPIDEMIOLOGY 446 (2005).

[15] C. Arden Pope III, *Mortality Effects of Longer Term Exposures to Fine Particulate Air Pollution: Review of Recent Epidemiological Evidence*, 19 INHALATION TOXICOLOGY 33 (Supp. 1, 2007) (concluding short-term exposure studies capture only small amount of overall health effects of long-term repeated PM exposure); Michael Jerrett et al., *Spatial Analysis of Air Pollution and Mortality in Los Angeles*, 16 EPIDEMIOLOGY 727, 732 (2005).

[16] Concentrations of chemicals in air are typically measured in units of the mass of chemical (milligrams, micrograms, nanograms, or picograms) per volume of air (cubic meter or cubic feet).

six percent greater risk of death from cardiovascular disease.[17] Previous, less specific studies had only found a twelve percent greater risk for every ten micrograms per cubic meter increase.[18] A 2009 review of epidemiological studies by the California Air Resources Board found a strong relationship between $PM_{2.5}$ and premature death generally, concluding that the risk of mortality rose by ten percent for every ten micrograms per cubic meter.[19]

Air pollution does not make people die just a few days earlier; rather, it causes premature deaths that would not have occurred until months or years later, if the air had been cleaner.[20] A National Academy of Sciences report confirms that premature death caused by ozone is not restricted to people who are already in poor health.[21]

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[17] Kristen A. Miller et al., *Long-Term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women*, 356 NEW ENG. J. MED. 447 (2007).

[18] *See* Douglas W. Dockery & Peter H. Stone, *Cardiovascular Risks from Fine Particulate Air Pollution*, 356 NEW ENG. J. MED. 511, 511 (2007).

[19] CAL. AIR RES. BD., METHODOLOGY FOR ESTIMATING PREMATURE DEATHS ASSOCIATED WITH LONG-TERM EXPOSURES TO FINE AIRBORNE PARTICULATE MATTER IN CALIFORNIA: STAFF REPORT 1 (2009) (attributing 18,000 deaths annually to $PM_{2.5}$ in California alone).

[20] Antonella Zanobetti et al., *The Temporal Pattern of Respiratory and Heart Disease Mortality in Response to Air Pollution*, 111 ENVTL. HEALTH PERSPS. 1188, 1192 (2003); Francesca Dominici et al., *Airborne Particulate Matter and Mortality: Timescale Effects in Four U.S. Cities*, 157 AM. J. EPIDEMIOLOGY 1055, 1062 (2003).

[21] NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES, ESTIMATING MORTALITY RISK REDUCTION AND

### b. Air Pollution Leads to Cardiovascular and Respiratory Illness.

Exposure to emissions from coal-fired power plants can also cause serious illness and disease. Researchers have found a significant association between air pollution and risk of heart attacks.[22] A 2010 analysis estimates that power plant emissions led to 20,400 heart attacks in 2010 alone.[23] Studies link air pollution with increased hospitalization for cardiovascular disease, strokes, and congestive heart failure.[24] Exposure to PM and ozone also increases the risk of blood clots[25] and affects blood vessel

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ECONOMIC BENEFITS FROM CONTROLLING OZONE AIR POLLUTION 8 (2008).

[22] Antonella Zanobetti & Joel Schwartz, *The Effect of Particulate Air Pollution on Emergency Admissions for Myocardial Infarction: A Multi-City Case-Crossover Analysis*, 113 ENVTL. HEALTH PERSPS. 978, 980 (2005); Daniela D'Ippoliti et al., *Air Pollution and Myocardial Infarction in Rome: A Case-Crossover Analysis*, 14 EPIDEMIOLOGY 528, 528 (2003).

[23] CLEAN AIR TASK FORCE, *supra* note 8, at 10.

[24] *See, e.g.*, Francesca Dominici et al., *Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases*, 295 J. AM. MED. ASS'N 1127, 1133 (2006); Kristi B. Metzger et al., *Ambient Air Pollution and Cardiovascular Emergency Department Visits*, 15 EPIDEMIOLOGY 46 (2004); William S. Linn et al., *Air Pollution and Daily Hospital Admissions in Metropolitan Los Angeles*, 108 ENVTL. HEALTH PERSPS. 427, 427 (2000); Tsai et al., *supra* note 10; Gregory Wellenius et al., *Particulate Air Pollution and Hospital Admissions for Congestive Heart Failure in Seven United States Cities*, 97 AM. J. CARDIOLOGY 404, 404 (2006).

