



PM_{2.5} THE INVISIBLE HEALTH HAZARD MAKING HEADLINES – HOW CHINA CAN IMPROVE AIR QUALITY BY LOOKING TO THE SUCCESS OF PM_{2.5} REGULATION IN THE UNITED STATES

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*Breathe, keep breathing
I can't do this alone.¹*

Fine particulate matter (PM_{2.5}) exists in the atmosphere as a result of combustion, but its incredibly small size makes it impossible to see with the naked eye.² It is only when the concentration of PM_{2.5} increases that we become aware of its presence. Because PM_{2.5} is so small, it is easily inhalable and can have grave impacts on human health.³ PM_{2.5} is unleashed into the atmosphere from a number of sources, and the only way to protect human health from PM_{2.5} is to reduce concentration in the atmosphere by limiting emissions of the substance.

The United States has made great strides in reducing PM_{2.5}. The job is not completely done, and a number of areas within the United States are still plagued by repeated instances of poor air quality. China is affected by poor air quality to a far greater extent. In recent years, China has repeated made international headlines because of the intensity of smog, particularly in Beijing. These stories are synonymous with images of people of all ages going about their daily lives wearing facemasks to protect themselves from smog so thick that it is hard to spot the sun.

¹ RADIOHEAD, *Exit Music (For a Film)*, on OK COMPUTER (Capitol Records 1997).

² ROY S. BELDEN, CLEAN AIR ACT, 12 (2d ed. 2011).

³ Revisions to the National Ambient Air Quality Standards for Particulate Matter, 52 Fed. Reg. 24,634, 24,639 (July 1, 1987) (to be codified at 40 C.F.R. pt. 50).

Limiting PM_{2.5} will require diligence and commitment to enforcement. As the United States continues to witness success stories of areas with significantly improved air quality, China will have to strive to set sufficient standards and effectively work to meet the standards in order to limit the number of days Chinese citizens are exposed to fine particulate matter.

This paper will highlight how the United States regulates PM_{2.5} and how the implementation on both a national and regional level prompted the New York City metro area to attain the standards set forth by the government as a means for making suggestions for China to address the similar issues with PM_{2.5}. The first section will provide background on particulate matter and why it is of concern. Next, the air quality issues within China and specifically Beijing will be discussed to express the enormity of the problem. Section C focuses on how China is present regulation PM_{2.5}, which is followed by section D on suggestions for the reducing PM_{2.5}. To demonstrate how the United States was successful in tackling PM_{2.5} issues in the New York City metro area, section E looks at how PM_{2.5} is regulated in the United States before delving into section F on the application within New York. Finally, the paper concludes by highlighting that short-term goals are not sufficient and any steps towards regulating particulate matter must have a long-term application.

A. Particulate Matter and its Impacts on Health

Particulate matter (PM) is a broad term applied to any number of small particles suspended in the atmosphere.⁴ Particulate matter can be comprised of any number of substances, including acids, metals, organic compounds, and dust.⁵ The particles can also be liquid.⁶ There are two categories of particulate matter. Coarse particulate matter (PM₁₀) covers particles that

⁴ PARTICULATE MATTER, <http://www.epa.gov/airquality/particlepollution/index.html> (last visited Apr. 22, 2015).

⁵ *Id.*

⁶ BELDEN, *supra* note 2, at 12.

range in size from 2.5 micrometers to 10 micrometers in diameter.⁷ Fine particulate matter (PM_{2.5}) includes any particles that are smaller than 2.5 micrometers.⁸

Sources for particulate matter are just as varied as its composition, but generally, particulate matter is emitted from combustion processes, which includes motor vehicles.⁹ Particulate matter can also be formed in the atmosphere as a result of “transformations of gaseous emissions.”¹⁰ Primary particles are emitted directly into the atmosphere from a source, and secondary particles are those resulting from atmospheric chemical reactions.¹¹ Most of the fine particulate matter in the United States constitutes secondary particles.¹² The concentration and effects of particulate matter in the atmosphere vary from place to place because the “chemical and physical properties of particulate matter vary greatly with time, region, meteorology, and source category.”¹³ The particles range in size, but the various species of particulate matter all have some impact on health with finer particles having a more drastic impact.¹⁴

Studies from the mid-1980s indicated that discussing particulate matter by its size instead of its chemical composition was a more efficient means of addressing the potential health impacts.¹⁵ The reasoning behind these size-specific considerations of particulate relates to how the particles penetrate the human body and the extent to which health is affected. When particulate matter is inhaled, the smallest particles are able to traverse more deeply into the

⁷ PARTICULATE MATTER, *supra* note 4.

⁸ *Id.*

⁹ BELDEN, *supra* note 2, at 12.

¹⁰ Richard E. Ayres & Jessica L. Olson, *Setting National Ambient Air Quality Standards*, in THE CLEAN AIR ACT HANDBOOK 13, 28 (Julie R. Domike & Alec C. Zacaroli eds. 3rd ed. 2011).

