CENTER *for* BIOLOGICAL DIVERSITY

Friends of the Earth

INTERNATIONAL CENTER FOR TECHNOLOGY ASSESSMENT

VIA FIRST CLASS MAIL, RETURN RECEIPT REQUESTED

September 21, 2010

Hon. Lisa P. Jackson
Administrator
United States Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Mail Code 1101A
Washington, DC 20460

PETITION FOR RULEMAKING UNDER THE CLEAN AIR ACT TO REDUCE GREENHOUSE GAS AND BLACK CARBON EMISSIONS FROM LOCOMOTIVES

I. INTRODUCTION

Pursuant to the Administrative Procedure Act ("APA"), 5 U.S.C. § 551 *et seq.*, and the Clean Air Act ("CAA"), 42 U.S.C. § 7400 *et seq.*, the Center for Biological Diversity, Friends of the Earth, and the International Center for Technology Assessment ("Petitioners") hereby petition the Administrator of the Environmental Protection Agency ("EPA") to undertake a rulemaking to promulgate regulations to reduce the emissions of greenhouse gases ("GHGs") and black carbon from locomotives.

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EPA has determined that greenhouse gas emissions endanger the public health and public welfare of current and future generations, and has also recognized that black carbon is an important contributor to climate change.[1] Locomotives, including freight and passenger rail,[2] emit a significant and increasing amount of both GHGs and black carbon.

In 2008 alone, locomotives in the U.S. emitted 50.6 million metric tons (MMT) of GHG CO_2e.[3] Consuming more than 4 billion gallons of diesel fuel each year, trains rank second among nonroad sources of carbon dioxide emissions.[4] Recognizing the impact of railroads on climate change, EPA has stated in its draft 2011-2015 Strategic Plan that it will develop standards to reduce GHG emissions from locomotives.[5] However, the Agency has not provided a timeline for introduction of these urgently needed regulations.

Locomotive engines also emit over 25,000 tons annually of particulate matter ($PM_{2.5}$).[6] Nationwide, locomotives and marine diesel engines account for about 25 % of mobile source diesel emissions of $PM_{2.5}$, [7] a classification that includes the finest airborne particles posing the gravest risk to health.[8] $PM_{2.5}$ is comprised of varying amounts of black carbon, a particularly harmful, light-absorbing aerosol particle with a potent global warming effect.[9] By some estimates, black carbon makes up between 43 and 59% of the

[1] U.S. Environmental Protection Agency ("EPA"), Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496, 66496-97, 66520 (Dec. 15, 2009) [hereinafter Endangerment Finding]. Although EPA has noted uncertainties regarding black carbon's total climate change effect, it has acknowledged that black carbon is an important climate forcing agent. Petitions under the CAA calling on the Agency to make an endangerment finding and regulate black carbon emissions are currently pending. *Id.* at 66520.

[2] The category "locomotives" includes diesel-powered engines only (coal-and wood-fired not included) used in freight and passenger rail, line-haul, local, and switch yard service. *See* EPA, What are Mobile Sources?, *available at* http://www.epa.gov/oms/invntory/overview/examples.htm.

[3] EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS 1990-2008, at 2-22 (Apr. 2010), available at http://epa.gov/climatechange/emissions/usinventoryreport.html [hereinafter EPA INVENTORY].

[4] EPA, Advanced Notice of Proposed Rulemaking, Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44354, 44462 (Jul. 30, 2008).

[5] EPA, DRAFT FY2011-2015 EPA STRATEGIC PLAN, 7 (Jun. 18, 2010).

[6] EPA, REGULATORY IMPACT ANALYSIS: CONTROL OF EMISSIONS OF AIR POLLUTION FROM LOCOMOTIVE ENGINES AND MARINE COMPRESSION IGNITION ENGINES LESS THAN 30 LITERS PER CYLINDER, EPA420-R-08-001a, Tables 3-72 and 3-82, at 3-81, 3-91 (May 2008) [hereinafter LOCOMOTIVE RIA] (presenting annual $PM_{2.5}$ emissions from locomotives at baseline and under the final regulations, in short tons).

[7] EPA, Control of Emissions of Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder, 73 Fed. Reg. 25098, at 25102 (May 6, 2008), republished at 73 Fed. Reg. 37095, 37097 (Jun. 30, 2008) (codified in scattered sections of 40 C.F.R.) [hereinafter Locomotive and Marine Engines Final Rule].

[8] "Particulate matter is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles less than 10 micrometers in diameter (PM_{10}) pose a health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter ($PM_{2.5}$) are referred to as "fine" particles and are believed to pose the greatest health risks. Because of their small size (approximately 1/30th the average width of a human hair), fine particles can lodge deeply into the lungs." EPA, Fine Particle Designations, Frequent Questions, *available at* http://www.epa.gov/pmdesignations/faq.htm#0.

[9] Black carbon is not a greenhouse gas, but an airborne particulate (the "carbonaceous" component of soot) that results from incomplete combustion of the carbon contained in fossil fuels, biofuels and biomass.

$PM_{2.5}$ emitted by locomotives in the U.S. each year, or between 11,000 and 15,000 tons annually.[10]

EPA has acknowledged that "[l]ocomotive and marine diesel engines contribute significantly to air pollution in many of our nation's cities and towns," and anticipates that such engines will account for a greater share of overall mobile source emissions as pollution control programs for cars, trucks, and non-road sources take effect.[11] EPA's estimates in 2008 show that by 2030, locomotive and marine diesel engines would contribute more than 65% of national mobile source diesel $PM_{2.5}$ emissions, if emissions standards remained static.[12] Thus, continuing improvements in reducing diesel $PM_{2.5}$ emissions from locomotives is essential.

Under Section 213(a)(5) of the CAA, 42 U.S.C. § 7547(a)(5), EPA is required to regulate GHG and black carbon emissions from locomotives. Under the statute, "the Administrator *shall* promulgate regulations containing standards applicable to emissions from new locomotives and new engines used in locomotives."[13] The statute further provides that the emission standards "*shall* achieve the *greatest degree of emission reduction achievable* through the application of technology which the Administrator determines will be available for the locomotives or engines to which the standards apply, giving appropriate consideration to the cost…and to noise, energy, and safety factors associated with … such technology."[14] Technologies currently exist that can feasibly and cost-effectively reduce emissions of GHGs and black carbon from locomotives. EPA must therefore promulgate standards to reduce these emissions at the earliest possible date.[15]

Petitioners file this Petition for Rulemaking pursuant to the Administrative Procedure Act, 5 U.S.C. § 553(e), and the CAA, 42 U.S.C. § 7547, and respectfully request that EPA undertake the following mandatory duties:

Diesel vehicle PM emissions contain a higher fraction of black carbon than most other PM emission sources. *See* Endangerment Finding, *supra* note 1, at 66520. Some scientific studies suggest that black carbon has a warming effect that exceeds that of methane, making it the second most significant contributor to global warming. *See* Mark Jacobson, *Strong Radiative Heating Due to the Mixing State of Black Carbon in Atmospheric Aerosols*, 409 NATURE 695, 695 (2001); V. Ramanathan and G. Carmichael, *Global and Regional Climate Changes Due to Black Carbon*, 1 NATURE GEOSCIENCE 221, 222, 227 (2008).

[10] William Battye and Katherine Boyer, U.S. EPA, *Methods for Improving Global Inventories of Black Carbon and Organic Carbon Particulates*, Table 3 ("Estimated Breakdown of BC Emissions in the U.S.") (n.d.).

[11] EPA, Regulatory Announcement: EPA Finalizes More Stringent Emissions Standards for Locomotives and Marine Compression-Ignition Engines, March 2008, EPA420-F-08-004, *available at*: http://www.epa.gov/oms/regs/nonroad/420f08004.htm [hereinafter Locomotive and Marine Regulatory Announcement]. In its Regulatory Impact Analysis, EPA uses "a projection by the Energy Information Administration (EIA) that locomotive fuel consumption will grow 1.6 percent annually." *See* LOCOMOTIVE RIA, *supra* note 6, at 3-77.

[12] *See* Locomotive and Marine Regulatory Announcement, *supra* note 11.

[13] 42 U.S.C. § 7547(a)(5) (emphasis added).

[14] *Id.* (emphasis added).

[15] *See* CAA §§ 213(a)(5), 213(b), 42 U.S.C. §§ 7547(a)(5), 7547(b).

(1) Propose regulations setting standards for GHG emissions from locomotives and locomotive engines under Section 213(a)(5) of the Clean Air Act, 42 U.S.C. § 7547(a)(5), such standards to take the form of emissions limitations, including requirements limiting the quantity, rate, or concentration of emissions of GHGs, and any design, equipment, work practice or operational standard necessary to carry out the emissions limitations.

(2) Promulgate final regulations setting standards for GHG emissions from locomotives and locomotive engines to take effect at the earliest possible date considering the lead time necessary to permit the development and application of the requisite technology, pursuant to Section 213(b) of the CAA, 42 U.S.C. § 7547(b).

(3) Propose regulations setting standards for black carbon emissions from locomotives and locomotive engines under Section 213(a)(5) of the Clean Air Act, 42 U.S.C. § 7547(a)(5), such standards to take the form of emissions limitations, including requirements limiting the quantity, rate, or concentration of emissions of black carbon, and any design, equipment, work practice or operational standard necessary to carry out the emissions limitations.

(4) Promulgate final regulations setting standards for black carbon emissions from locomotives and locomotive engines to take effect at the earliest possible date considering the lead time necessary to permit the development and application of the requisite technology, pursuant to Section 213(b) of the CAA, 42 U.S.C. § 7547(b).

II. PETITIONERS

Petitioner Center for Biological Diversity is a nonprofit environmental organization dedicated to the protection of imperiled species and their habitats through science, education, policy, and environmental law. The Center has approximately 43,000 members throughout the United States. The goal of the Center's Climate Law Institute is to reduce U.S. greenhouse gas emissions and other air pollution to protect biological diversity, the environment, and public health. Specific objectives include securing protections for species threatened by the impacts of global warming, ensuring compliance with applicable law in order to reduce greenhouse gas emissions and other air pollution, and educating and mobilizing the public on global warming and air quality issues.

Petitioner Friends of the Earth ("FoE") is a nonprofit environmental advocacy organization with a mission to defend the environment and champion a healthy and just world. One of FoE's main programs, undertaken in collaboration with the 77 member group affiliates of Friends of the Earth International, is the promotion of policies and actions to reduce greenhouse gas emissions and avoid irreparable climate change. FoE promotes policies and actions that reduce the use of fossil fuels and works to adopt clean, efficient, low-greenhouse gas technologies. The many actions FoE has undertaken in pursuit of these goals include filing petitions to compel the National Park Service, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration to initiate planning and mitigation measures to address global arming impacts on America's national parks, forests, wildlife refuges, and marine sanctuaries.

Petitioner International Center for Technology Assessment ("ICTA") is a non-profit organization committed to providing the public with full assessments and analyses of technological impacts on society. ICTA seeks to protect the environment, individuals, and society from technologies that have advanced more rapidly than our ability to control the pollution they produce and the other social threats they pose. ICTA has had a global warming project since its inception in 1994. In 1999, ICTA led a coalition of environmental organizations in petitioning EPA to set emission standards for carbon dioxide and other motor vehicle greenhouse gas emissions under section 202 of the Clean Air Act. The denial of the ICTA petition and the ensuing litigation resulted in the seminal Supreme Court decision, *Massachusetts v. EPA*, 549 U.S. 497 (2007), which in turn has eventually resulted in EPA beginning the CAA regulatory process for greenhouse gas emissions.

Petitioners submit this Petition on their own behalf and on behalf of their members and staff with an interest in protecting the environment.

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III. RIGHT TO PETITION

The right of an interested party to petition a federal agency is a freedom guaranteed by the first amendment: "Congress shall make no law . . . abridging the . . . right of people . . . to petition the Government for redress of grievances."[16] Under the Administrative Procedure Act ("APA"), all citizens have the right to petition for the "issuance, amendment, or repeal" of an agency rule.[17] In the instant case, Petitioner seeks the promulgation of standards to control emissions from locomotives under Section 213(a)(5) of the CAA, 42 U.S.C. § 7547(a)(5), a non-discretionary duty. EPA is required to respond to this petition: "Prompt notice shall be given of the denial in whole or in part of a written application, petition, or other request of an interested person made in connection with any agency proceeding."[18] Petitioners request that EPA respond within 180 days of receipt of this Petition, as CO_2 and black carbon emitted by locomotives and other sources continue to cause calamitous and rapid global climate changes that threaten public health and welfare.