[25] Andrea Baccarelli et al., *Exposure to Particulate Air Pollution and Risk of Deep Vein Thrombosis*, 168 ARCHIVES OF INTERNAL MED. 920, 926 (2008); Andrew J. Ghio et al., *Exposure to Concentrated Ambient Air Particles Alters Hematologic Indices in Humans*, 15 INHALATION TOXICOLOGY 1465, 1476 (2003).

reactivity,[26] hindering the amount of blood that reaches the heart and the brain.[27] PM may inhibit the body's ability to vary the heart rate in response to environmental or situational changes.[28]

Long-term exposure to air pollution can inflict significant damage to the lungs[29] and cause chronic respiratory illness.[30] Ambient concentrations of ozone and PM are related to increased hospital admissions for pneumonia and chronic obstructive pulmonary disease.[31] Exposure to PM also increases

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[26] Bruce Urch et al., *Relative Contributions of $PM_{2.5}$ Chemical Constituents to Acute Arterial Vasoconstriction in Humans*, 16 INHALATION TOXICOLOGY 345 (2004).

[27] Robert D. Brook et al., *Inhalation of Fine Particulate Air Pollution and Ozone Causes Acute Arterial Vasoconstriction in Healthy Adults*, 105 CIRCULATION 1534, 1535 (2002).

[28] Y.C. Huang et al., *The Role of Soluble Components in Ambient Fine Particles-Induced Changes in Human Lungs and Blood*, 15 INHALATION TOXICOLOGY 327, 327 (2003).

[29] Ira B. Tager et al., *Chronic Exposure to Ambient Ozone and Lung Function in Young Adults*, 16 EPIDEMIOLOGY 751, 751 (2005); Andrew Churg et al., *Chronic Exposure to High Levels of Particulate Air Pollution and Small Airway Remodeling*, 111 ENVTL. HEALTH PERSPS. 714 (2003); Patrick L. Kinney & Morton Lippmann, *Respiratory Effects of Seasonal Exposures to Ozone and Particles*, 55 ARCHIVES ENVTL. HEALTH 210 (2000).

[30] *See* John M. Peters et al., *A Study of Twelve Southern California Communities with Differing Levels and Types of Air Pollution: II. Effects on Pulmonary Function*, 159 AM. J. RESPIRATORY & CRITICAL CARE MED. 768 (1999).

[31] Mercedes Medina-Ramón et al., *The Effect of Ozone and $PM_{10}$ on Hospital Admissions for Pneumonia and Chronic Obstructive Pulmonary Disease: A National Multicity Study*, 163 AM. J. EPIDEMIOLOGY 579 (2006). *See also* Dominici et al., *supra* note 24.

emergency room visits for patients suffering from acute and chronic respiratory ailments.[32]

Scientists observe that the relationship between ozone and respiratory illness is "so well established that emergency admissions have been suggested as a surrogate measure of ozone."[33] Even in healthy adults, short-term exposure can inflame the lungs and cause immediate discomfort.[34] A study of hikers in New Hampshire indicated that healthy individuals were more likely to experience significant declines in lung function on days with higher ambient ozone; adverse health effects were observable even on days when ozone levels were well below the regulatory standard.[35] PM can also induce inflammation of lung tissue in healthy adults.[36]

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[32] STEPHEN VAN DEN EEDEN ET AL., PARTICULATE AIR POLLUTION AND MORBIDITY IN THE CALIFORNIA CENTRAL VALLEY: A HIGH PARTICULATE POLLUTION (2002).

[33] David V. Bates, *Ambient Ozone and Mortality*, 16 EPIDEMIOLOGY 427, 428 (2005).

[34] Ian S. Mudway & Frank J. Kelly, *An Investigation of Inhaled Ozone Dose and the Magnitude of Airway Inflammation in Healthy Adults*, 169 AM. J. RESPIRATORY & CRITICAL CARE MED. 1089, 1093 (2004); W.F. McDonnell et al., *Ozone-Induced Respiratory Symptoms: Exposure-Response Models and Association with Lung Function*, 14 EUROPEAN RESPIRATORY J. 845 (1999).