¹¹ PARTICULATE MATTER (PM) – BASIC INFORMATION, <http://www.epa.gov/airquality/particulatepollution/basic.html> (last visited Apr. 22, 2015).

¹² *Id.*

¹³ Revisions to the National Ambient Air Quality Standards for Particulate Matter, 52 Fed. Reg. 24,634, 24,635 (July 1, 1987) (to be codified at 40 C.F.R. pt. 50).

¹⁴ PARTICULATE MATTER, *supra* note 4.

¹⁵ Revisions to the National Ambient Air Quality Standards for Particulate Matter, 52 Fed. Reg. at 24,639.

respiratory system.¹⁶ Because of this, those with compromised immune systems or recurring respiratory conditions are more likely to be affected by particulate matter in the ambient air.¹⁷ Ambient air contains a multitude of substances that could each potentially impact human health and welfare. Particulate matter is comprised of various acids, sulfates, nitrates, and metals, which can all be damaging to the body.¹⁸ Illnesses that are commonly associated with fine particulate matter include lung cancer and cardiovascular diseases.¹⁹ Worldwide observations suggest that particulate matter may contribute to 16% of lung cancer deaths and more than 20% of heart disease and stroke deaths.²⁰ Besides those with pre-existing conditions, children and older adults are particularly vulnerable to the effects of particulate matter.²¹

Research on the health impacts of particulate matter revolves around epidemiologic studies.²² Scientists must evaluate a dizzying amount of data with an array of statistical analysis methods to evaluate the extent to which particulate matter affects human health.²³ The epidemiological studies focus on the ambient air components and the observed health problems observed in an area.²⁴

These studies are constantly being updated by more recent observations and a general better understanding of the science behind particulate matter and its impact on human health, and the updated studies “generally strengthen the evidence that long- and short-term exposures to

¹⁶ *Id.*

¹⁷ PARTICULATE MATTER (PM) RESEARCH, <http://www.epa.gov/airscience/air-particulatematter.htm> (last visited Apr. 22, 2015).

¹⁸ C. Arden Pope III & Douglas W. Dockery, *Health Effects of Fine Particulate Air Pollution: Lines that Connect*, 56 J. AIR & WASTE MANAGE. ASSOC. 709, 711 (June 2006).

¹⁹ GLOBAL HEALTH OBSERVATORY DATA, AMBIENT AIR POLLUTION, http://www.who.int/gho/phe/outdoor_air_pollution/en/ (last visited Apr. 22, 2015).

²⁰ *Id.*

²¹ PARTICULATE MATTER (PM) RESEARCH, *supra* note 17.

²² National Center for Environmental Assessment RTP Division, *Provisional Assessment of Recent Studies on Health Effects of Particulate Matter Exposure 2* (December 2012), <http://www.epa.gov/ttn/naaqs/standards/pm/data/20121213psa.pdf>.

²³ EPIDEMIOLOGY, <http://www.who.int/topics/epidemiology/en/> (last visited Apr. 22, 2015).

²⁴ Pope & Dockery, *supra* note 18, at 711.

fine particles are associated with a wide range of health effects.”²⁵ Some of studies focus on the short-term impacts while others direct attention to the long-term impacts.²⁶ Probably most troubling about the studies is the connection of health effects for relatively low concentrations of particulate matter.²⁷ Over time, many studies have been replicated and the statistical methods reevaluated, but the conclusion remains the same that short-term exposure to particulate matter can have a serious impact on health.²⁸ Notably, these studies focus on ambient air and how subtle changes in the concentration in particulate matter can increase mortality in addition to exacerbating existing issues.²⁹ Correlation between long-term exposure and health studies are not as cohesive in terms of extent of impact, but some studies suggest the potential for health impacts from prolonged exposure to elevated levels of particulate matter in ambient air.³⁰

B. Air Quality in Beijing

As China has rapidly developed, the pollution in the country has not only increased but also featured prominently in the global arena. Leading up to the 2008 Summer Olympics in Beijing, people around the world expressed concern over the air quality and how it might impact those visiting for the games.³¹ To limit the impact, China implemented various restrictions on

²⁵ National Ambient Air Quality Standards for Particulate Matter, 78 Fed. Reg. 3086, 3095 (Jan. 15, 2013) (to be codified at 40 C.F.R. pt. 50).

²⁶ *Id.*

²⁷ Pope & Dockery, *supra* note 18, at 711.

²⁸ *Id.*

²⁹ *Id.* at 713.

³⁰ *Id.* at 717.

³¹ *WHO Fears over Beijing Pollution*, BBC NEWS (August 17, 2007, 10:33 PM), <http://news.bbc.co.uk/2/hi/asia-pacific/6950883.stm>.

vehicles allowed to traverse the city and what construction projects, if any, could be built.³² The pollution within Beijing was improved, but the problem was far from solved.³³

Since then, reports of high pollution events have continued to make international headlines. While the previous perception was a lack of transparency, China has taken steps in recent years to allow more insight into the environmental concerns of the nation. In 2011, the city of Beijing bucked those trends by opening the doors of the city's pollution monitoring center.³⁴ At the time, PM_{2.5} was not one of the pollutants measured, but the concern over the pollutant was growing and would soon be among the pollutants broadcast to the people of Beijing.