STATEMENT OF FACTS

A. Emissions of GHGs and Black Carbon Are Causing Global Climate Change.

Climate change caused by global warming is the most pressing issue of our time. Greenhouse gases, such as carbon dioxide, methane, and nitrous oxide are accumulating in the atmosphere, decreasing the amount of solar radiation that is reflected back into space and warming the Earth's climate. In *Massachusetts v. EPA*, the U.S. Supreme Court held unequivocally that greenhouse gases, including carbon dioxide, are air pollutants within the meaning of the Clean Air Act, and that EPA is authorized to regulate them.[19] EPA thereafter issued a finding that these pollutants "endanger both the public health and the public welfare of current and future generations."[20] This finding was based on currently observed and projected future effects of GHGs on the atmosphere, and is supported by an overwhelming body of scientific evidence.[21] According to the

[16] U.S. Const., amend I; *see also United Mine Workers v. Illinois State Bar Ass'n*, 389 U.S. 217, 222 (1967) (asserting that right to petition for redress of grievances is among most precious of liberties without which the government could erode rights).
[17] 5 U.S.C. § 553(e).
[18] *Id*.
[19] *Massachusetts v. EPA*, 549 U.S. 497 (2007).
[20] Endangerment Finding, *supra* note 1, at 66496.
[21] This body of scientific evidence includes major climate assessments by the U.S. Global Climate Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC), and the National Research Council (NRC). Endangerment Finding, *supra* note 1, at 66497.

Intergovernmental Panel on Climate Change ("IPCC"),[22]"[w]arming of the climate system is unequivocal, as is now evident from observations of increases in global air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."[23] Additionally, the observed increase in average temperatures since the mid-20th century "is *very likely* due to the increase in anthropogenic GHG concentrations."[24] Thus, the world's leading scientific body on the subject has concluded, with greater than 90 % certainty, that emissions of GHGs are responsible for climate change.[25]

Compounding the atmospheric impact of greenhouse gases, black carbon contributes to climate change by absorbing sunlight and converting it to heat radiation, and by darkening bright surfaces such as snow and ice, reducing reflectivity.[26] According to EPA's latest *Integrated Science Assessment for Particulate Matter*, "the evidence is sufficient to conclude that a causal relationship exists between PM [of which black carbon is a primary component] and effects on climate, including both direct effects on radiative forcing and indirect effects that involve cloud feedbacks that influence precipitation formation and cloud lifetimes."[27] Because the total quantity of CO_2 in the atmosphere is greater than that of black carbon, the overall contribution of CO_2 to global warming remains more significant than that of black carbon, despite the latter's potent radiative forcing potential.[28] However, many leading experts believe that black carbon is the second or third strongest contributor to global warming and an important target of

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[22] The IPCC was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme to provide an authoritative international statement of scientific understanding of climate change.

[23] IPCC, SUMMARY FOR POLICYMAKERS: CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS; CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 5 (Feb. 2007) [hereinafter WORKING GROUP I SUMMARY FOR POLICYMAKERS].

[24] *Id.* at 10 (emphasis in original).

[25] *Id.* at 3.

[26] *See* Endangerment Finding, *supra* note 1, at 66520; Piers Forester et al., *Changes in Atmospheric Constituents and Radiative Forcing, in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP 1 TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 136, 163 (S. Solomon et al. eds., 2007).

[27] EPA, INTEGRATED SCIENCE ASSESSMENT FOR PARTICULATE MATTER, 2-29 (Dec. 2009), *available at*: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546. "Radiative forcing is a measure of how the energy balance of the Earth-atmosphere system is influenced when factors that affect climate are altered. Radiative forcing is usually quantified as the 'rate of energy change per unit area of the globe as measured at the top of the atmosphere' and is expressed in units of Watts per square meter. When radiative forcing is positive, the energy of the Earth-atmosphere system will ultimately increase, leading to a warming of the system." Piers Forster et al., *supra* note 26, at 136. Ramanathan and Carmichael found the radiative forcing of black carbon to be 0.9 Wm^{-2}, as much as 55% of the "forcing" due to carbon dioxide – a figure significantly greater than the 0.34 Wm^{-2} [± 0.25] estimated by the IPCC in its Fourth Assessment Report. *See* Ramanathan & Carmichael, *supra* note 9, at 222, and Piers Forster et al., *supra* note 26, at 207.

[28] Because black carbon is an aerosol and not a greenhouse gas, there is no standardized formula for developing global warming potentials (GWP) for black carbon. However, estimates of the GWP of black carbon over a period of 100 years vary widely. *See, e.g.,* Tami Bond & Haolin Sun, *Can Reducing Black Carbon Emissions Counteract Global Warming?*, 39 ENVTL. SCI. & TECH. 5921, 5921 (2005) (estimating the GWP of BC to be 680); Clean Air Task Force ("CATF"), Problems of Diesel, *available at* http://www.catf.us/diesel/problems ("As a global warming pollutant, black carbon is about 2,000 times more potent than the equivalent amount of CO_2 over a 20-year period.").

short-term emissions reductions.[29] According to the Clean Air Task Force, sixteen percent of the black carbon emissions in the U.S. come from off-road diesel engines, including those used in locomotives.[30]

1. Carbon dioxide is the leading cause of global warming

Carbon dioxide has been deemed "the most important anthropogenic GHG," with rapidly rising global atmospheric concentrations.[31] Since the pre-industrial period, the primary source of CO_2 emissions has been humans' ever-increasing burning of fossil fuels.[32] The latest IPCC report shows that atmospheric concentrations of CO_2 grew 80% between 1970 and 2004, by far exceeding the natural range over the last 650,000 years.[33] In 2006, the U.S. was responsible for just under 20.25% of global energy-related CO_2 emissions,[34] making it the world's second-largest emitter.[35] Although the U.S. Energy Information Administration ("EIA") projects that the U.S. share of world CO_2 emissions will decline to 18.6% through 2010, and to 15.4 % in 2030 (6,207 MMT out of a global total of 40,178 MMT), absolute emissions in the U.S. will continue to rise.[36] In 2008, fossil fuel combustion alone accounted for 94.1% of U.S. CO_2 emissions.[37] Overall energy-related CO_2 emissions in the U.S. are projected to increase to 6,320 MMTCO_2e in 2035, nearly 9% above 2008 levels (5,814 MMTCO_2e in 2008).[38]

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[29] Mark Jacobson, *Strong Radiative Heating Due to the Mixing State of Black Carbon in Atmospheric Aerosols*, 409 NATURE 695, 695 (2001); *see EPA Black Carbon and Global Warming: Hearing Before the H. Comm. on Oversight and Gov't. Reform*, 110th Cong. 12-29 (2007) [hereinafter *Hearing*] (statement of Mark Z. Jacobson, Professor, Stanford University); Mark Jacobson, *Correction to 'Control of Fossil Fuel Particulate Black Carbon and Organic Matter, Possibly the Most Effective Method of Slowing Global Warming*,' 110 J. GEOPHYSICAL RES. D14105 (2005); Ramanathan & Carmichael, *supra* note 9, at 222, 227.

[30] CATF, Problems of Diesel, *supra* note 28.

[31] WORKING GROUP I SUMMARY FOR POLICYMAKERS, *supra* note 23, at 2.

[32] *Id*.

[33] *Id*.

[34] Calculation derived from Climate Analysis Indicators Tool (CAIT) Version 7.0 (Washington, DC: World Resources Institute, 2010), *available at* http://cait.wri.org. *See* tool documentation, World Resources Institute, CAIT: INDICATOR FRAMEWORK PAPER, at 12, (Dec. 2009) *available at* http://cait.wri.org/downloads/framework_paper.pdf. *See also* Energy Information Administration ("EIA"), International Energy Statistics, *available at* http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8. For 2006 global data and analysis, see EIA, EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 2008, DOE/EIA-0573, Table 3 at 8, (Dec. 2009) *available at* www.eia.doe.gov/oiaf/1605/ggrpt/pdf/0573(2008).pdf. According to the U.S. EPA , the U.S. accounted for approximately 19 percent of global carbon dioxide emissions from the combustion of fossil fuels in 2008. EPA INVENTORY, *supra* note 3, at ES-6.

[35] Only China emitted more CO_2 from energy-related fossil fuel consumption than the U.S., releasing 21.5% of the global total. See EIA, International Energy Statistics, *supra* note 34.

[36] EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 2008, *supra* note 34, Table 3 at 8.

[37] EPA INVENTORY, *supra* note 3, at ES-6.

[38] EIA, ANNUAL ENERGY OUTLOOK 2010 WITH PROJECTIONS TO 2035, 82, Table 19 ("Energy Related Carbon Dioxide Emissions by End-Use") (Apr. 2010) [hereinafter AEO 2010]. These recent projections, based on the EIA's "Reference Scenario," are significantly lower than those presented on the Department of Transportation ("DOT") website. *See* Transportation GHG Emissions and Trends, *available at* http://climate.dot.gov/ghg-inventories-forcasts/national/us-inventory-structure.html#fore (projecting that energy-related carbon dioxide emissions in 2030 will reach 7, 650 MMT, 23% above projected 2010 levels of 6,214 MMT CO_2e).

One of the major sources of such emissions is the transportation sector, which comprised 32% of carbon dioxide emissions from fossil fuel combustion and 27% of overall U.S. GHG emissions in 2008.[39] The IPCC expects GHG emissions from global transport to increase 80 % between 2002 and 2030.[40] According to the EPA, GHG emissions from the U.S. transportation sector, which today represent approximately 10% of energy-related GHG emissions worldwide, could also increase by as much as 80% above current levels over the next 50 years, if vehicle and fuel technologies are not deployed to slow or halt this trajectory.[41] Within the transportation sector, emissions from locomotives are projected to rise more quickly than those from other sources and will comprise a growing share of transportation-related greenhouse gases. GHG emissions from freight rail are projected to be 55.4 $MMTCO_2e$ in 2030, a 13.5% increase over 2007 levels.[42] Passenger rail CO_2e emissions are projected to increase 24.7% over the same time period, from 6.6 to 8.2 $MMTCO_2e$ by 2030.[43]

2. Black carbon is a potent warming agent

In addition to being a leading cause of carbon dioxide emissions, the burning of fossil fuels is also a major contributor to annual global emissions of black carbon.[44] Diesel engines, such as those used in passenger and freight trains, are among the chief sources of black carbon in the U.S.,[45] making diesel combustion a prime target for reduction efforts.[46] As black carbon absorbs not only reflected but also direct solar radiation, "together the two processes contribute to a significant enhancement of lower atmosphere solar heating" by as much as 50% in certain regions of the world.[47]

One of black carbon's most pernicious effects on climate is its contribution to the melting of sea ice and glaciers by reducing the reflectivity of snow and ice. The direct and indirect warming effects of black carbon may make it an important contributor to the

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[39] EPA INVENTORY, *supra* note 3, at ES-8, 2-21.These transportation sector emissions figures exclude emissions from international bunker fuels: "If emissions from international bunker fuels are included, the transportation end-use sector accounted for 35 percent of U.S. emissions from fossil fuel combustion in 2008." EPA INVENTORY, at ES-8, n 11. The Energy Information Administration estimates that the transportation sector was responsible for 33.1% of energy-related carbon dioxide emissions in the U.S. in 2008. EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 2008, *supra* note 34, at 2.
[40] IPCC, CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE; CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 357 (May 2007).
[41] DOT, A WEDGE ANALYSIS OF THE U.S. TRANSPORTATION SECTOR (Oct. 2007) *available at* http://www.epa.gov/oms/climate/420f07049.htm.
[42] DOT, TRANSPORTATION'S ROLE IN REDUCING U.S. GREENHOUSE GAS EMISSIONS VOLUMES 1 AND 2, Table 2.3, 2-28 (Apr. 2010) [hereinafter TRANSPORTATION'S ROLE].
[43] *Id.*
[44] Ramanathan & Carmichael, *supra* note 9, at 221.
[45] *Hearing*, *supra* note 29, at 74 (statement of Charles Zender, Associate Professor, University of California at Irvine) [hereinafter Zender].
[46] Dorothy Koch et al., *Global Impact of Aerosols from Particular Source Regions and Sectors*, 112 J. GEOPHYSICAL RESEARCH D02205, at 18 (2007).
[47] *Id*.

retreat of Arctic sea ice.[48] Snow and ice contaminated with black carbon heat the Arctic surface very efficiently due to strong Arctic temperature inversions and the insulating properties of snow.[49] During springtime, black carbon's direct warming effect on snow can be three times as strong as carbon dioxide.[50] Because of its combined heating of the Arctic atmosphere and surface, some leading experts believe black carbon warms the Arctic more than any other agent except carbon dioxide.[51]

The climate impacts of black carbon are not limited to the Arctic, however. By some estimates, black carbon may be responsible for as much as 25 % of observed global warming over the past century.[52] Unlike GHGs, which are well-mixed due to their long atmospheric lifetimes, black carbon remains in the atmosphere for a relatively brief period and is thus not well-mixed.[53] Precisely because of its short lifetime, many scientists believe black carbon mitigation offers the greatest chance of slowing down climate change in the short term. Reducing black carbon emissions can lead to rapid declines in radiative forcing, reducing warming within weeks.[54] Because of the strong temporal element to avoiding a global average temperature increase of more than two degrees, short-term reduction of pollutants that contribute to climate change is of critical importance.