[35] Susan Korrick et al., *Effects of Ozone and Other Pollutants on the Pulmonary Function of Adult Hikers*, 106 ENVTL. HEALTH PERSPS. 93 (1998).

[36] Andrew J. Ghio et al., *Concentrated Ambient Air Particles Induce Mild Pulmonary Inflammation in Healthy Human Volunteers*, 162 AM. J. RESPIRATORY & CRITICAL CARE MED. 981, 986 (2000).

Recent research has also found a strong and consistent correlation between adult diabetes and air pollution, suggesting PM is a risk factor for diabetes.[37]

**c. Air Pollution Exacerbates Asthma.**

Asthma is a chronic respiratory disease affecting 24.6 million Americans—8.2 percent of the nation.[38] Asthma inflames and narrows the airways of the lung, making it difficult for individuals to breathe.[39] People with asthma have heightened sensitivity to stimulants, like allergens or pollutants, and airway irritations cause recurring symptoms, such as wheezing, chest tightness, shortness of breath, and coughing.[40] Asthma attacks can be both painful and frightening, as their onset is often sudden. Left untreated, asthma can lead to permanent lung damage or fatalities.[41]

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[37] *See* John F. Pearson et al., *Association Between Fine Particulate Matter and Diabetes Prevalence in the United States*, 33 DIABETES CARE 2196 (2010).

[38] LARA J. AKINBAMI ET AL., CENTERS FOR DISEASE CONTROL AND PREVENTION, ASTHMA PREVALENCE, HEALTH CARE USE, AND MORTALITY: UNITED STATES, 2005-2009 (2011).

[39] NATIONAL HEART, LUNG, AND BLOOD INSTITUTE, NATIONAL INSTITUTES OF HEALTH, PUB NO. 09-7429, AT A GLANCE: ASTHMA (2009).

[40] *Id*.

[41] Diane E. McLean et al., *Asthma Among Homeless Children: Undercounting and Undertreating the Underserved*, 158 ARCHIVES PEDIATRICS & ADOLESCENT MED. 244, 247 (2004).

Exposure to PM and ozone is especially harmful for people with asthma.[42] In 2010, power plant emissions caused an estimated 217,600 asthma attacks nationwide, nearly 12,300 of which led to emergency room visits.[43] Indeed, health experts maintain that air pollution is "one of the most under-appreciated contributors to asthma exacerbation."[44] Asthma exacerbations can cause permanent scarring, and they are dangerous, expensive, and inconvenient. Children with asthma are particularly vulnerable to ozone pollution, even at levels currently considered safe.[45]

**d. Air Pollution Increases Risk for Vulnerable Subpopulations.**

The adverse health effects of air pollution pose greater risks for certain populations, including children (18 years and younger), the elderly (65 years and older), people with chronic cardiovascular and lung disease, and people with diabetes.[46] Children are especially susceptible because their

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[42] Janneane F. Gent et al., *Association of Low-Level Ozone and Fine Particles with Respiratory Symptoms in Children with Asthma*, 290 J. AM. MED. ASS'N 1859, 1859 (2003); Helene Desqueyroux et al., *Short-Term Effects of Low-Level Air Pollution on Respiratory Health of Adults Suffering from Moderate to Severe Asthma*, 89 ENVTL. RESEARCH 29, 29 (2002).

[43] CLEAN AIR TASK FORCE, *supra* note 8, at 10.

[44] George D. Thurston & David V. Bates, *Air Pollution as an Underappreciated Cause of Asthma Symptoms*, 290 J. AM. MED. ASS'N 1915, 1915 (2003).

[45] Gent et al., *supra* note 42, at 1859.

[46] *See* INTEGRATED SCIENCE ASSESSMENT, *supra* note 4, at Ch. 8.

lungs are still developing,[47] and because they breathe more air per pound of body weight than adults, which increases the dose of inhaled pollutants.[48] Children also spend more time outdoors and have higher activity levels, which means they inhale greater volumes of polluted air.[49]

Air pollution can affect health even before birth, as PM exposure during pregnancy is linked to increased risk of premature birth[50] and lower birth weight.[51] Infants face a nine percent greater risk of bronchiolitis for every increase of ten micrograms per cubic meter in $PM_{2.5}$.[52] In Canada's largest cities, ozone is associated with increased hospitalization for respiratory problems in babies under one month old.[53]

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[47] Janice J. Kim et al., *Ambient Air Pollution: Health Hazards to Children*, 114 PEDIATRICS 1699, 1699 (2004) (observing that eighty percent of alveolar function occurs post-natally).