Starting in 2012, China began regulating PM_{2.5}. Many people within the country had been concerned with the growing problem of pollution from fine particulate matter, even when the observations were not public knowledge. Before China started recording air quality and far before sharing the information with citizens, the United States published the information recorded at the U.S. Embassy via Twitter.³⁵ While Twitter may be blocked within China, the information was still shared within the country as well as to anyone globally who wished to access the account.³⁶ Chinese officials were not in favor of the information being brandied about

³² Anne Ju, *Improved Air Quality During Beijing Olympics Could Inform Pollution Curbing Policies*, CORNELL CHRONICLE (July 23, 2009), <http://www.news.cornell.edu/stories/2009/07/beijing-air-quality-improved-during-olympics>.

³³ T. Wang et al., *Air quality during the 2008 Beijing Olympics: secondary pollutants and regional impact*, 10 ATMOSPHERIC CHEMISTRY & PHYSICS 7603, 7613 (August 2010), available at <http://www.atmos-chem-phys.net/10/7603/2010/acp-10-7603-2010.pdf>.

³⁴ Jason Miks, *Beijing Opens Up on Pollution*, THE DIPLOMAT (November 9, 2011), <http://thediplomat.com/2011/11/beijing-opens-up-on-pollution/>.

³⁵ BeijingAir Twitter, <https://twitter.com/BeijingAir>.

³⁶ Edward Wong, *Outrage Grows Over Air Pollution and China's Response*, NY TIMES (December 6, 2011), http://www.nytimes.com/2011/12/07/world/asia/beijing-journal-anger-grows-over-air-pollution-in-china.html?_r=0.

the Internet, but citizens embraced the data and clamored for the government to rectify the problem.³⁷

In January 2013, there was a remarkable instance of hazardous air pollution in Beijing. The extreme magnitude of the event was the result of a combination of emissions from the usual suspects coupled with atmospheric conditions conducive to increased aerosol concentration in lower atmosphere.³⁸ The haziest days in Beijing typically occur during the winter months, particularly December and January.³⁹ Headlines around the world detailed the acridity of the air as the PM_{2.5} readings hit 886 µg/m³.⁴⁰ The readings in Beijing far exceeded the newly implemented national standards of 35 µg/m³ for PM_{2.5} concentrations.⁴¹ PM_{2.5} levels of that magnitude are incredibly dangerous to human health.⁴²

Spurred by the January 2013 event and repeated occurrences of less-extreme poor air quality days, Beijing implemented the Beijing Clean Air Action Plan.⁴³ The goal of the plan was to reduce all pollutants by 2% by transforming coal-fired power plants, scrapping old vehicles, and stricter standards for companies that are building new plants.⁴⁴ The Beijing Municipal Environmental Protection Bureau was charged with supervising the implementation of the

³⁷ *Id.*

³⁸ L.T. Wang et al., *The 2013 severe haze over southern Hebei, China: model evaluation, source appointment, and policy implications*, 14 *ATMOSPHERIC CHEMISTRY & PHYSICS* 3152, 3157 (March 2014). Stability of the atmosphere can often be a determining factor in the persistence of an event of haze or fog. Air that is more stable sinks, and this subsidence contains the emitted pollution in the lower atmosphere and limits dispersion of the pollutants due to limited mixing.

³⁹ *Id.* at 3156.

⁴⁰ Monica Tan, *Black Cloud Over Beijing*, *THE DIPLOMAT* (January 16, 2013), <http://thediplomat.com/2013/01/black-cloud-over-beijing/>.

⁴¹ *Beijing passes regulation on air pollution control*, *XINHUA* (January 22, 2014, 4:43 PM), http://news.xinhuanet.com/english/china/2014-01/22/c_133065832.htm.

⁴² AIR QUALITY INDEX (AQI) BASICS, <http://www.airnow.gov/index.cfm?action=aqibasics.aqi> (last updated Mar. 16, 2015).

⁴³ Zheng Xin, *Beijing Launches Action Plan to Bring Clean Air*, *CHINA DAILY* (March 16, 2013), http://www.chinadaily.com.cn/beijing/2013-03/16/content_16315957.htm.