Black carbon also influences the behavior of aerosols, such as sulfates, that are traditionally credited with a "cooling" influence when they occur in isolation. The reduction of sulfates without a concurrent reduction of black carbon not only removes their cooling influence, but also "unmasks" the heating due to black carbon.[55] Thus, as determined by a recent study, a higher ratio of black carbon to sulfates is associated with a stronger warming effect of black carbon.[56] These findings suggest that $PM_{2.5}$ reduction strategies which focus on lowering sulfur levels in ambient PM without seeking close-to-equivalent reductions in black carbon may inadvertently increase the ratio of black

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48 Ramanathan & Carmichael, *supra* note 9, at 224.
49 Zender, *supra* note 45, at 72; *see also*, P.K. Quinn et al., S*hort-lived Pollutants in the Arctic: Their Climate Impact and Possible Mitigation Strategies*, 8 ATMOSPHERIC CHEMISTRY & PHYSICS 1723, 1731 (2008).
50 *See* Zender, *supra* note 45, at 73; *see also* M. Flanner et al., *Present-Day Climate Forcing and Response from Black Carbon in Snow*, 112 J. GEOPHYSICAL RES. D11202 at 15 (2007) ("BC snowpack can provoke disproportionately large springtime climate response because the forcing tends to coincide with the onset of snowmelt, thus triggering more rapid snow ablation and snow-albedo feedback.").
51 Zender, *supra* note 45, at 73.
52 GODDARD INSTITUTE FOR SPACE STUDIES, BLACK SOOT AND SNOW: A WARMER COMBINATION (2003), *available at:* http://www.gcrio.org/OnLnDoc/pdf/black_soot.pdf.
53 BAHNER ET AL, RTI INT'L, & DEANGELO, EPA, USE OF BLACK CARBON AND ORGANIC CARBON INVENTORIES FOR PROJECTIONS AND MITIGATION ANALYSIS 1, 2 (n.d.), *available at*: www.epa.gov/ttn/chief/conference/ei16/session3/k.weitz.pdf.
54 KAREN BICE ET AL., PRINCETON U. WOODROW WILSON SCHOOL OF PUBLIC & INT'L AFFAIRS, BLACK CARBON: A REVIEW AND POLICY RECOMMENDATIONS WWS591E, at 1, 3 (2009) *available at* http://www.wws.princeton.edu/research/PWReports/F08/wws591e.pdf; *see also Hearing, supra* note 29, at 17 (statement of Mark Z. Jacobson, Professor, Stanford University).
55 BICE ET AL, *supra* note 54, at 10.
56 *See* M.V. Ramana et al., *Warming Influenced by the Ratio of Black Carbon to Sulphate and the Black-Carbon Source,* NATURE GEOSCIENCE 3, 542-545, DOI: 10.1038/NGE0918 (July 25, 2010) (published online).

carbon to sulfates in the PM mix, thereby intensifying black carbon-induced heating. The same study showed that fossil fuel-dominated plumes of black carbon are approximately twice as efficient warming agents as plumes caused by biomass burning, underscoring the urgent need to reduce black carbon emissions from sources like locomotive diesel engines.

A second consideration relating to sulfates arises from the fact that they rarely occur in isolation. Instead, they are often combined with other particles like black carbon.[57] When sulfates combine with carbon particles by coating their surfaces, black carbon's warming effect is increased because the lens-like coating allows light to focus more intensely onto the black carbon particle. Lowering the overall black carbon levels will counteract the warming effect of black carbon particles that are internally mixed with sulfates.

Thus, reducing black carbon must be an essential component of any policy to address climate change.

3. EPA has Determined That GHGs Endanger Public Health and Welfare.

In December 2009, the EPA issued "Endangerment and Cause or Contribute Findings for Greenhouse Gases," which unequivocally state that six directly-emitted, long-lived and well-mixed greenhouse gases[58] "endanger both the public health and public welfare of current and future generations."[59] This conclusion is "compellingly" supported by a wide body of scientific evidence.[60] As EPA has established, changes in climate caused by GHG emissions from anthropogenic sources have profound implications for human life and endanger public health and welfare, posing risks that are expected to increase over time.[61]

EPA has identified that increased ambient concentrations of CO_2 and other GHGs, the projected rise in temperatures and sea levels worldwide, and the increased frequency and intensity of extreme weather events will have adverse impacts on public health, increasing both morbidity and mortality.[62] For instance, intense heat waves and ground-level concentrations of pollutants exacerbate the risks and severity of respiratory infections, asthma aggravation, allergy symptoms, chest pain, and heat-related deaths. Also, extreme weather events resulting from climate change may result in greater casualties from fires, storms, and floods, diminishing freshwater resources and creating

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[57] Ramana et al., *supra* note 56, at 542; *see Hearing, supra* note 29, at 2 (statement of Mark Z. Jacobson, Professor, Stanford University).
[58] The six named greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbon (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
[59] Endangerment Finding, *supra* note 1, at 66496.
[60] *Id.*
[61] Endangerment Finding, *supra* note 1, at 66499.
[62] Endangerment Finding, *supra* note 1, at Section IV(B), 66523-536.

conditions for increased malnutrition and the spread of infectious diseases.[63] As with other forms of air pollution, certain vulnerable segments of the population, such as children with asthma, the elderly and the poor, are the most likely to be affected.[64] Future warming is also projected to increase heat-related mortality and morbidity, especially among these vulnerable groups.[65] Furthermore, EPA has found that "[c]limate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death."[66]

EPA has also found that greenhouse gases and resulting climate change endanger public welfare, for both current and future generations, through a host of adverse effects, including: enhanced pest and weed growth leading to lower crop yields; higher temperatures reducing livestock production and increasing the frequency of forest fires, insect-outbreaks, and tree mortality; more intense precipitation and more droughts, disrupting food production and leading to crop failure; warmer water temperatures and increased risk of floods, runoff and erosion, affecting water quality; diminished snow pack and increased evaporation, affecting seasonal water availability; elevated sea levels, exacerbating impacts of storm-surge flooding and shoreline erosion and compromising sources of drinking water; increased storm severity, threatening coastal habitats and communities, dependent species and water infrastructure; elevated ocean acidification; and increased habitat fragmentation.[67] In short, allowing concentrations of atmospheric GHGs to continue to rise will ensure increased harm on society.[68]

4. Emissions of Black Carbon Endanger Public Health and Welfare.

Black carbon presents a threat to public health and welfare both through its contribution to global warming, and as a key component of PM, particularly diesel PM, which has been shown to increase rates of morbidity and mortality in exposed populations. Conscious of the local and global impacts of black carbon on public health and the environment, the Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010, directed the EPA Administrator to carry out and submit to Congress the results of a study on domestic and international black carbon emissions. EPA's draft Strategic Plan 2011-2015 indicates that the agency is developing "a comprehensive report to Congress on black carbon that will provide a foundation for evaluating future approaches to black carbon mitigation."[69] The report, due in April 2011, will inventory major sources of black carbon, assess its impacts on global and regional climate, assess potential metrics and approaches for quantifying the climatic effects,

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[63] *Id.* at 66525. *See also* IPCC, SUMMARY FOR POLICYMAKERS: CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY, WORKING GROUP II CONTRIBUTION TO THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE FOURTH ASSESSMENT REPORT Chapter 8 ("Human Health") (Apr. 2007).
[64] Endangerment Finding, *supra* note 1 at 66498, 66526 (emphasizing that certain groups, including children, the elderly, and the poor, are most vulnerable to climate-related health effects).
[65] Endangerment Finding, *supra* note 1, at 66524-525.
[66] *Id.* at 66525.
[67] *Id.*
[68] *See* IPCC, CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, TECHNICAL SUMMARY (2007).
[69] EPA DRAFT STRATEGIC PLAN, *supra* note 5, at 8.

identify the most cost-effective approaches for reductions, and analyze the climatic effects and other environmental and public health benefits expected to result from the identified approaches.

Scientific evidence has established that black carbon – an airborne form of PM generated from the incomplete combustion of fossil fuels, biofuels, and biomass – has detrimental impacts on global climate. EPA "recognizes that black carbon is an important climate forcing agent and takes very seriously the emerging science on black carbon's contribution to global climate change in general and the high rates of observed climate change in the Arctic in particular."[70] This recognition is reflected in the Agency's recent call for proposals regarding research into black carbon's effects on climate and air quality.[71]

As a component of fine particulate matter ($PM_{2.5}$), black carbon is often transported over hundreds to thousands of kilometers, mixing with other aerosols along the way to form transcontinental plumes of atmospheric brown clouds. These clouds consequently dim the Earth's surface, affecting the hydrological cycle and fueling increases in atmospheric humidity and rainfall.[72] These impacts, coupled with the warming caused by black carbon's absorption of incoming and reflected sunlight and darkening of bright surfaces such as snow and ice, contribute significantly to the health and welfare threats posed by climate change.

In addition to the effects on public health and welfare caused by black carbon's role in global warming, an extensive body of scientific studies shows a wide spectrum of adverse health effects associated with exposure to ambient particulate matter, of which diesel exhaust and its black carbon particulates are important components.[73] Diesel exhaust, which contains a higher fraction of black carbon than most other PM sources, has been classified by EPA as a likely human carcinogen.[74] As a subcomponent of fine particulate matter ($PM_{2.5}$), small enough to be inhaled into the deepest parts of the lung, black carbon poses a danger to public health. EPA has recognized the unique impacts of individual $PM_{2.5}$ components, like black carbon, stating that no component can be eliminated as a key contributor to adverse health effects.[75]

Short- and long-term exposure to $PM_{2.5}$ emissions has been causally associated with: aggravated asthma, acute respiratory symptoms like coughing and difficulty breathing, chronic bronchitis, decreased lung function, changes in heart rate rhythm and

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[70] Endangerment Finding, *supra* note 1, at 66520.
[71] *See*, Black Carbon's Role in Global to Local Scale Climate and Air Quality: EPA-G2010-STAR-L1, (at http://www.epa.gov/ncer/rfa/2010/2010_star_blackcarbon.html) (May 19, 2010).
[72] *Id.* *See also* Ramanathan & Carmichael, *supra* note 9, at 223.
[73] Locomotive and Marine Engines Final Rule, *supra* note 7, 73 Fed. Reg. at 37105-113. *See also* WORLD HEALTH ORGANIZATION, WHO REPORT BY WORKING GROUP IN BONN, GERMANY: HEALTH ASPECTS OF AIR POLLUTION WITH PARTICULATE MATTER, OZONE AND NITROGEN DIOXIDE (Jan. 2003).
[74] Endangerment Finding, *supra* note 1, at 66520; Locomotive and Marine Engines Final Rule, *supra* note 7, 73 Fed. Reg. at 37109.
[75] TERRY J. KEATING & MARCUS SAROFIM, EPA OFFICE OF AIR & RADIATION, BLACK CARBON 101, at 4 (Mar. 6, 2009).

other cardiac effects, and premature mortality in people with heart and lung disease.[76] Particulate matter increases have also been associated with decreased reactivity in diabetes sufferers.[77] A 2005 report by the Clean Air Task Force estimated that nearly 21,000 people will die prematurely in 2010 in the U.S. as a result of exposure to fine particle emissions from mobile diesel sources, which include rail as well as other on-road and non-road engines.[78]

Beyond impacts on human health, EPA has found that "emissions from locomotive and marine diesel engines cause harm to public welfare, including contributing to visibility impairment and other harmful environmental impacts across the U.S."[79] Thus, reducing black carbon emissions would have significant direct and indirect benefits for public health and welfare.[80]

B. Locomotives Are a Significant Source of GHGs and Black Carbon

1. Locomotives Emit GHGs and Have a Significant and Increasing Impact on Global Warming.

Locomotive emissions of GHGs are composed of approximately 94.66% carbon dioxide, 4.5% hydrofluorocarbons, and less than 1% each of nitrous oxide and methane.[81] These emissions contribute to global warming as byproducts of fuel consumption—indeed, 92 % of locomotive GHG emissions are from the combustion of diesel fuel.[82] EPA ranks "diesel locomotives" as the second-most important nonroad engine producing the greatest CO_2 emissions, after "nonroad diesel."[83]

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[76] *Id. See also* U.S. EPA, INTEGRATED SCIENCE ASSESSMENT FOR PARTICULATE MATTER (Dec. 2009), *available at:* http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546; U.S. EPA, OFFICE OF AIR QUALITY PLANNING AND STANDARDS STAFF PAPER: REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARD FOR PARTICULATE MATTER: POLICY ASSESSMENT OF SCIENTIFIC AND TECHNICAL INFORMATION (Dec. 2005), *available at* http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20051221.pdf.