[48] *See* Kent E. Pinkerton et al., *Ozone, a Malady for All Ages*, 176 AM. J. RESPIRATORY & CRITICAL CARE MED. 107, 107 (2007).

[49] American Academy of Pediatrics, Committee on Environmental Health, *Ambient Air Pollution: Health Hazards to Children*, 114 PEDIATRICS 1699 (2004).

[50] Sharon K. Sagiv et al. *A Time Series Analysis of Air Pollution and Preterm Birth in Pennsylvania, 1997-2001*, 113 ENVTL. HEALTH PERSPS. 602 (2005).

[51] Michelle L. Bell, *Prenatal Exposure to Fine Particulate Matter and Birth Weight*, 21 EPIDEMIOLOGY 884 (2010).

[52] Catherine Karr et al., *Effects of Subchronic Exposure to Ambient Air Pollutants on Infant Bronchiolitis*, 165 AM. J. EPIDEMIOLOGY 553, 557 (2007).

[53] Robert E. Dales et al., *Gaseous Air Pollutants and Hospitalization for Respiratory Disease in the Neonatal Period*, 114 ENVTL. HEALTH PERSPS. 1751, 1754 (2006). *See also* Richard T. Burnett et al., *Association Between Ozone and*

The adverse effects of high ozone exposure can stay with children for life. A five-year study tracking 3,500 students in Southern California found that children who played team sports in areas with high daytime ozone concentrations had a greater risk of developing asthma.[54] Asthmatic children also have increased hospitalization rates, more severe asthma attacks, and decreased pulmonary function when exposed to air pollution.[55] A study of 255 college freshmen similarly found that students who grew up in areas with more ambient ozone had decreased lung function, a risk factor for lung disease later in life.[56]

Older adults are also susceptible to the adverse health effects of air pollution because they have a higher prevalence of pre-existing illness and the aging process has contributed to their sensitivity.[57] Healthy elderly adults can experience significant decreases in heart rate variability following PM exposure, which may induce adverse

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*Hospitalization for Acute Respiratory Diseases in Children Less than 2 Years of Age*, 153 AM. J. EPIDEMIOLOGY 444, 449 (2001).

[54] Rob McConnell et al., *Asthma in Exercising Children Exposed to Ozone: A Cohort Study*, 359 LANCET 386 (2002).

[55] Leonardo Trasande & George D. Thurston, *The Role of Air Pollution in Asthma and Other Pediatric Morbidities*, 115 J. ALLERGY & CLINICAL IMMUNOLOGY 689, 691-96 (2005); Toby C. Lewis et al., *Air Pollution-Associated Changes in Lung Function Among Asthmatic Children in Detroit*, 113 ENVTL. HEALTH PERSPS. 1068 (2005); George D. Thurston et al., *Summertime Haze Air Pollution and Children with Asthma*, 155 AM. J. RESPIRATORY & CRITICAL CARE MED. 654 (1997).

[56] Tager et al., *supra* note 29.

[57] INTEGRATED SCIENCE ASSESSMENT, *supra* note 4, at 8-3.

cardiovascular events.[58] PM can trigger hospitalization for congestive heart failure among the elderly,[59] and low-level ozone exposure increases emergency room visits for respiratory illnesses among older populations.[60]

Also vulnerable are non-elderly individuals with pre-existing medical conditions. Adults with chronic obstructive pulmonary disease are particularly sensitive to ozone exposure,[61] and patients with cystic fibrosis are at greater risk of pulmonary exacerbations and significant loss in lung function when exposed to air pollution.[62] Individuals with diabetes are susceptible to air pollution, as well, as they experience increased risk of pollution-associated cardiovascular events.[63]

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[58] R.B. Devlin et al., *Elderly Humans Exposed to Concentrated Air Pollution Particles Have Decreased Heart Rate Variability*, 21 EUROPEAN RESPIRATORY J. 76s, 79s (2003).