⁴⁴ *Id.*

procedures.⁴⁵ Most impressively, the Plan required a moratorium on construction projects within Beijing that burned heavy polluting fuels like coal and residual oil.⁴⁶ Additionally, the plan called for increasing green space as “green shield” to help limit dust.⁴⁷

The efforts of the Beijing Clean Air Action Plan were admirable yet not sufficient to solve the problem of fine particulate matter pollution. In 2013, Beijing had fifty-eight days of serious pollution of PM_{2.5}.⁴⁸ Pollutants were reduced by 3% from the previous year as China “replaced 366,000 old vehicles and overhauled 288 polluting factories.”⁴⁹ Even with the cuts, pollution in Beijing remained a major concern. The annual average for PM_{2.5} in 2013 was 89.5 µg/m³, which is more than double the national standard.⁵⁰ Going into 2014, China had additional goals for pollution reduction. The country intended to cut coal use by 2.6 million tonnes and transform 300 pollution companies.⁵¹ The central government had set aside five billion RMB “for air pollution control by Beijing and several of its neighbors” and the municipal government intended to set aside 15 billion RMB for air pollution control.⁵²

The Beijing Municipal People’s Congress emphatically supported the intention to reduce pollution by passing a regulation on air pollution to replace the regulation from 2000.⁵³ In March 2014, the new pollution law went into place in Beijing to “ban construction of new oil refining, steel, cement, and thermal power plants as well as the expansion of existing projects.”⁵⁴ Part of the city plan to cut PM_{2.5} by 5% in 2014, and the municipal plan related to the plan by central

⁴⁵ *Id.*

⁴⁶ *Id.*

⁴⁷ *Id.*

⁴⁸ *Beijing goes “all-out” against air pollution*, XINHUA (January 16, 2014, 5:03 PM), http://news.xinhuanet.com/english/china/2014-01/16/c_133050798.htm.

⁴⁹ *Id.*

⁵⁰ *Id.*

⁵¹ *Id.*

⁵² *Id.*

⁵³ *Beijing passes regulation on air pollution control*, *supra* note 41.

⁵⁴ *Id.*

government to “reduce dependence on coal and close outdated industrial capacity.”⁵⁵ Industries in Beijing must now limit “total discharge of major air pollutants” and set “yearly quotas for districts and county governments and individual polluters”.⁵⁶ The long-term goal of this method for reducing overall pollution requires an initial limitation of emissions and a gradual reduction.⁵⁷ The local government planned to enforce the new pollution standards with fines reaching up to 500,000 RMB with an additional penalty possible for failure to comply or losing emission permit allocation for subsequent year.⁵⁸ China is also considering a trading scheme for pollution permits.⁵⁹

In 2014, Beijing managed to reduce PM_{2.5} concentration by 4%, relative to 2013 values, which is good news for the city.⁶⁰ However, concentrations of other pollutants, including PM₁₀ and nitrogen dioxide, increased.⁶¹ Because nitrogen dioxide can break down into PM_{2.5}, the increased concentration of the nitrogen oxide limits the victory of reducing PM_{2.5} to a small extent.⁶² The average concentration of PM_{2.5} for 2014 was 85.9 µg/m³, which is still 1.5 times greater than the national standard.⁶³ The city did have 93 days of excellent air quality, which is 22 days more than in 2013, and heavily polluted days dropped to 45 days.⁶⁴ To accomplish these successes, Beijing reduced coal use by 2.6 million tonnes (keeping the total usage to under 19 million tonnes), removing 476,000 old vehicles from the roads, and shutting down 375

⁵⁵ *Beijing passes anti-pollution law*, CHINA DAILY (January 1, 2014, 1:34 PM), http://www.chinadaily.com.cn/china/2014-01/22/content_17250238.htm.

⁵⁶ *Beijing passes regulation on air pollution control*, *supra* note 41.

⁵⁷ *Id.*

⁵⁸ *Beijing passes anti-pollution law*, *supra* note 55.

⁵⁹ *Id.*

⁶⁰ *PM_{2.5} Density in Beijing Falls Slightly in 2014*, XINHUA (January 4, 2015, 4:47 PM), http://news.xinhuanet.com/english/china/2015-01/04/c_133895835.htm.

⁶¹ *Id.*

⁶² EPA, *Guidance for PM_{2.5} Permit Modeling 15* (May 2014), available at http://www.epa.gov/scram001/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf.

⁶³ *PM_{2.5} Density in Beijing Falls Slightly in 2014*, *supra* note 60.

⁶⁴ *Id.*

factories.⁶⁵ The goal for 2015 is similar to the previous few years—reduce PM_{2.5} by 5% by keeping coal under 15 million tonnes, removing an additional 200,000 vehicles, closing 300 polluting factories, and cutting cement production capacity down to 5 million tonnes.⁶⁶

PM_{2.5} has only been monitored and made public in recent years. In that time, the concern for air pollution has steadily risen, but more importantly, the dissemination of the information to the citizens of China has become an essential part improving air quality.⁶⁷ Technology that addresses the magnitude of it is making waves. An application (“app”) for computers and mobile phones has been developed in China that shows the location of polluters and their emission in real time.⁶⁸ Automated monitoring stations allow the information from about 10,000 plants around the country to be shared with any user that downloads the app.⁶⁹ The existence app reflects the changing landscape of information dissemination in China. Just years ago, China kept its pollution information tightly guarded, but in the last three years has since made information available to the public. Nearly 200 Chinese cities record and report air quality information to the public.⁷⁰ However, even with the information readily available, it does not solve the pollution problem as enforcement is still very weak and the cost of violating pollution limits is far too low.⁷¹

C. Regulating Particulate Matter in China

The Ninth National People’s Congress passed legislation to address air quality in the autumn of 2000 titled the Law of the People’s Republic of China on the Prevention and Control

⁶⁵ *Id.*

⁶⁶ *Id.*

⁶⁷ David Lauter, *In China, App Aims to Shame Polluters by Showing Who Is Fouling Air*, LA TIMES (December 30, 2014, 5:00 AM), <http://www.latimes.com/world/asia/la-fg-china-bad-air-20141230-story.html#page=1>.