[77] EPA, Provisional Assessment of Recent Studies on Health Effects of Particulate Matter Exposure (Jul. 2006) *available at* http://www.epa.gov/articles/pdfs/ord_report_20060720.pdf.

[78] CONRAD G. SCHNEIDER, L. BRUCE HILL, CLEAN AIR TASK FORCE, DIESEL AND HEALTH IN AMERICA: THE LINGERING THREAT, 5 (Feb. 2005).

[79] EPA, Summary and Analysis of Comments: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder Chapter 2 ("Air Quality and Health Impacts") at 2-1, 2-2, *available at*: http://www.epa.gov/oms/regs/nonroad/420r08006.htm.

[80] *See* STATE AND TERRITORIAL AIR POLLUTION PROGRAM ADMINISTRATORS & ASSOC. OF LOCAL AIR POLLUTION CONTROL OFFICIALS, CANCER RISK FROM DIESEL PARTICULATE: NATIONAL AND METROPOLITAN AREA ESTIMATES FOR THE U.S. (Mar. 15, 2000), *available at* http://www.4cleanair.org/comments/Cancerriskreport.PDF.

[81] EPA INVENTORY, *supra* note 3, at 2-22.

[82] EPA, GREENHOUSE GAS EMISSIONS FROM THE U.S. TRANSPORTATION SECTOR 1990-2003 (Mar. 2006) at 25 [hereinafter GHGS FROM THE TRANSPORTATION SECTOR]. *See also*, TRANSPORTATION'S ROLE, *supra* note 42, at Volume 1: Synthesis Report, 2-14.

[83] Advanced Notice of Proposed Rulemaking, Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44354, 44462 (Jul. 30, 2008). The "nonroad diesel" category includes recreational, construction and mining, industrial, lawn and garden, farm, commercial, logging, airport service, railway maintenance, and recreational marine vessels. *See* EPA, What are mobile sources?, http://www.epa.gov/oms/invntory/overview/examples.htm.

In consuming more than 4 billion gallons of diesel fuel per year, locomotives nationwide emit significant amounts of CO_2, the primary GHG produced by anthropogenic activities in the United States and globally.[84] Today, locomotives contribute almost one percent of the United States' total CO_2 emissions, and approximately 2.4% of such emissions from the transportation end-use sector.[85] More than 13 % of all off-road CO_2 emissions currently come from locomotives.[86] The Department of Energy ("DOE") reports that annual energy-related CO_2 emissions from freight and passenger rail in 2008 amounted to 47.46 $MMTCO_2$ with 41.62 $MMTCO_2$ from freight locomotive fuel consumption alone.[87]

Moreover, GHG emissions from locomotives are anticipated to increase substantially in the coming decades because of a projected growth in locomotive freight transport in the United States.[88] The U.S. Department of Transportation ("DOT") estimates that demand for rail freight transportation in the United States will increase by two percent annually from 2000 to 2020, resulting in significant annual growth in locomotive fuel consumption, miles traveled, and units of operation.[89] According to DOE, CO_2 emissions from locomotives (both freight and passenger) are expected to rise to 55.49 $MMTCO_2e$ in 2030 – an increase of nearly 17% over 2008 levels.[90] In 2030,

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[84] *See* TRANSPORTATION'S ROLE, *supra* note 42, at Vol. 2, 3-87; DOT, Research and Innovative Technology Administration, Bureau of Transportation Services, Class I Rail Freight Fuel Consumption and Travel (2008) at Table 4-17, *available at* http://www.bts.gov/publications/national_transportation_statistics/2008/html/table_04_17.html (last visited Jul. 28, 2010). *See, e.g.,* EPA, "Locomotive Switcher Idling and Idle Control Technology" Factsheet (Jun. 2005). Compared to rail freight locomotives, which consume an average of 3.5 billion gallons of fuel per year, switchyard locomotives can consume 120 million gallons of fuel a year, burning 24,000 gallons just through 4,000 hours of idling per year.

[85] U.S. GHG emissions from all sources totaled 7,052.6, $MMTCO_2e$ in 2008. *See* DOE, Energy Information Administration, Emissions of Greenhouse Gases in the United States 2008, DOE/EIA-0573(2008) (Dec. 2009) at 1-2; *see also* American Association of Railroads, POLICY & ECON. DEP'T, FREIGHT RAILROADS OFFER A SMART, EFFECTIVE WAY TO REDUCE GHG EMISSIONS, 1, (May 2010) *available at* http://www.aar.org/environment/%7E/media/aar/backgroundpapers/freightrailroadsofferasmarteffectivewaytoreducegreenhousegasemissions.ashx (last visited Jul. 28, 2010). Transportation was the second largest source of energy-related CO_2 emissions, accounting for 33.1%, or 1,925.3 $MMTCO_2$. Total transportation GHG emissions amounted to 1,946$MMTCO_2e$. DOE, EIA 2008 at 2, 4.

[86] Calculation derived from AEO 2010, *supra* note 38, Table A19 ("Energy Related Carbon Dioxide Emissions by End Use"), at 144. Non-road engines include rail, shipping, boats, air and military use.

[87] AEO 2010, *supra* note 38, at 144 (Table A19).

[88] In 2003, about 89 percent of rail GHGs were from freight haulage. *See* GHGS FROM THE TRANSPORTATION SECTOR, *supra* note 82, at 25.

[89] ICF Consulting, Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level, Final Report, Chapter 2, Section 2, Table 2-5 (Apr. 2005), *prepared for* DOT Federal Highway Administration, *available at* http://www.fhwa.dot.gov/environment/freightaq/index.htm#toc (last visited Jul. 28, 2010). ICF notes that the most rapid growth is expected to occur in the air freight sector (4 percent annual growth), followed by trucking (2.5 percent) and then rail.

[90] AEO 2010, *supra* note 38, at 144 (Table A19). Numbers reflect the combined CO_2 emissions from freight and passenger rail.

locomotives will thus account for about 14 % of CO_2 emissions from non-road engines nationwide.[91]

This projection is in accord with long-term trends showing locomotives as an increasing source of GHGs. Since 1990, EPA has documented a steady increase in GHG emissions and CO_2 emissions, in particular, from locomotives.[92] According to the DOT, fuel consumed by freight rail has steadily increased from 2.9 billion gallons in 1991 to 4.2 billion gallons in 2006.[93] This fuel consumption is expected to increase to 5.4 billion gallons in 2030.[94] Miles traveled by freight trains and locomotive units have similarly increased from 375 million and 1.2 billion miles, respectively, in 1991, to 524 million and 1.6 billion miles in 2008.[95] Miles traveled are expected to increase to 2.2 billion miles in 2030.[96] The number of locomotives in operation has also increased over the past decade.[97] Even in 1998, EPA had already projected a 5.1% increase in the annual growth rate of locomotive diesel engines.[98]

Market demands within the United States facilitate these increases. EPA has identified several factors contributing to the growth in rail shipments beginning in 1990, including economic expansion, steady increases in coal shipments and demand for bulk commodities, such as chemicals, lumber and wood products, and farm products, which rely heavily on rail transport.[99] Passenger rail services have also grown significantly, with a number of light-rail and commuter rail lines coming into service or expanding operations.[100]

A further increase in GHG emissions from locomotives may occur due to efficiency losses as a result of technology and practices that reduce other air pollutants. For instance, nitrogen oxide (NO_x) emissions from locomotives can be inversely related

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[91] Calculation derived from AEO 2010, Table A19, at 144. Non-road engines include rail, shipping, boats, air and military use.
[92] GHGS FROM THE TRANSPORTATION SECTOR, *supra* note 82, at 49-50. This is EPA's most current report on GHG emissions in the U.S. transportation sector. *See also* EPA INVENTORY, *supra* note 3, at 2-20-2-21.
[93] DOT, Research and Innovative Technology Administration, Bureau of Transportation Services, National Transportation Statistics (2010) at Table 4-25: Energy Intensity of Class I Railroad Freight Service, *available at* http://www.bts.gov/publications/national_transportation_statistics/html/table_04_25.html.
[94] DOE, ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2009 WITH PROJECTIONS TO 2030, UPDATED ANNUAL ENERGY OUTLOOK 2009 REFERENCE CASE WITH ARRA, Table 7 (Mar. 2009) [hereinafter AEO 2009]. According to the latest AEO figures, locomotive fuel consumption will reach 0.36 million barrels per day oil equivalent in 2030 – more than 15 million gallons of diesel fuel per day, and over 5.4 billion gallons per year.
[95] DOT, National Transportation Statistics, *supra* note 93, at Table 4-17: Class I Rail Freight Fuel Consumption and Travel, *available at* http://www.bts.gov/publications/national_transportation_statistics/html/table_04_17.html.
[96] AEO 2010, *supra* note 38, at 122 (Table A7).
[97] DOT, National Transportation Statistics, Table 4-17, *supra* note 93.
[98] GARY J. DOLCE, EPA OFFICE OF MOBILE SOURCES, NONROAD ENGINE GROWTH ESTIMATES, REPORT NO. NR-008 1, 3 (1998), *available at* http://www.epa.gov/otaq/models/nonrdmdl/nr-008.pdf.
[99] GHGS FROM THE TRANSPORTATION SECTOR, *supra* note 82, at 25.
[100] *Id.* at 26.

to CO_2 emissions from diesel fuel consumption.[101] Consequently, current locomotive standards requiring NO_x reductions give rise to increases in GHG emissions. Although lower combustion temperatures and pressure levels are conducive to reductions in NO_x formation, cooler engine chambers tend to be out of the range of ideal CO_2 forming conditions.[102] Thus, while locomotives lower NO_x emissions, emissions of CO_2 and other GHGs continue to increase.[103] Therefore, despite existing emissions standards reducing emissions of this criteria pollutant, because EPA does not currently regulate GHG emissions from any nonroad engines, total GHG emissions from locomotives will continue to climb.

In short, there is an unrelenting demand for increased locomotive transport of both passengers and goods – a demand that appears undeterred by escalating fuel prices and minimal gains in fuel efficiency. While the fuel economy of Class I railroads reportedly increased about 1.6 % annually from 1990 to 2003,[104] significant gains in locomotive fuel efficiency have not continued and are not expected in the future. The DOE calculates rail fuel efficiency at 3.1 ton miles per thousand Btu in 2008 and expects it to increase to only 3.2 ton miles per thousand Btu by 2030.[105] This fuel efficiency is equivalent to approximately 430 ton-miles per gallon of diesel fuel. Given the anticipated expansion in rail use in the United States, CO_2 emissions from locomotives could grow by at least seven percent by mid-century, making locomotives a significant source of GHGs with increasing climate consequences.

2. Black Carbon Emissions from Locomotives are Significant and Increasing.

Globally, transportation accounts for 25% of all black carbon emissions, and diesel engines account for 70% of that global quarter. Off-road transport, including locomotives, is responsible for 9% of global black carbon.[106] In the United States, diesel engines are estimated to be the largest source of black carbon emissions.[107] Locomotive diesel emissions constitute between 2.5 and 3.3% of total U.S. black carbon emissions.[108]

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[101] *See* Comments by the Passenger Vessel Association on docket no. EPA-HQ-OAR-2003-0l90. *See* also Energy Conversions Inc., Emissions and Natural Gas Locomotives: Technical Bulletin, *available at* http://www.energyconversions.com/locoemis.htm.
[102] *See* Energy Conversions Inc., *supra* note 101.
[103] *Id. See also* LOCOMOTIVE RIA, *supra* note 6, at 4-15 (noting how the use of exhaust gas recirculation will decrease NO_x formation but increase CO_2 and water vapor concentrations).
[104] GHGS FROM THE TRANSPORTATION SECTOR, *supra* note 82, at 26 (2006) (citing Association of American Railroads ("AAR"), Railroad Facts (2004) at 40).
[105] AEO 2010, *supra* note 38, at 122 (Table A7). *But see* DOT, TRANSPORTATION'S ROLE, *supra* note 42, at Vol. 2, 3-88 ("Locomotives have become about 16 percent more efficient over the last decade, and currently emit approximately 24 g CO_2e/ton-mile. DOE initiated a program in 2002 to improve rail fuel efficiency by 25 percent by 2010 and 50 percent by 2020 (relative to the 2002 base year), on a gallons per revenue ton-mile basis.").
[106] DIESEL TECHNOLOGY FORUM, CLIMATE CHANGE, BLACK CARBON, AND CLEAN DIESEL, 1 (Oct. 2009), *available at*: http://www.dieselforum.org/news-center/pdfs/Black%20Carbon_FINAL.pdf.
[107] BAHNER, *supra* note 53 at 1. *See also* KEATING & SAROFIM, *supra* note 75. In 2002, diesel engines emitted the greatest amount of black carbon of any source, more than 250,000 tons per year.
[108] Battye et al., *supra* note 10, at Table 4.