[59] *See* Gregory Wellenius et al., *Particulate Air Pollution and the Rate of Hospitalization for Congestive Heart Failure Among Medicare Beneficiaries in Pittsburgh, Pennsylvania*, 161 AM. J. EPIDEMIOLOGY 1030, 1030 (2005).

[60] Ralph J. Delfino et al., *Emergency Room Visits for Respiratory Illnesses Among the Elderly in Montreal: Association with Low Level Ozone Exposure*, 76 ENVTL. RESEARCH 67, 67, 75 (1998).

[61] Helene Desqueyroux et al., *Effects of Air Pollution on Adults with Chronic Obstructive Pulmonary Disease*, 6 ARCHIVES ENVTL. HEALTH 554, 554 (2002).

[62] Christopher H. Goss et al., *Effect of Ambient Air Pollution on Pulmonary Exacerbations and Lung Function in Cystic Fibrosis*, 169 AM. J. RESPIRATORY & CRITICAL CARE MED. 816, 816 (2004).

[63] Marie S. O'Neill et al., *Air Pollution and Inflammation in Type 2 Diabetes: A Mechanism for Susceptibility*, 64 OCCUPATIONAL & ENVTL. MED. 373 (2007); Marie S. O'Neill et

## II. AIR POLLUTION FROM TVA'S COAL-FIRED POWER PLANTS ENDANGERS THE SOCIAL AND ECONOMIC WELFARE OF NORTH CAROLINA'S CITIZENS.

Air pollution from coal-fired power plants also has serious implications for social and economic welfare. The economic costs associated with the adverse health effects of power plant emissions are staggering. In 2010, the National Research Council (NRC) estimated that the annual "hidden" costs of power plant emissions were $62 billion nationwide.[64] Over ninety percent of these damages are from PM-related mortality.[65] Using NRC's data, a 2011 Harvard Medical School report calculated that removing a single ton of $SO_2$ from power plant emissions in Kentucky would create almost $6,000 in public health savings; by removing the nearly 500,000 tons of $SO_2$ emitted from its power plants each year, the state would save close to $3 billion in annual health costs.[66]

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al., *Diabetes Enhances Vulnerability to Particulate Air Pollution-Associated Impairment in Vascular Reactivity and Endothelial Function*, 111 CIRCULATION 2913 (2005); Antonella Zanobetti & Joel Schwartz, *Are Diabetics More Susceptible to the Health Effects of Airborne Particles?*, 164 AM. J. RESPIRATORY & CRITICAL CARE MED. 831 (2001).

[64] NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCE, HIDDEN COSTS OF ENERGY: UNPRICED CONSEQUENCES OF ENERGY PRODUCTION AND USE 92 (2010) (damages related to climate change were not included).

[65] Epstein, *supra* note 9, at 86.

[66] *Id*.

According to the same Harvard Medical School report, the health costs of power plant emissions may be even greater. Based on data from more recent studies than those NRC used, the health damages from coal combustion are three times higher, costing the nation $187.5 billion per year.[67] A 2010 study by Abt Associates also estimates that the total monetized value of the adverse health impacts of power plant emissions adds up to more than $100 billion per year.[68] This financial burden disproportionately affects vulnerable subpopulations and other people who live in areas downwind of multiple power plants.[69]

Higher rates of illness and disease place great pressure on the health care industry and exact a toll on family budgets because pollution-related hospitalization, emergency room visits, and medications are costly.[70] Researchers estimate that adult asthma patients spend an average of about $5,000 annually on direct and indirect asthma-

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[67] *Id*. This figure corresponds with estimates that public health damages from coal combustion range from $30,000 to $500,000 per ton of primary $PM_{2.5}$; $6,000 to $50,000 per ton of $SO_2$; and $500 to $15,000 per ton of $NO_x$. *See* Jonathan I. Levy, *Uncertainty and Variability in Health-Related Damages from Coal-Fired Power Plants in the United States*, 29 RISK ANALYSIS 1000, 1008 (2009).

[68] CLEAN AIR TASK FORCE, *supra* note 8, at 4.

[69] *Id*.

[70] *See, e.g.*, Katayoun Bahadori et al., *Economic Burden of Asthma: A Systematic Review*, 9 BMC PULMONARY MED. 1 (2009).

related expenses.[71] In 2007, the total social and economic cost of asthma in the United States was $56 billion, including medical expenses and productivity losses due to death and disease.[72] States and the federal government, as well as individuals, bear these costs because many of those affected are Medicare and Medicaid patients.