⁶⁸ *Id.*

⁶⁹ *Id.*

⁷⁰ *Id.*

⁷¹ *Id.*

of Atmospheric Pollution.⁷² The first article of the Law embraces the necessity of reducing air pollution for safeguard human health and protect the environment while maintaining awareness of the importance of economic development.⁷³ As such, the Law outlines the ability of the national government to implement regulations to limit emissions to improve air quality. These can apply to construction projects⁷⁴ and emissions from motor vehicles⁷⁵ and requirements of vehicle testing.⁷⁶ The State Council will establish national standards, and municipalities may establish their own standards beyond what the nation stipulates.⁷⁷

National standards exist for monitoring emissions of many different pollutants, including PM_{2.5}.⁷⁸ These standards specify technical requirements and stipulate that monitoring must be a continuous, automated system.⁷⁹ Ambient Air Quality Standards were promulgated in 2012 to update the previously established standards from 1996.⁸⁰ The inclusion of PM_{2.5} is the greatest difference in the updated standards. Like the United States, the standards were divided into annual and 24-hour standards. The annual average Grade I standard for PM_{2.5} is 15 µg/m³, and the Grade II standard is 35 µg/m³.⁸¹ The 24-hour Grade I standard is 35 µg/m³, and the Grade II

⁷² Prevention and Control of Atmospheric Pollution (promulgated by the Standing Comm. Nat'l People's Cong., Sep. 1, 2000, effective Sep. 1, 2000), *available at* http://english.mep.gov.cn/Policies_Regulations/laws/environmental_laws/200710/t20071009_109943.htm (China).

⁷³ *Id.* at art. 1.

⁷⁴ *Id.* at art. 11.

⁷⁵ *Id.* at art. 33.

⁷⁶ *Id.* at art. 35.

⁷⁷ *Id.* at art. 6.

⁷⁸ National Standards on Environmental Protection (promulgated by the Ministry of Environmental Protection, effective Aug. 1, 2013), *available at* http://english.mep.gov.cn/standards_reports/standards/Catalogue_Standards/201308/t20130815_257518.htm (China).

⁷⁹ *Id.*

⁸⁰ CHINA RELEASES NEW AMBIENT AIR QUALITY STANDARDS, <http://cleanairinitiative.org/portal/node/8163> (last visited Apr. 22, 2015).

⁸¹ *Id.*

standard is $75 \mu\text{g}/\text{m}^3$.⁸² Grade I standards apply to nature reserves and areas necessitating special protection.⁸³ Grade II standards apply to residential, commercial, and industrial areas.⁸⁴

To implement the Ambient Air Quality Standards, Beijing created an Atmospheric Pollution Prevention Action Plan in 2013.⁸⁵ There are ten measures listed under the action plan to reduce air pollution, some of which will have an impact on $\text{PM}_{2.5}$, either through directly reducing $\text{PM}_{2.5}$ emissions directly or by reducing emissions of precursors to $\text{PM}_{2.5}$.⁸⁶ The measures includes Beijing's desire to reduce overall discharges of air pollutants, including requiring treatments to limit emissions of SO_2 , NO_x , and dust; increase technological reform "to promote innovative development and industrialization to major environmental equipment and products"; increase utilization of clean energy to revamp energy structure of the country, including limiting coal use to below 65% by 2017; ensure strict supervision and sufficient enforcement; employ regional coordination; and increase public awareness of the issue and further support public participation.⁸⁷

Enforcement of the national and regional $\text{PM}_{2.5}$ standards and emissions reductions is imperative to success. Creating and inflicting substantial fines are one way to encourage compliance with the regulations.⁸⁸ If fines are greater than the cost of correcting the pollution issue, companies will be more likely to reduce the emissions to maintain financial gain.⁸⁹ In July

⁸² *Id.*

⁸³ *Id.*

⁸⁴ *Id.*

⁸⁵ THE STATE COUNCIL ISSUES ACTION PLAN ON PREVENTION AND CONTROL OF AIR POLLUTION INTRODUCING TEN MEASURES TO IMPROVE AIR QUALITY, http://english.mep.gov.cn/News_service/infocus/201309/t20130924_260707.htm (Sep. 12, 2013).

⁸⁶ *Id.*

⁸⁷ *Id.*

⁸⁸ Erin Ryan, *The Elaborate Paper Tiger: Environmental Enforcement and the Rule of Law in China*, 24 DUKE ENVIRONMENTAL LAW AND POLICY FORUM 183, 218 (Fall 2013).