The percentage of black carbon in $PM_{2.5}$ emitted by diesel engines is not uniform, but varies depending on temperature, ventilation and other factors affecting the efficiency of combustion.[109] However, studies suggest that black carbon typically constitutes over 60% of the content in diesel particulate matter emitted by locomotive diesel engines.[110] The remaining fumes mostly consist of high levels of NO_x, sulfur dioxide and volatile organic compounds.[111] Upon emission into the atmosphere, the components of diesel particulate matter react to form $PM_{2.5}$.[112] Thus, in urban and rural areas across the U.S., carbonaceous elements, which include black carbon, are major contributors to ambient $PM_{2.5}$.[113] Carbonaceous $PM_{2.5}$ is responsible for over half of ambient $PM_{2.5}$ concentrations in the Northwest and nearly half in the Southwest.[114] Accordingly, EPA has found that locomotive engines contribute significantly to ambient $PM_{2.5}$ levels (and non-attainment of National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$), largely through direct emissions of carbonaceous $PM_{2.5}$.[115]

EPA reports that diesel exhaust typically comprises 10% of $PM_{2.5}$, with data showing up to 36% diesel PM.[116] For example, the California Air Resources Board (CARB) estimates that diesel PM makes up 10% of statewide $PM_{2.5}$ emissions.[117] Currently, locomotives and marine diesel engines account for 25 percent of mobile source diesel $PM_{2.5}$ emissions in the United States.[118] In 2001, locomotive engines contributed 20,137 tons of diesel $PM_{2.5}$, amounting to almost five percent of the national

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[109] NOVAKOV ET AL., ERNEST ORLANDO LAWRENCE BERKELEY NAT'L LABORATORY, LARGE HISTORICAL CHANGES OF FOSSIL-FUEL BLACK CARBON AEROSOLS, 3 (Sept. 2002), *available at* http://ies.lbl.gov/drupal.files/ies.lbl.gov.sandbox/50881.pdf.

[110] According to Bond, T.C. et al, *A Technology Based Global Inventory of Black and Organic Carbon Emissions From Combustion*, 109 J. GEOPHYSICAL RESEARCH, D14203, at 15, black carbon makes up 66% of the fine particulate matter generated by diesel fuel combustion. *See also* EPA, HEALTH ASSESSMENT DOCUMENT FOR DIESEL ENGINE EXHAUST, EPA/600/8-90/057F, 2-70 (May 2002) (presenting data on the percentage of elemental carbon in diesel exhaust) [hereinafter EPA, HEALTH ASSESSMENT DOCUMENT] *available at* www.epa.gov/ttn/atw/dieselfinal.pdf.

[111] Health and Safety Executive, Diesel Engine Exhaust Emissions (Jun. 2, 1999), *available at* http://www.hse.gov.uk/pubns/indg286.htm. In general, products of combustion include: black carbon, nitrogen, water, carbon monoxide, aldehydes, nitrogen dioxide, sulfur dioxide, and polycyclic aromatic hydrocarbons.

[112] EPA, HEALTH ASSESSMENT DOCUMENT, *supra* note 110, at 2-1.

[113] LOCOMOTIVE RIA, *supra* note 6, at 2-6.

[114] *Id*.

[115] *See id*. at 2-6, 2-10. EPA notes that, "While we believe that the mobile source sector is a substantial contributor to total $PM_{2.5}$ mass, our current mobile source inventory is likely underestimated and information on control measures is incomplete." *Id.* at 2-7, n. A.

[116] EPA, HEALTH ASSESSMENT DOCUMENT, *supra* note 110, at 9-19, 1-2 ("Nationwide, data in 1998 indicated that DE [diesel exhaust] as measured by DPM [diesel particulate matter] made up about 6% of the total ambient PM2.5 inventory (i.e., particles with aerodynamic diameter of 2.5 micrometers or less) and about 23% of the inventory, if natural and miscellaneous sources of PM2.5 are excluded. Estimates of the DPM percentage of the total inventory in urban centers are higher.").

[117] California Environmental Protection Agency Air Resources Board, HEALTH EFFECTS OF DIESEL EXHAUST PARTICULATE MATTER, 2 (2008), *available at* www.arb.ca.gov/research/**diesel**/dpm_health_fs.pdf.

[118] 73 Fed. Reg. 37097.

mobile source inventory.[119] Although rail $PM_{2.5}$ emissions are expected to decrease annually past 2015 because of current regulations targeting particulate matter, by 2030, locomotives are projected to contribute 8.3% of the national mobile source $PM_{2.5}$ inventory.[120]

Moreover, in the longer term, EPA expects $PM_{2.5}$ emissions to rise in this sector absent additional regulation, largely because of the growth expected in the nonroad sector (as discussed above).[121] Because of the growth expected in rail transportation, locomotive particulate matter emissions and emissions of black carbon will increase.

C. Existing and Developing Technologies Can Enable Locomotive Manufacturers and Operators to Greatly Decrease Their GHG Emissions.

1. Existing, Feasible, and Cost-Effective Technologies Can Reduce GHG and Black Carbon Emissions from Locomotives.

A great number of technologies currently exist that, if implemented in new locomotives and new locomotive engines, could significantly reduce GHG emissions and black carbon from these sources. The Department of Transportation has found that significant efficiency gains and GHG reductions could be achieved through power system modifications, improvements to line-haul locomotives and train sets, and rail modal diversion, using technologies that are commercially available and that would pay for themselves in less than ten years through fuel savings alone.[122] In EPA's Advanced Notice of Proposed Rulemaking ("ANPR") regarding the regulation of GHGs under the Clean Air Act, from July 30, 2008,[123] the Agency acknowledged a number of these technologies.[124] Furthermore, in a report from August 2009, CARB also noted several measures that could be taken to reduce GHG emissions from locomotives.[125] All of these

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[119] EPA, FINAL REGULATORY IMPACT ANALYSIS: CONTROL OF EMISSIONS FROM NONROAD DIESEL ENGINES, EPA420-R-04-007, Table 3.1-6a, at 3-19 (May 2004).

[120] *Id.* Table 3.2-1 at 3-32. It should be noted that these projections may be altered by the implementation of the locomotive and marine diesel engine rule adopted in May 2008.

[121] *Id.* at 3-61.

[122] See DOT, TRANSPORTATION'S ROLE, *supra* note 42, at Vol. 2, Sections 3.5 and 4.4. "GHG reductions are possible through the use of GenSet and hybrid locomotives in rail yards (35 to 60 percent per locomotive), as well as through improvements to line-haul locomotives and train sets, including more efficient line-haul locomotives (10 to 20 percent improvement), lightweight cars, aerodynamic improvements, wheel-to-rail lubrication technologies, and drive system operation (22 to 31 percent combined improvement per train). All of these technologies are commercialized and available for immediate use, although some must be phased in over time as fleet turnover occurs. While incurring higher up-front capital costs, most of these strategies have the potential to pay for themselves in less than 10 years through fuel cost savings." *See also*, Manufacturers of Emission Controls Association (MECA), Case Studies of the Use of Exhaust Emission Controls on Locomotives and Large Marine Diesel Engines September 2009, *available at* http://www.meca.org/galleries/default-file/Loco%20Marine%20Case%20Studies%20update%200909.pdf.

[123] ANPR, 73 Fed. Reg. 44354.

[124] *Id.* at 44464.

[125] CARB, Technical Options to Achieve Additional Emissions and Risk Reductions from California Locomotives and Railyards, 13-15 (Aug. 2009).

methods focus on fuel efficiency and would serve to reduce emissions of CO_2 as well as black carbon.

DOT estimates that significant GHG reductions could be achieved through technology-based modifications to locomotive power systems. The introduction of "GenSet" engines could reduce per-vehicle GHG emissions by 35-50%, hybrid yard engines by 35-57% and common rail injection systems by 5-15%.[126] Other rail fuel economy strategies, such as lightweight cars, aerodynamic improvements and modified lubrication systems, could result in a 15-19% fuel savings in 2030, equivalent to a reduction of 8.7 – 10.8 MMTCO2e in GHG emissions. Projections for 2050 indicate that these measures could generate a fuel savings of 18-24%, or between 10.1 and 13.6MMTCO_2.[127] DOT estimates that improving the loading configuration of trains can also cut fuel consumption by as much as 27%.[128]

Further reductions in GHG emissions can be achieved through improved rail yard operations and traffic management. DOT has found that efficiencies can be achieved through rail chokepoint relief to reduce congestion, as well as revised operational practices, such as locomotive idle reduction in rail yards.[129] Both the ANPR and the CARB study cite reducing the time locomotives spend idling in switchyards as a GHG emissions reduction strategy. Although this idling wastes fuel, locomotives often need to remain running in switchyards in order to maintain cabin temperature for the operator, pressurize the brakes, or power refrigerated freight cars. The latest EPA regulations require automatic engine start/stop ("AESS") systems in new locomotives.[130] These systems automatically shut off locomotive engines in response to a number of factors, including engine coolant temperature, battery voltage, and independent braking.[131]

Although AESS measures are a good start, more advanced technologies are available that can further reduce emissions from idling. "Emissions reduction kits" are now available that can monitor more emissions factors while locomotives are idling and shut off the engines accordingly. Although such kits used to be expensive, more affordable versions, which reduce operating costs by reducing fuel usage, are now on the market.[132]

In addition to these systems and kits, locomotive manufacturers can also reduce their GHG emissions during idling by incorporating "idle reduction technology" that enables engine operators to cease idling of the main propulsion engine for long periods of time by using alternative energy sources. EPA has already compiled a list of such

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[126] TRANSPORTATION'S ROLE, *supra* note 42, at Vol. 2, 3-87.
[127] *Id*, at 3-90.
[128] *Id*, at 3-94.
[129] *See* TRANSPORTATION'S ROLE, *supra* note 42, Vol. 1 at 3-16; Vol. 2, 4-56.
[130] Locomotive and Marine Engine Final Rule, *supra* note 7, 73 Fed. Reg. at 37099.
[131] *See* CARB, AESS and Other Emissions Reduction Strategies, powerpoint presentation, Apr. 25, 2006, *available at* http://www.arb.ca.gov/railyard/ryagreement/aess_electromotive.pdf.
[132] *See* Locomotive emission reduction kit and method of earning emission credits, U.S. Patent No. 6,636,798 (issued Oct. 21, 2003).

technologies under its SmartWay Transport program.[133] These save money through decreasing fuel consumption, and usually pay for themselves in their first year.[134] The government has also incentivized the purchase of such technologies by eliminating federal excise taxes on a number of them, but has not yet required their use.[135]

Another measure recommended in both the ANPR and CARB report is the use of computer- or global positioning system ("GPS")-based speed management. The system is projected to minimize braking, over-accelerations, and run-out/run-in losses at couplings. Additionally, similar computer-based systems can help to assemble trains more efficiently in the yard and to plan trips more efficiently to avoid congestion. One currently-available example of this technology is GE's Trip Optimizer™ System. This system uses an on-board computer and GPS to determine the optimal speed for a locomotive at all points along its journey. According to the manufacturer, the system typically reduces particulate matter and fuel consumption by 10%, and its implementation would result in a reduction of CO_2 by 365 tons per year per locomotive.[136]

The CARB report also suggests that locomotive operators can decrease fuel consumption and ensuing GHG emissions through more advanced training. Some railroad companies are currently using such training practices. According to the American Association of Railroads ("AAR"), "railroads commonly offer training programs through which engineers offer suggestions to their colleagues on ways to save fuel."[137]

The ANPR lists a number of other currently feasible technologies and railroad practices that, if implemented, would reduce GHG emissions. One such technology is electronically-controlled pneumatic ("ECP") brakes. ECP brakes reduce the time necessary to initiate braking in long trains with many cars. This improves train-handling capabilities and in turn reduces fuel consumption and emissions. In October 2008, the Federal Railroad Administration issued a final rule that facilitates the voluntary use of this technology.[138]

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[133] *See* U.S. EPA SmartWay Transport, Verified Technologies page, http://www.epa.gov/smartway/transport/what-smartway/verified-technologies.htm (last visited Jul. 28, 2010).

[134] *See* Locomotive and Marine Engines Final Rule, 73 Fed. Reg. at 37124 (discussing the cost savings and "short payback times for adding idle reduction technologies to a typical locomotive").