Because children are particularly susceptible to air pollution, another social and economic impact resulting from power plant emissions is lost school days. Studies document a significant relationship between air pollution and school absenteeism due to respiratory illness.[73] School absences are costly to students, educators, and parents because children who miss school are likely to suffer academically and frustrate educators' efforts to teach them. Parents of children who are too sick to go to school face a Hobson's choice: they must decide between leaving their sick children home alone, missing work to care for their children, or locating childcare, a resource that is scarce and costly.

Employers are harmed by the loss of productivity when workers must take sick days.

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[71] Miriam G. Cisternas et al., *A Comprehensive Study of Direct and Indirect Costs of Adult Asthma*, 111 J. ALLERGY & CLINICAL IMMUNOLOGY 1212 (2003).

[72] Sarah Beth L. Barnett & Tursynbek A. Nurmagambetov, *Costs of Asthma in the United States: 2002-2007*, 127 J. ALLERGY & CLINICAL IMMUNOLOGY 145, 145 (2011).

[73] *See, e.g.*, Frank D. Gilliland et al., *The Effects of Ambient Air Pollution on School Absenteeism Due to Respiratory Illness*, 12 EPIDEMIOLOGY 43, 53 (2001); Michael R. Ransom & C. Arden Pope, *Elementary School Absences and $PM_{10}$ Pollution in Utah Valley*, 58 ENVTL. RESEARCH 204, 216-17 (1992).

Researchers estimate that air pollution from power plants resulted in 1,627,800 lost work days in 2010, costing the nation $150 million in productivity.[74] Productivity losses just due to asthma cost the nation $5.9 billion in 2007.[75] An earlier study suggested the health effects of air pollution are responsible for about 322,000 lost work days per year in North Carolina alone.[76]

Air pollution can also lead to days in which people are not able to participate fully in their normal activities.[77] Bad air quality and unhealthy lungs change adult lifestyles, as individuals must stay indoors and forgo ordinary activities, such as jogging, bicycling, walking outside, or gardening, to avoid life-threatening or otherwise harmful effects of air pollution exposure. Power plant emissions contribute to 1,640,000 restricted activity days per year in North Carolina, according to researchers' estimates.[78]

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[74] CLEAN AIR TASK FORCE, *supra* note 8, at 10.

[75] Barnett & Nurmagambetov, *supra* note 72, at 145.

[76] ABT ASSOCIATES, THE PARTICULATE-RELATED HEALTH BENEFITS OF REDUCING POWER PLANT EMISSIONS 6-10 (2000). *See also* CAL. AIR RES. BD. & AM. LUNG. ASS'N OF CAL., RECENT RESEARCH FINDINGS: HEALTH EFFECTS OF PARTICULATE MATTER AND OZONE AIR POLLUTION 4 (2004) (estimating air pollution causes 2.8 million lost work days per year in California).

[77] ABT ASSOCIATES, *supra* note 76, at 5-25.

[78] *Id*. at 6-10.

## III. SIGNIFICANT PUBLIC HEALTH BENEFITS WILL RESULT IF TVA CONTROLS EMISSIONS AS THE DISTRICT COURT REQUIRED.

Installing readily available pollution control equipment at TVA's power plants would yield significant and immediate public health benefits for the citizens of North Carolina. The District Court's requirement that TVA use scrubbers and selective catalytic technology would decrease TVA's emissions from 260,000 tons per year to less than 45,000 tons per year,[79] removing a significant amount of PM and ozone from the atmosphere. Numerous studies demonstrate that decreases in air pollution, like PM and ozone, improve human health and welfare.[80] Reduced exposure is associated with reduced mortality from all causes, including cardiovascular disease and lung cancer.[81] Even incremental reductions at lower concentrations can save lives.[82] The installation of 130 scrubbers on coal-fired units

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[79] *See North Carolina ex rel. Cooper v. Tennessee Valley Authority*, 593 F. Supp. 2d 812, 827 (W.D.N.C. 2009); (Pet. App. 82a).

[80] *See, e.g.*, Joel Schwartz et al., *The Effect of Dose and Timing of Dose on the Association between Airborne Particles and Survival*, 116 ENVTL. HEALTH PERSPS. 64, 68 (2008) (finding no evidence of a threshold in the association between $PM_{2.5}$ exposure and risk of death, suggesting efforts to reduce PM as low as feasible are most effective way to improve public health).