⁸⁹ *Id.*

2014, Babcock & Wilcox Company was fined 600,000 for air pollution.⁹⁰ The initial fine was issued two months earlier and was only 300,000 yuan.⁹¹ Officials noted that after the initial fine that the company continued to release VOCs into the atmosphere and thus decided to double the penalty.⁹² This is not the first instance of fines for the company. In 2012 and 2013, the Beijing Environment Protection Bureau issued fines of 40,000 yuan for failure to comply with regulations to reduce emissions.⁹³ The increase in the amount of fines reflects the growing concern for pollution in China. In the first four months of 2014, Beijing authorities fined 652 industrial facilities 14.5 million yuan for pollution, three-quarters of which were for air pollution.⁹⁴

D. Suggestions for Reducing Particulate Matter in China

China must take numerous steps across multiple sectors to effectively reduce particulate matter in the atmosphere. In November 2014, Beijing shut down factories and limited the number of cars on the road to ensure blue skies during the APEC meeting.⁹⁵ But this sort of temporary solution is not sustainable, and more permanent solutions must be established in China to better air quality. Every possible solution cannot be contained within this paper, but there are some steps that China could take to help alleviate the problem. China should continue to reduce the permissible amount of fine particulate matter, increase enforcement and fines for violations, reduce dependence on coal, and consider additional regulations on motor vehicles.

⁹⁰ *Babcock & Wilcox Fined for Beijing Air Pollution*, XINHUA (Jul. 7, 2014, 4:25 PM), http://news.xinhuanet.com/english/business/2014-07/07/c_133466126.htm.

⁹¹ *Id.*

⁹² *Id.*

⁹³ *Beijing Slaps Polluting Firm with Highest Fine*, CHINA DAILY (May 13, 2014, 7:20 AM), http://usa.chinadaily.com.cn/china/2014-05/13/content_17502784.htm.

⁹⁴ *Beijing Fines 652 Firms for Polluting in 4 Months*, CHINA DAILY (May 5, 2014), http://www.chinadaily.com.cn/beijing/2014-05/05/content_17485011.htm.

⁹⁵ Christina Larson, *How Did Beijing Achieve "APEC Blue"*, BLOOMBERG BUSINESS (Nov. 18, 2014), <http://www.bloomberg.com/bw/articles/2014-11-18/beijings-blue-sky-act-for-apec>.

The World Health Organization (WHO) recommends that average annual concentrations of PM_{2.5} should not exceed 10 µg/m³ and average daily concentrations should not exceed 25 µg/m³ because of the potential health impacts at higher concentrations.⁹⁶ Both China and the United States allow greater concentrations of PM_{2.5} than the WHO standard, but the United States is closer to the WHO target.⁹⁷ China has restricted the limit on PM_{2.5} in recent years,⁹⁸ but China should reduce the allowable concentrations of PM_{2.5} over the next decade until it approaches the WHO recommended level because even small amounts of PM_{2.5} can have health impacts.⁹⁹ The gradual reduction of allowable concentrations of PM_{2.5} allows time for development of better emissions-reducing technology.

When reducing the limits of PM_{2.5} in the atmosphere, China should keep enforcement a priority. Tracking down violators and penalizing them a sufficient amount will reinforce the purpose of particulate matter regulations that are in place and hopefully encourage others to stay within the governmentally proscribed limits for emissions. Fines should be substantial enough to deter violation of the standard but not so high that it oversteps the violator's ability to pay.¹⁰⁰ To be effective, fines must be perceived as fair and justified to further the overall goal of deterrence.¹⁰¹ The money gathered from these fines should be utilized by the government to fund technological development to decrease air pollution and to assist those striving for compliance.¹⁰²

⁹⁶ AMBIENT (OUTDOOR) AIR QUALITY AND HEALTH – FACTSHEET NO. 313, <http://www.who.int/mediacentre/factsheets/fs313/en/> (last updated March 2014).

⁹⁷ 40 C.F.R. § 50.18 (2014).

⁹⁸ CHINA RELEASES NEW AMBIENT AIR QUALITY STANDARDS, *supra* note 80.

⁹⁹ Pope & Dockery, *supra* note 18, at 711.

¹⁰⁰ INECE, *Principles of Environmental Compliance and Enforcement Handbook 77*, available at http://inece.org/principles/PrinciplesHandbook_23sept09.pdf (Sep. 2009).

¹⁰¹ *Id.*

¹⁰² *Beijing goes "all-out" against air pollution*, *supra* note 48.