[135] *See* U.S. EPA SmartWay Transport, Federal Excise Tax Exemption, http://www.epa.gov/smartway/transport/what-smartway/idling-reduction-fet.htm (last visited Jul. 28, 2010).

[136] *See* GE Ecomagination: Trip Optimizer™ System, http://ge.ecomagination.com/products/trip-optimizer.html (last visited Jul. 28, 2010).

[137] AAR, FREIGHT RAILROADS OFFER A SMART, EFFECTIVE WAY TO REDUCE GHG EMISSIONS, *supra* note 85, at 3.

[138] *See* DOT, Federal Railroad Administration Electronically Controlled Pneumatic Brakes Fact Sheet, Oct. 2008, *available at* http://www.fra.dot.gov/downloads/PubAffairs/ECP%20Brakes%20FINAL.pdf (last visited Jul. 28, 2010).

Other technologies listed in the ANPR include low-friction/low-torque wheel bearings,[139] high-adhesion trucks (wheel assemblies),[140] and better-insulated refrigeration cars. Other practices include the application of lubricants or friction modifiers to minimize wheel-to-track friction losses,[141] higher-speed railroad crossings, use of consist managers (automated throttling of each locomotive in a consist team for lowest overall GHG emissions),[142] reduction of empty-car trips, and earlier scrappage of older locomotives. All of these practices are feasible today, and technology is available to facilitate them.

In addition, locomotives capable of running on alternative fuels that produce fewer GHG emissions at the tailpipe already exist. According to one source, "existing diesel rail locomotives can easily be converted to run on 70 per cent CNG [compressed natural gas]…." Such CNG locomotives have been in use in Peru and other countries since 2005.[143]

Some hybrid locomotives are also currently in use. RJ Corman Railpower's "Green Goat" switcher locomotive has a small 300 HP engine that charges a bank of batteries.[144] RJ Corman RailPower has also developed a new line of cleaner locomotives with what it calls "GenSet Technology." According to the developer of the technology, these locomotives can reduce fuel consumption by 40-60% while also reducing NO_x emissions by 80%.[145]

The use of any of these technologies and practices on their own or in combination could significantly reduce GHGs from locomotives. Furthermore, nearly all of them will reduce operating costs for railroad companies by cutting down on fuel usage. All of these technologies are ready to be implemented for large-scale use today.

2. More Technologies Will Soon be Available to Further Reduce GHG Emissions from Locomotives.

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[139] For example, *see* Timken, "Global Rail Capabilities" brochure, *available at* http://www.timken.com/zh-cn/solutions/rail/Documents/GlobalRailBrochure.pdf (last visited Jul. 28, 2010).
[140] For example, *see* Bradken Corporation, "Transit and Locomotive Truck Designs" brochure, *available at* http://www.americasttech.com/brochures/RailTransitBrochureWEB.pdf (last visited Jul. 28, 2010).
[141] For example, *see* L.B. Foster, Rail Products, Rail Lubrication, http://www.lbfoster.com/Rail/lubrication.html (last visited Jul. 28, 2010).
[142] GE has developed a "consist manager" to reduce fuel consumption 1-3% for each locomotive. *See* GE Transportation - North America, Products: Consist Manager, http://www.getransportation.com/na/en/consistmanager.html (last visited Jul. 28, 2010).
[143] *See* Ben Rose, *Need for shift to low carbon fuels and rail: STCWA*, CARBON OFFSETS DAILY, Sep. 2, 2009, *available at* http://www.carbonoffsetsdaily.com/news-channels/australasia/need-for-shift-to-low-carbon-fuels-and-rail-stcwa-11330.htm (last visited Jul. 28, 2010)); Reuters, *Peru Puts First CNG-Powered Locomotive into Service*, June 17, 2005, *available at* http://www.greencarcongress.com/2005/06/peru_puts_first.html (last visited Jul. 28, 2010).
[144] *See* Comments by the American Association of Railroads on docket no. EPA-HQ-OAR-2003-0l90-0566.1, at 4 [hereinafter AAR Comments].
[145] *See* RJ Corman Railpower page, http://www.rjcorman.com/railpower.html (last visited Jul. 28, 2010).

The CARB report stresses that the largest reduction of GHG emissions will most likely come from new, clean locomotives. Such locomotives should be available soon. General Electric is currently developing a hybrid locomotive that makes use of energy emitted during braking.[146] According to the manufacturer's claims, these new hybrid locomotives may reduce fuel consumption by up to 15% and reduce CO_2 by 10% compared to a standard locomotive, and a single locomotive could potentially save 1 million gallons of fuel over its lifetime.[147] Hybrid locomotives would also reduce NO_x emissions, responding to industry fears that decreasing NO_x must come at the cost of increasing GHGs.[148] According to CARB, "[m]ultiple nonroad engine (gen-set) and electric-hybrid yard locomotives have demonstrated a reduction of NO_x and diesel PM emissions by up to 90% as compared to existing locomotives."[149] These hybrids could thus exceed the benefits discussed in the recent final rule concerning locomotive emissions, which suggests reducing NO_x by methods that increase fuel consumption.

Locomotives equipped with hydrogen fuel cells are also being developed.[150] Some railroad companies, including GO Transit in Ontario, Canada, are considering hydrogen-fueled systems that would eventually eliminate the bulk of GHGs. Although these systems are not yet in use today, they could be implemented and required by regulation in the coming years.[151]

The ANPR suggests making locomotives and train cars more aerodynamic to reduce drag and increase fuel efficiency. Currently, aerodynamic drag accounts for 8% of fuel use/loss in standard trains.[152] Several train manufacturers are looking to reduce this ratio. For example, Burlington Northern Santa Fe Corporation is working to improve intermodal loading methods to reduce aerodynamic drag.[153] Also, Union Pacific is working with Brigham Young University engineers to produce more aerodynamic locomotives. Such designs may be able to cut overall fuel consumption by 1%.[154]

The ANPR also suggests tare weight reduction as a method for reducing GHG emissions. "Tare weight" is the weight of the train without any goods. Manufacturers can reduce tare weight by using lighter-weight materials such as aluminum for components

[146] *See* GE Ecoimagination: Evolution Hybrid Locomotive, http://ge.ecomagination.com/products/evolution-hybrid-locomotive.html (last visited Jul. 28, 2010).
[147] *Id.*
[148] *See* AAR Comments, *supra* note 144, at 4.
[149] CARB, Strategies to Reduce Locomotive and Associated Railyard Emissions, Fact Sheet (Feb. 2008), *available at* http://www.arb.ca.gov/railyard/hra/031808hra_stra_fs.pdf.
[150] TRANSPORTATION'S ROLE, *supra* note 42, at Vol. 2, 2-49.
[151] *See generally* Y. Haseli, G.F. Naterer, I. Dincer, *Comparative Assessment of GHG Mitigation of Hydrogen Passenger Trains*, 33 INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 1788-96 (2008).
[152] Marc Stehly, Train Resistance and Railroad Emissions and Efficiency, powerpoint presentation, Oct. 24, 2008, at 24, *available at* http://ict.illinois.edu/railroad/CEE/pdf/PPT's/fall08/Stehly_10-24.pdf (last visited Jul. 28, 2010).
[153] *Id.* at 53.
[154] *See* Brigham Young University, *On the fast track: Making locomotives more environmentally friendly*, Mar. 30, 2009, *available at* http://news.byu.edu/archive09-Mar-capstoneUnionPacific.aspx (last visited Jul. 28, 2010).

including wheels, axle hubs, fuel tanks and the cab frame, or by using a smaller engine.[155] Reducing weight can greatly improve fuel efficiency and reduce GHG emissions.

Finally, the ANPR suggests making rail yard infrastructure improvements to eliminate congestion and idling, as well as using more eco-friendly materials. A recent study at UC Berkeley proposed that non-operational factors such as the construction and maintenance of train stations my produce twice as many GHGs as the actual operation of locomotives.[156] The article suggests that although incorporating new technologies and lower-emission fuels is an important strategy for reducing GHG emissions, in addition, "the reduction in concrete use or switching to lower energy input and GHG-intensity materials would improve infrastructure construction performance while reduced electricity consumption and cleaner fuels for electricity generation would improve infrastructure operation."[157]

With all of the technology that is either currently available or will be available in the near future, reducing GHG emissions from locomotives is and will continue to be feasible and cost-effective.

3. Existing, Feasible, and Cost-Effective Technologies Can Reduce the Black Carbon Content in Locomotive Emissions.

While the fuel-saving technologies discussed above will reduce black carbon as well as GHG emissions by reducing overall diesel combustion, there are additional technologies that can minimize the amount of particulate matter in emissions from locomotive diesel engines. Fuel switching to compressed natural gas or other fuels may lower emissions and must be considered,[158] though such choices require a full lifecycle analysis of the relevant fuels and consideration of all the global warming pollutants emitted, including black carbon.

In its final rule on pollutant emissions from locomotive and marine engines, adopted in 2008, EPA proposed a number of measures designed to reduce PM that would also decrease black carbon. For example, fuel system changes such as increased injection pressure or improved injector tip design that can enhance fuel atomization would improve combustion efficiency and reduce black carbon emissions.[159]

[155] U.S. EPA SmartWay Transport, Partner Resources Glossary page, "Weight Reduction." http://www.epa.gov/smartway/transport/partner-resources/resources-glossary.htm (last visited Jul. 28, 2010).
[156] Mikhail V. Chester & Arpad Horvath, *Environmental Assessment of Passenger Transportation Should Include Infrastructure and Supply Chains*, 4 ENVTL. RESEARCH LETTERS 3 (2009), *available at* http://www.iop.org/EJ/article/1748-9326/4/2/024008/erl9_2_024008.pdf?request-id=409841b2-42f4-4f25-a6fe-809b8c35fec1 (last visited Jul. 28, 2010).
[157] *Id.* at 7.
[158] *Reducing Black Carbon May be Fastest Strategy for Slowing Climate Change*, IGSD/INECE Climate Briefing Note, 6 (Aug. 2008) *available at* www.igsd.org/docs/BC%20Summary%206July08.pdf.
[159] Locomotive and Marine Engine Final Rule, *supra* note 7, 73 Fed. Reg. at 25136.

Largely as a result of recent EPA regulation of PM from mobile sources such as diesel vehicles and nonroad diesel, black carbon emissions in the U.S. are projected to decline by 42% between 2001 and 2020. [160] Most of these reductions are attributable to increased use of catalytic particulate filters, enabled by mandated reductions in the sulfur content of diesel fuels. However, studies suggest that the black carbon component of PM can be further reduced through regulations that require the use of technologies which increase fuel efficiency of engines, enable more complete combustion of fuels, and improve after-treatment exhaust.

Experts agree that the most effective black carbon reduction strategies include installation of a diesel particulate filter (DPF), which traps carbon from diesel engines, coupled with the use of ultra-low sulfur fuels.[161] According to the International Council on Clean Transportation (ICCT), DPFs can practically eliminate black carbon emissions when used with ultra-low sulfur fuel of 15 parts per million (ppm) or less, with immediate results upon installation of the device.[162] EPA has mandated reductions in sulfur content in nonroad diesel fuels. Effective June 2012, the sulfur content in locomotive fuels will be capped at 15 ppm, facilitating the use of DPFs.[163] According to the CATF, "[t]he DPF is a proven, off-the-shelf technology that can reduce black carbon emissions by 90 % or more."[164] EPA's National Clean Diesel Campaign agrees that DPFs can reduce PM emissions by 89%.[165]

ANALYSIS

A. EPA Must Regulate GHGs from Locomotives.

1. EPA Does Not Currently Regulate GHG Emissions from Locomotives.

The Administrator's obligation to promulgate regulations applicable to emissions from new locomotives and new engines used in locomotives are defined by section 213(a)(5) of the CAA, 42 U.S.C. § 7547(a)(5). That section states that "the Administrator *shall* promulgate regulations containing standards applicable to emissions

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[160] Mark Bahner et al., *Use of Black Carbon and Organic Carbon Inventories for Projections and Mitigation Analysis*, RTI International, US EPA (2007), *available at*: http://www.epa.gov/ttn/chief/conference/ei16/session3/k.weitz.pdf. ; *see also*, IGSD/INECE briefing, *supra* note 158.

[161] IGSD/INECE briefing, *supra* note 158, at 6.

[162] International Council on Clean Transportation, A Policy-Relevant Summary of Black Carbon Climate Science and Appropriate Emission Control Strategies, 9 (2009) *available at* http://www.theicct.org/climate_change/a_policy-relevant_summary_of_black_carbon_climate_science_and_appropriate_emission_control_strategies.

[163] BAHNER ET AL., *supra* note 53, at 4.