[81] Francine Laden et al., *Reduction in Fine Particulate Air Pollution and Mortality: Extended Follow-Up for the Harvard Six Cities Study*, 173 AM. J. RESPIRATORY & CRITICAL CARE MED. 667, 670 (2006).

[82] *Id.*

in the eastern United States between 2004 and 2010 has saved nearly 11,000 lives per year.[83]

In 2009, researchers explored the effect of improved air quality by comparing data on PM pollution and life expectancy in fifty-one U.S. cities between 1980 and 2000. After controlling for socioeconomic, demographic, and lifestyle factors like smoking, the study revealed that decreasing $PM_{2.5}$ by ten micrograms per cubic meter could increase life expectancy by six months to two years. The study also demonstrated that reduced pollution accounted for as much as fifteen percent of the overall increase in life expectancy seen in those cities.[84] Other studies also show that limiting air pollution can produce substantial improvements in public health in a short period of time.[85] Decreases in long-term exposure reduce mortality rates to a greater extent than previously believed.[86]

North Carolina's ability to safeguard the health and welfare of its citizens depends on reversal

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[83] *See* CLEAN AIR TASK FORCE, *supra* note 8, at 5.

[84] C. Arden Pope III et al., *Fine Particulate Air Pollution and Life Expectancy in the United States*, 360 NEW ENG. J. MED. 371 (2009).

[85] Antonella Zanobetti & Joel Schwartz, *The Effect of Fine and Coarse Particulate Air Pollution on Mortality: A National Analysis*, 117 ENVTL. HEALTH PERSPS. 898, 902 (2009); Robin C. Puett et al., *Chronic Particulate Exposure, Mortality and Coronary Heart Disease in the Nurses' Health Study*, 168 AM. J. EPIDEMIOLOGY 1161, 1167 (2008); Antonella Zanobetti et al., *Particulate Air Pollution and Survival in a COPD Cohort*, 7 ENVTL. HEALTH 48, 55-56 (2008); Sara H. Downs et al., *Reduced Exposure to $PM_{10}$ and Attenuated Age-Related Decline in Lung Function*, 357 NEW ENG. J. MED. 2338, 2346 (2007).

[86] *See* Roman et al., *supra* note 7, at 2268.

of the Fourth Circuit's decision. Compliance with air pollution permits is not enough. Healthy individuals experience reduced lung function and airway obstruction at pollution levels far below the national standards.[87] A study in Virginia found that infants exposed to ozone below the current NAAQS also experience respiratory symptoms and have difficulty breathing.[88] According to a series of epidemiological studies, there is a consistent association between premature mortality and ozone exposures below regulatory standards.[89] A report by the National Academy of Sciences confirms that the relationship between reductions in ozone concentrations and reductions in premature mortalities is generally linear, even below the NAAQS.[90] In other words, reducing ozone concentrations beyond levels required by the Clean Air Act saves lives.

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[87] Ephraim Thaller et al., *Moderate Increases in Ambient $PM_{2.5}$ and Ozone are Associated with Lung Function Decreases in Beach Lifeguards*, 50 J. OCCUPATIONAL ENVTL. MED. 202, 202 (2008); Morton Lippmann, *Health Effects of Airborne Particulate Matter*, 357 NEW ENG. J. MED. 2395, 2396 (2007); Edward S. Schelegle et al., *6.6-Hour Inhalation of Ozone Concentrations from 60 to 87 Parts Per Billion in Healthy Humans*, 180 AM. J. RESPIRATORY & CRITICAL CARE MED. 265, 265 (2009).

[88] Elizabeth W. Triche et al., *Low-Level Ozone Exposure and Respiratory Symptoms in Infants*, 114 ENV. HEALTH PERSPS. 911, 915 (2006).

[89] Pinkerton et al., *supra* note 48, at 107.

[90] NATIONAL RESEARCH COUNCIL, *supra* note 21, at 9.

## CONCLUSION

For the foregoing reasons, *amici* urge this Court to grant North Carolina's petition for *certiorari* to review the Fourth Circuit's decision and reverse that judgment to protect the health and welfare of the citizens of North Carolina.

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