Coal-fired power plants are major contributors to PM_{2.5} in the atmosphere through both direct emissions of PM_{2.5} and emissions of sulfur dioxide and nitrogen dioxide that breakdown into PM_{2.5} once in the atmosphere.¹⁰³ Beijing has been closing coal-fired power plants and plans to shut down the remaining four power plants next year.¹⁰⁴ Closing coal-fired power plants should be a priority, and care should be taken to not simply relocate the plants because PM_{2.5} is easily transported through the atmosphere.¹⁰⁵ PM_{2.5} can be transported approximately 2000 to 3000 kilometers during its time in the atmosphere, which ranges from one to six days.¹⁰⁶ While shutting down all of the coal-fired power plants within Beijing is a step in the right direction, the entire region surrounding the city must be considered in order to protect the air quality.¹⁰⁷

China has been making progress with limiting emissions of motor vehicles by removing older vehicles from the fleet of vehicles on the roads.¹⁰⁸ Programs like this should remain in place while creating additional opportunities for reducing emissions of PM_{2.5}. The United States has implemented requirements for retrofitting vehicles with purification and filtration technologies to reduce emissions from vehicles, and the established technology bodes well for the feasibility of implementation within China.¹⁰⁹ Filtration is beneficial for limiting emissions of nitrogen dioxide and particulate matter, but limiting sulfur in fuels is another method for

¹⁰³ Greenpeace East Asia, *The Health Impact from Coal Power Plants in Beijing, Tianjin, and Hebei* 10-11, available at <http://www.greenpeace.org/eastasia/publications/reports/climate-energy/2013/health-impacts-coal-power/> (Jul. 16, 2013). Research done by Greenpeace showed that coal-fired power plants produced 50% of sulfur dioxide, 70% of nitrogen dioxide, and 20% of soot emissions.

¹⁰⁴ *Beijing to Shut All Major Coal Power Plants to Cut Pollution*, BLOOMBERG BUSINESS, (March 23, 2015, 11:52 PM) <http://www.bloomberg.com/news/articles/2015-03-24/beijing-to-close-all-major-coal-power-plants-to-curb-pollution>.

¹⁰⁵ European Centre for Environment and Health, *Health risks of particulate matter from long-range transboundary air pollution* 57 (2006), available at http://www.euro.who.int/_data/assets/pdf_file/0006/78657/E88189.pdf.

¹⁰⁶ *Id.*

¹⁰⁷ *Beijing goes "all-out" against air pollution*, *supra* note 48.

¹⁰⁸ *PM_{2.5} Density in Beijing Falls Slightly in 2014*, *supra* note 60.

¹⁰⁹ EPA – National Clean Diesel Campaign (NCDC), *Verified Technologies List*, <http://epa.gov/cleandiesel/verification/verif-list.htm> (last visited Apr. 22, 2015).

reducing emissions of PM_{2.5}.¹¹⁰ High quality fuels, a technology that is currently implemented in other countries, would limit the emissions from vehicles remaining on the roads.¹¹¹ China cannot remove every vehicle, and trends indicate that the number of vehicles in China will continue to rise in the future.¹¹²

Many of the strategies suggested above are based on those that were implemented in the United States and play off the steps presently being taken in China. The successes of these strategies can hopefully inspire China of the possibility of attaining better air quality through an array of calculated steps to reduce emissions of PM_{2.5}. Major cities in the United States have suffered from poor air quality in the past, but through increasingly tightened restrictions of allowable concentrations of fine particulate matter coupled with a multifaceted approach to reducing emissions, some cities have achieved significantly better air quality.

E. Regulating Particulate Matter in the United States

Some version of the Clean Air Act (CAA) has existed since 1955.¹¹³ Congress revised the Act in 1970, 1977, and 1990.¹¹⁴ Section 109 of the CAA requires the Environmental Protection Agency (EPA) to promulgate rules for National Ambient Air Quality Standards (NAAQS). There are six criteria pollutants for which the EPA is responsible: sulfur dioxide, particulate

¹¹⁰ Michael Patrick Walsh, *PM_{2.5}: Global Progress in Controlling the Motor Vehicle Contribution*, 8 FRONTIERS OF ENVIRONMENTAL SCIENCE AND ENGINEERING 1, 10 (2014).

¹¹¹ *Id.*

¹¹² *Id.*

¹¹³ James E. McCarthy, Claudia Copeland, & Linda-Jo Schierow, *Clean Air Act: A Summary of the Act and Its Major Requirements*, in CLEAN AIR AND WATER – SUMMARIES OF MAJOR FEDERAL LAWS 1, 1 (Caroline McNulty & Roger Huber ed., 2013).

¹¹⁴ *Id.*

matter (PM_{2.5} and PM₁₀), nitrogen dioxide, carbon monoxide, ozone, and lead.¹¹⁵ The EPA is tasked with establishing, reviewing, and revises NAAQS.¹¹⁶

Primary standards for the NAAQS are those that are promulgated to protect public health.¹¹⁷ Public health concerns require consideration of an “adequate margin of safety”.¹¹⁸ Secondary standards protect public welfare.¹¹⁹ For public welfare, the ambient air standards must protect the population from known or anticipated adverse effects of the pollutant.¹²⁰ The threshold for the evidence that must be considered has been debated in the courts. Generally, the EPA is given deference for what information is considered and eventually incorporated into the rulemaking, so long as the EPA explains how it arrived at the conclusion given the facts presented.¹²¹

The first NAAQS were promulgated in 1971 and included particulate matter.¹²² In 1987, the EPA revised the rule and specified that particulate matter of particles consisting of diameters smaller than ten microns would be regulated.¹²³ Beginning in 1997, PM_{2.5} was designated a separate ambient air standard.¹²⁴ Like PM₁₀, the primary and secondary standards were the same, but the standards for PM_{2.5} were far more restrictive than the PM₁₀ standards because PM_{2.5} has such a significant impact on human health.¹²⁵ The annual average limitations, which were calculated with the same method of PM₁₀ by calculating over a three-year period, were set to a

¹¹⁵ *Id.* at 5.