[164] Clean Air Task Force, THE CARBON DIOXIDE-EQUIVALENT BENEFITS OF REDUCING BLACK CARBON EMISSIONS FROM U.S. CLASS 8 TRUCKS USING DIESEL PARTICULATE FILTERS: A PRELIMINARY ANALYSIS, (Jul. 2009, revised Sept. 2009) *available at*: http://www.catf.us/publications/view/100 (last visited Jul. 28, 2010). DPFs for locomotives have not yet been verified.

[165] *See* EPA, National Clean Diesel Campaign, Diesel Retrofit Technologies from Caterpillar, *available at* http://www.epa.gov/otaq/retrofit/techlist-cat.htm#dpf.

from new locomotives and new engines used in locomotives" (emphasis added). To date, the Administrator has promulgated such regulations for several pollutants: nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), volatile organic compounds and hydrocarbons.

The first regulations to reduce emissions from locomotives were included in 40 CFR § 92 et al., originally promulgated on April 16, 1998,[166] and revised on July 13, 2005.[167] These comprised graduated standards depending on the age of locomotives: locomotives and locomotive engines manufactured from 1973 to 2001 are subject to the least-stringent Tier 0 standards, those manufactured from 2002 to 2004 are subject to Tier 1 standards, and those manufactured from 2005 and after are subject to the most-stringent Tier 2 standards. On May 6, 2008, EPA issued a final rule promulgating stricter emissions standards for locomotives manufactured after 2005.[168] These include stricter limits for existing locomotives, and Tiers 3 and 4 for further reducing PM and NO_x in locomotives manufactured after 2012 and 2015 respectively.

But these regulations fail to address GHGs, including CO_2, the top GHG emitted by locomotives, and do not directly address black carbon.

2. CAA § 213(a)(5) Requires EPA to Regulate GHG Emissions from Locomotives.

Section 213(a)(5) of the Clean Air Act, 42 U.S.C. § 7547(a)(5), requires that EPA regulate GHG emissions from locomotives. The statute expressly states that "the Administrator *shall* promulgate regulations containing standards applicable to emissions from new locomotives and new engines used in locomotives."[169] Since GHGs are "emissions from new locomotives and new engines used in locomotives," EPA must promulgate regulations concerning them.

The statute also requires that the emission standards

> *shall* achieve the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the locomotives or engines to which the standards apply, giving appropriate consideration to the cost…and to noise, energy, and safety factors associated with … such technology.[170]

Thus, as long as technology is available for reducing an emission, standards must be set to do so. In other words, while the Administrator may exercise judgment in

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[166] Emission Standards for Locomotives and Locomotive Engines, *supra* note 7, 63 Fed. Reg. 18998 (Apr 16, 1998).
[167] Test Procedures for Testing Highway and Nonroad Engines and Omnibus Technical Amendments, 70 Fed. Reg. 40452 (July 13, 2005).
[168] Locomotive and Marine Engine Final Rule, *supra* note 7, 73 Fed. Reg. at 25199 (May 6, 2008), *republished at* 73 Fed. Reg, 37197 (Jun. 30, 2008).
[169] 42 U.S.C. § 7547(a)(5) (emphasis added).
[170] CAA § 213(a)(5), 42 U.S.C. § 7547(a)(5) (emphasis added).

considering factors such as cost, noise, energy and safety that affect stringency of standards, as long as control technology is available, the Administrator has no such discretion about *whether* to promulgate a standard. Nor may she set a standard at less than the maximum stringency achievable in light of those factors.[171] Courts have declined to read discretion into the CAA where it employs mandatory language because to do so would be contrary to the structure of the Act and the public policy underlying it.[172] It would be similarly contrary to principles of statutory interpretation to read Section 213(a)(5) as leaving to EPA's discretion *whether* to promulgate regulations containing standards applicable to emissions where economic and feasible control technologies are in existence – especially as to emissions that have already been found to endanger public health and welfare.

As noted above, a great deal of technology is currently available and/or will be available in the near future to reduce GHG emissions *as well as* costs. For example, EPA should mandate that new locomotives incorporate idling reduction technologies. EPA has already compiled a list of these technologies; moreover, the government encourages their use through tax incentives. Furthermore, some of these technologies pay for themselves after a year of use, and save operators money beyond that. Other emission reduction technologies discussed above can be applied to reduce GHG emissions immediately while taking costs (as well as the enormous societal benefits that accrue as a result of GHG reductions) into account. The current regulations do not require implementation of available and cost-effective technology to reduce GHG emissions. Therefore, they do not provide the "greatest degree of emission reduction" currently achievable. EPA thus must promulgate new regulations to comply with the statutory mandate.

The fact that EPA is required to regulate GHGs from locomotives is further evidenced by the legislative history of the 1990 amendments to the Clean Air Act, which included section 213. In the notes from the Senate Debate on Conference Report from Oct. 27, 1990, the conferees note that "the revised language [of § 213] *requires* EPA to adopt the most effective regulations feasible, ones that should be equal in stringency to the controls established on similar engines used in motor vehicles."[173] Prompted by the Endangerment Finding, EPA has acted to regulate GHGs from motor vehicles under

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[171] The Administrator was required to promulgate the initial standards for locomotives by November 1995, as mandated by section 213(a)(5), 42 U.S.C. § 7547(a)(5); but in addition, under section 213(d), 42 U.S.C. § 7547(d), she also "*shall revise or promulgate regulations as may be necessary*" to enforce the required standards – i.e., those that achieve the greatest degree of emission reduction achievable through the application of available technology, giving appropriate consideration to the factors listed in section 213(a)(5), 42 U.S.C. § 7547(a)(5).

[172] *See Natural Resources Defense Council, Inc. v. Train*, 545 F.2d 320, 324-25 (2d Cir. N.Y. 1976) (holding that to read discretion into the CAA where it provides that the Administrator "shall…publish … a list" of air pollutants would render the mandatory language "mere surplusage" and vitiate the policy objectives of the Act).

[173] *Available in* HEIN, W.S., A LEGISLATIVE HISTORY OF THE CLEAN AIR ACT AMENDMENTS OF 1990, 1021 (1998) (emphasis added).

section 202 of the Clean Air Act.[174] To be "equal in stringency" to the GHG emission controls on motor vehicles, the regulations for locomotives must also reduce GHGs. In light of EPA's finding that GHGs endanger public health and welfare, any decision not to regulate GHGs from significant sources, such as locomotives, would be arbitrary and capricious in light of the mandatory nature of section 213(a)(5) and the Congressional history.

Further, section 213(a)(5) unquestionably pertains to GHGs. Although the section does not define "emissions," section 302(k) defines "emissions standard" as a requirement " which limits the quantity, rate, or concentration of *emissions of air pollutants* on a continuous basis…."[175] The Clean Air Act defines "air pollutant" broadly as "*any* air pollution agent or combination of such agents, including *any* physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) *substance or matter* which is emitted into or otherwise enters the ambient air."[176] Given that GHGs are air pollutants under *Massachusetts v. EPA*, the EPA's Endangerment Finding and the GHG Vehicle Rule, the "standards applicable to emissions from new locomotives and new engines used in locomotives" required by section 213(a)(5) must include standards for regulating these gases.

A definition contained in rules promulgated by EPA under the Clean Air Act further supports the mandatory nature of regulating GHG emissions from locomotives and their engines. In 40 C.F.R. 92.2, "emission control system" is defined as "those devices, systems or elements of design which control or reduce the *emission of substances from an engine*" (emphasis added). This implies that any attempt at controlling emissions, which "includes, but is not limited to, mechanical and electronic components and controls, and computer software," is targeted at reducing the emission of substances in general. As CO_2 and other GHGs are "substances" emitted from locomotive engines that can be controlled through technology, emission control systems must be designed to control these harmful pollutants as well.

Finally, the dictionary definition of "emission" makes it clear that the word has a broad meaning that encompasses GHGs. The American Heritage Dictionary defines "emission" as "a substance discharged into the air, especially by an internal combustion engine."[177] Carbon dioxide and other GHGs certainly fall within this definition, and are emitted in large quantities by locomotives. Since EPA "shall promulgate regulations containing standards applicable to emissions from new locomotives," it is required to regulate the substances discharged from these locomotives, including GHGs.

[174] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25324 (May 10, 2010) (to be codified at 49 C.F.R. pt. 85, 86, 600) [hereinafter GHG Vehicle Rule].
[175] 42 U.S.C. § 7602(k)(emphasis added).
[176] CAA § 302(g), 42 U.S.C. §7602(g) (emphasis added).
[177] AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE (4th ed. 2009).

The fact that regulations pertaining to locomotives and their engines are set forth separately from regulations for other nonroad vehicles evidences a Congressional intent to regulate locomotive emissions from locomotives even more broadly.

3. EPA Must Require a High Technological Standard for Control Technology Used to Regulate GHGs from Locomotives.

As with other sections under Title II of the Clean Air Act, Section 213, 42 U.S.C. § 7547 authorizes EPA to set technology-forcing standards to achieve the maximum degree of reductions while considering other enumerated factors: the standards "shall achieve the greatest degree of emission reduction achievable through the application of technology…giving appropriate consideration to the cost of applying such technology within the period of time available to manufacturers and to noise, energy, and safety factors associated with the application of such technology."[178] Indeed, a court will generally defer to EPA even if a manufacturer deems regulations too costly, provided that the agency reasonably arrived at its decision.[179]

The technology standard under § 213(a)(5), 42 U.S.C. § 7547(a)(5), is similar to the "best available control technology" (BACT) described in CAA §169(3), 42 U.S.C. § 7479(3), which calls for the "maximum degree of reduction of each pollutant…taking into account energy, environmental, and economic impacts and other costs...." BACT is a very high standard of control, despite its allowance for consideration of costs.[180] If regulations are required to provide the "greatest degree of emission reduction achievable through the application of technology," this cannot be done without accounting for GHGs, especially considering the availability of the GHG-reducing technologies discussed above.

Although fuel efficiency goals are secondary to the goal of reducing emissions, EPA still must take them into account because of their close relationship to CO_2 emissions. These concerns are particularly relevant with respect to measures for reducing NO_x. Reducing NO_x emissions should remain a primary goal, but these reductions need not be achieved in the future at the cost of fuel efficiency. This trade-off is not necessary, as technologies and procedures such as the use of "GenSet Technology" locomotives can reduce NO_x as well as GHGs and black carbon.[181]

B. EPA Must Regulate Black Carbon Emissions from Locomotives.

1. Current Regulations for Particulate Matter Do Not Adequately Constrain Black Carbon Emissions.

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[178] 73 Fed. Reg. 44354, 44433.
[179] *Husqvarna AB v. EPA*, 254 F.3d 195, 200-201 (D.C. Cir. 2001) (holding that in promulgating factors for regulating emissions from hand-held engines, EPA had to consider cost but did not have to "balance" it against emissions reductions).
[180] *See, e. g. Alaska Dept. of Environmental Conservation v. EPA*, 124 S.Ct. 983, 1004-09 (2004) (forcing a more stringent BACT technological standard over complaints of high costs).
[181] These include technologies mentioned *supra* in part C of the Statement of Facts, including locomotives incorporating "GenSet Technology". *See* RJ Corman Railpower, *supra* note 145.

Black carbon is a component of PM, and PM as a whole, is already regulated as a criteria pollutant. While EPA has recognized black carbon's climate forcing impact in a variety of contexts, it has yet to take targeted action or set specific standards to address the warming impact of this specific PM component.[182]

However, public health concerns have already driven several changes in the present PM standard. For example, EPA has recognized the effects of diesel PM within its analysis of $PM_{2.5}$ reductions by proposing fuel system changes that can enhance fuel atomization, thereby improving combustion efficiency and reducing diesel PM.[183] Current NAAQS have also been repeatedly revised to provide increasing stringency on $PM_{2.5}$ standards in response to studies showing linkages between PM and serious health and environmental harms.[184]

Despite EPA's regulation of $PM_{2.5}$, black carbon emissions, including those from locomotives, remains a serious problem. As discussed above, ambient $PM_{2.5}$ levels are affected by locomotive engines emitting large amounts of black carbon as diesel PM.[185] Although regulations adopted in 2008 aim to reduce PM from locomotives, overall use of freight and passenger rail is expected to increase, at least partially offsetting any emissions reductions achieved through the new standards. In light of these increases, more stringent standards are necessary just to maintain the same net PM reductions in the future.

Further, because particulate matter is composed of multiple aerosol compounds, the overall PM level from a given source can be reduced by decreasing any one or more of its constituent pollutants – without, however, necessarily reducing the black carbon component in equal proportion. For example, diesel oxidation catalysts can reduce diesel PM emission as a whole by approximately 20 to 40%, yet they do not decrease the carbonaceous component of the PM.[186] While black carbon is the predominant component of diesel PM, sulfates are the other major contributor. Measures that aim to reduce sulfates, such as low-sulfur diesel fuel, may reduce PM levels, but do not necessarily maximize BC reductions, leading some industry experts to recognize that low

[182] *Compare* Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18898 (discussing black carbon) with Endangerment Finding, *supra* note 1, at 66520 (discussing EPA's approach to addressing black carbon), EPA**,** INTEGRATED REVIEW PLAN FOR THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER AT 15, 29 (March 2008), EPA 452/R-08-004.

[183] 73 Fed. Reg. 25136.

[184] *See* 71 Fed. Reg. 61144 (Oct. 2006); EPA, Air Quality Index Reporting and Significant Harm Level for Fine Particulate Matter (Jan. 2009), *available at* http://www.epa.gov/particles/pdfs20090115fr.pdf; *see also*, EPA, INTEGRATED SCIENCE ASSESSMENT FOR PARTICULATE MATTER, Ch. 2 and 6-9 (Dec. 2009), *available at* http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546 (discussing health and environmental impacts of PM).

[185] Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder, Regulatory Impact Analysis (May 2008) at 2-6, 2-10.

[186] A.P. Walker, *Controlling Particulate Emissions from Diesel Vehicles*, 28 TOPICS IN CATALYSIS 1-4, AT 165, 166 (Apr. 2004)

sulfur fuels may be necessary, but not sufficient to achieve black carbon reductions.[187] Low sulfur fuel is important because it *allows* for better technology to reduce black carbon, such as the use of diesel particulate filters (DPFs).[188] However, desulphurization of fuels does not guarantee the significant cuts in black carbon that climate scientists recommend.

Studies have shown that reducing sulfate aerosols, which reflect solar radiation and cool the surface of the earth, without a corresponding reduction in black carbon levels can increase the ratio of black carbon to sulfates, thereby removing the "masking" of black carbon's warming effect.[189] Thus, it is essential that EPA regulate black carbon specifically and directly as a separate component of PM. Researchers concluded that "[w]orldwide efforts to decrease SO_2 emissions…should be accompanied by larger percentage reductions in BC [black carbon], such that the BC-to-SO_2 emission ratio is also decreased."[190]

Because overall PM emissions may be reduced without proportionately decreasing black carbon emissions, depending on which reduction strategies and technologies are used or how locomotive remanufacturing is completed, EPA's PM emission standards for locomotives alone are inadequate to ensure needed reductions in black carbon. With the projected increase in locomotive PM emissions driven by increased use of rail, black carbon emissions may increase unless black carbon emissions are specifically constrained. Thus, constraining black carbon from locomotives should constitute a vital part of the nation's climate change strategy.

2. CAA § 213(a)(5) Requires EPA to Regulate Black Carbon Emissions from Locomotives.

As with GHG emissions, Section 213(a)(5) of the Clean Air Act, 42 U.S.C. § 7457(a)(5), requires that EPA regulate black carbon emissions from locomotives. As stated above, the statute specifically requires that "the Administrator shall promulgate regulations containing standards applicable to emissions from new locomotives and new

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[187] Dante Bonaquist & Riva Krut, The Role of Hydrogen in Minimizing Black Carbon Emissions from Diesel Engines: A White Paper, Praxair (May 2010), *available at*: http://www.google.com/url?q=http://www.praxair.com/praxair.nsf/0/6D73B5DA741457DA8525772900703E30/%24file/Praxair-H2MinimizingBlackCarbonEmissions-WhitePaper.pdf&sa=X&ei=KpFHTOOHLoXfnAen4b3QBA&ved=0CBUQzgQoADAA&usg=AFQjCNG0X8ZW5l-DtwXG3Z6Iy6ttW8iLhw.

[188] *See, e.g.*, 69 Fed. Reg. 38957, 38995 (Jun. 29, 2004)

[189] Ramana et al, *supra* note 56, at 1, 3. *See also* Subramanian et al, *Climate-Relevant Properties of Diesel Particulate Emissions: Results from a Piggyback Study in Bangkok, Thailand*, 43 ENVTL. SCI. TECH. 4213, 4214-15 (2009). Although not the focus of the study, Figures 1 and 2 suggest that some diesel vehicles had lower PM emission rates (g/kg-fuel) but higher ratios of elemental carbon (nearly equivalent to black carbon) to PM than comparable vehicles under different emissions regulations. For example, "Euro II" heavy duty trucks showed a lower PM emission rate, yet a higher EC/PM fraction than "early regulation" heavy duty trucks. Likewise, Euro I heavy duty buses showed a lower PM emission rate, yet a higher EC/PM ratio than Euro II heavy duty buses. These data suggest that overall PM levels can be reduced without reducing the black carbon component of PM proportionately.

[190] Ramana et al, *supra* note 56, at 3.

engines used in locomotives." As the legislative history demonstrates, EPA possesses a mandate to regulate locomotive emissions as rigorously as possible.[191] Black carbon's increasing presence and significant harm render it a crucial target for EPA's locomotive regulations. Because of black carbon's effect as a global warming agent, independent of and in addition to its adverse health and environmental impacts as a component of $PM_{2.5}$, it must be targeted for reduction for climate mitigation purposes.

EPA also has clear authority to regulate black carbon as a substance emitted from locomotive engines based on the broad definition of "emissions" under § 213(a)(5) discussed *supra*. Like NO_x, black carbon is emitted by locomotives as a component of diesel fumes and thus is similarly within the definition of an "emission" under this section. Separate regulation of black carbon would by no means be unusual. For example, the fact that NOx is a component of diesel fumes that in turn react to form PM does not preclude EPA from regulating NOx independently of PM under the CAA. Similarly, EPA can and should issue standards for the reduction of black carbon emissions from locomotives.

Black carbon emissions are directly related to diesel fuel consumption by locomotives. Thus, EPA can effectively regulate locomotive emissions of black carbon using existing and emerging technologies that focus on improving rail fuel efficiency and thereby decreasing combustion products. As previously discussed, AESS and emissions reduction kits can reduce idling time, cutting unnecessary fuel consumption and thereby lowering diesel emissions. Computer- or GPS-based speed management can increase locomotive trip efficiency. Other rail technologies and practices, such as improving braking systems and upgrading rail parts, are also currently feasible for improving locomotive fuel efficiency. Diesel particulate filters (DPFs) and other aftertreatment technologies that dramatically reduce black carbon content in emissions are readily available for non-road diesel engines and should be more easily installed once ultraslow-sulfur fuel standards apply to trains in June 2012. Furthermore, fuel-switching technology, to replace diesel with compressed natural gas, has been demonstrated in rail engines abroad. With all the available technology that can be utilized to effectively reduce fuel consumption and black carbon emissions in diesel PM, EPA can and should directly target black carbon from locomotives, setting high standards for control technology to regulate black carbon directly.

Experts have identified black carbon as the second or third strongest contributor to current global warming. Dire projections of large-scale harms to our environment and public health as a result of climate change require immediate and aggressive action. In the preamble to 40 CFR § 9, 85, et al., EPA stated that it was "adopting a comprehensive program to dramatically reduce *pollution* from locomotives."[192] Reducing black carbon emissions fits squarely into EPA's overarching objective of reducing the role of locomotives in exacerbating human health and environmental problems.

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[191] *Available in* Hein, W.S., A LEGISLATIVE HISTORY OF THE CLEAN AIR ACT AMENDMENTS OF 1990, Buffalo, N.Y. 1998, p. 1021.
[192] Locomotive and Marine Engine Final Rule, supra note 7, 73 Fed. Reg. at 37096 (emphasis added).

Most importantly, leading scientists have deemed black carbon to be the "low-hanging fruit" for fighting climate change: reductions can be achieved with large-scale implementation and current technologies with "a nearly instant return in lowering the impact of the man-made greenhouse effect."[193] Due to black carbon's short atmospheric lifespan, mitigation measures targeting black carbon would yield short-term climate benefits, and therefore hedge against the full effects of global warming caused by GHGs.[194] Black carbon emission reductions can lead to rapid short-term reductions in radiative forcing, reducing warming within weeks.[195] Mitigation will also offset the warming expected to result from reductions in emissions of reflective particles that act as cooling agents, such as sulfur dioxide.[196]

Reductions in carbon dioxide pollution are the *sine qua non* of any meaningful effort to mitigate the impacts of global warming. Yet, even if swift and deep reductions in carbon dioxide emissions occur, the long lifetime of carbon dioxide in the atmosphere may prevent them from stopping the complete loss of summer sea ice in the Arctic and of U.S. glaciers. Major cuts in black carbon emissions, however, could slow the effects of climate change for a decade or two, buying policy makers more time to cut carbon dioxide emissions and potentially avoid some of the irreversible effects of global warming.[197] The potential restoration of snow albedos to levels approaching pristine pre-industrial values would have the double benefit of reducing global warming and pushing back the point at which dangerous anthropogenic interference with the climate occurs.[198]

Reducing black carbon emissions would also lower morbidity and mortality associated with short and long-term exposure to fine airborne particles. It would decrease respiratory infections caused by breathing in black carbon smog, recognized as "the fourth-leading cause of premature death in developing countries."[199] Finally, as discussed above, technologies that can reduce black carbon already exist.[200] Targeting black carbon and controlling its emission sources is thus not only desirable but also viable and cost-effective. If EPA is to carry out the goal of the CAA to protect "the quality of the Nation's air resources so as to promote the public health and welfare," and to act in the interests of the public to combat climate change through emissions regulations, it must implement standards to regulate black carbon emissions from locomotives.

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[193] United Nations Environment Programme, Non-CO2 Emissions: Options for a Way Forward, 1 Black Carbon e-Bulletin (Jul. 2009) at 3, *available at* http://www.unep.org/dec/PDF/ebulletin/blackcarbonvol1july2009.pdf. *See also* Jessica Seddon Wallack & Veerabhadran Ramanathan, *The Other Climate Changers: Why Black Carbon and Ozone Also Matter*, FOREIGN AFFAIRS (Sept.-Oct. 2009).
[194] *See, e.g., 9, supra* note 28, at 17 (statement of Mark Z. Jacobson, Professor, Stanford University).
[195] KAREN BICE ET AL., *supra* note 54, at 3; *See, e.g., Hearing, supra* note 29, at 17 (statement of Mark Z. Jacobson, Professor, Stanford University).
[196] *Id.* at 10.
[197] *Hearing, supra* note 29, at 53 (statement of V. Ramanathan, Professor, University of San Diego).
[198] James Hansen & Larissa Nazarenko, *Soot Climate Forcing via Snow and Ice Albedos*, 101 PROC. NAT'L ACAD. SCI. U.S. 423, 427 (2004), *available at* http://www.pnas.org/content/101/2/423.full.
[199] *See* Wallack & Ramanathan, *supra* note 193.
[200] *See supra* Statement of Facts, Section C.

CONCLUSION

Locomotives are a significant and increasing source of harmful GHGs, including CO_2, and black carbon. GHGs and black carbon contribute to global climate change that is likely to have catastrophic consequences if not mitigated in the near future. Furthermore, black carbon particulates are linked to adverse health and environmental consequences of exposure to PM, particularly from diesel emissions. Technological advances allow for a quick, feasible, and cost-effective reduction of these emissions from locomotives. Therefore, given the mandate of CAA § 213(a)(5), 42 U.S.C. § 7457(a)(5), EPA must promulgate regulations setting standards for reducing GHG and black carbon emissions from locomotives.

RELIEF REQUESTED

Petitioners respectfully request that the Administrator:

(1) Propose regulations setting standards for GHG emissions from locomotives and locomotive engines under Section 213(a)(5) of the Clean Air Act, 42 U.S.C. § 7547(a)(5), such standards to take the form of emissions limitations, including requirements limiting the quantity, rate, or concentration of emissions of GHGs, and any design, equipment, work practice or operational standard necessary to carry out the emissions limitations.

(2) Promulgate final regulations setting standards for GHG emissions from locomotives and locomotive engines to take effect at the earliest possible date considering the lead time necessary to permit the development and application of the requisite technology, pursuant to Section 213(b) of the CAA, 42 U.S.C. § 7547(b).

(3) Propose regulations setting standards for black carbon emissions from locomotives and locomotive engines under Section 213(a)(5) of the Clean Air Act, 42 U.S.C. § 7547(a)(5), such standards to take the form of emissions limitations, including requirements limiting the quantity, rate, or concentration of emissions of black carbon, and any design, equipment, work practice or operational standard necessary to carry out the emissions limitations.

(4) Promulgate final regulations setting standards for black carbon emissions from locomotives and locomotive engines to take effect at the earliest possible date considering the lead time necessary to permit the development and application of the requisite technology, pursuant to Section 213(b) of the CAA, 42 U.S.C. § 7547(b).

We request that the Administrator take initial action within six months of receipt of this petition.[201]

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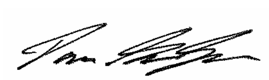

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