¹¹⁶ BELDEN, *supra* note 2, at 16.

¹¹⁷ Clean Air Act § 109(b)(1), 42 U.S.C. § 7409(b)(1) (2012).

¹¹⁸ BELDEN, *supra* note 2, at 17.

¹¹⁹ Clean Air Act § 109(b)(2), 42 U.S.C. § 7409(b)(2) (2012).

¹²⁰ BELDEN, *supra* note 2, at 17.

¹²¹ BELDEN, *supra* note 2, at 17, *citing* Lead Industries Association v. E.P.A., 647 F.2d 1130 (D.C. Cir. 1980) and American Lung Association v. E.P.A., 134 F.3d 388 (D.C. Cir. 1998).

¹²² BELDEN, *supra* note 2, at 13.

¹²³ *See* Revisions to the National Ambient Air Quality Standards for Particulate Matter, 52 Fed. Reg. 24,634.

¹²⁴ National Ambient Air Quality Standards for Particulate Matter, 62 Fed. Reg. 38,652, 38,652 (July 18, 1997) (to be codified at 40 C.F.R. pt. 50).

¹²⁵ *Id.* at 38,657.

limit of $15.0 \mu\text{g}/\text{m}^3$.¹²⁶ For the 24-hour standard, $\text{PM}_{2.5}$ was not allowed to exceed $65 \mu\text{g}/\text{m}^3$.¹²⁷

The 24-hour standard created a violation when $\text{PM}_{2.5}$ exceeded the threshold when calculated by determining the 98th percentile when averaged over three years.¹²⁸

The regulations were altered for $\text{PM}_{2.5}$ and PM_{10} in 2006.¹²⁹ For $\text{PM}_{2.5}$, the annual standard was not changed from the 1997 Standards, but the 24-hour standard was tightened.¹³⁰ The 24-hour standard for $\text{PM}_{2.5}$ method was reduced to $35 \mu\text{g}/\text{m}^3$, and the method for calculating the 24-hour standard was not changed in this update.¹³¹ In 2012, the $\text{PM}_{2.5}$ ambient air standards were further refined and officially published in early 2013.¹³² This time, the 24-hour standard remained the same as the previous alterations and the annual standard was tightened.¹³³ More importantly, the more restrictive annual standard was only applied to the primary standard for $\text{PM}_{2.5}$; the secondary standard was not modified from the 2006 Standards.¹³⁴ The new primary standard for $\text{PM}_{2.5}$ created an annual ambient air limit of $12.0 \mu\text{g}/\text{m}^3$.¹³⁵

The EPA has authority to establish the NAAQS and institute the requirement of routine review of the standards.¹³⁶ To ensure that the best possible standards are set, the EPA must consult a scientific review committee every five years.¹³⁷ Even with meticulous overview of the scientific information, the EPA is often challenged in the courts, and the ensuing litigation can

¹²⁶ *Id.* at 38,652.

¹²⁷ *Id.*

¹²⁸ *Id.*

¹²⁹ National Ambient Air Quality Standards for Particulate Matter, 71 Fed. Reg. 61,144, 61,144 (Oct. 17, 2006) (to be codified at 40 C.F.R. pt. 50).

¹³⁰ *Id.*

¹³¹ *Id.*

¹³² National Ambient Air Quality Standards for Particulate Matter, 78 Fed. Reg. at 3086,

¹³³ *Id.*

¹³⁴ *Id.*

¹³⁵ *Id.* The news rules promulgated by the EPA continue using the same 3-year averaging method as the secondary standard put in place under the 2006 Standards.

¹³⁶ BELDEN, *supra* note 2, at 16.

¹³⁷ Clean Air Act § 109(d)(2), 42 U.S.C. § 7409(d)(2) (2012).

sometimes delay implementation of the standards.¹³⁸ The EPA determines the standards for ambient air, but the implementation is left to the states.¹³⁹ States are responsible for creating the procedures to attain and maintain ambient air quality for both primary and secondary standards.¹⁴⁰

To ensure effective implementation of EPA issued NAAQS standards, states must develop State Implementation Plans (SIPs) within three years of an EPA-promulgated rule.¹⁴¹ The SIPs have many requirements. First, the SIPs require “enforceable emission limitations and other control measures, means, or techniques” and a timeline for compliance.¹⁴² The state is charged with enforcing these control measures¹⁴³ and must assure the EPA that there are sufficient personnel, funding, and authority to implement the plan.¹⁴⁴ The state must provide a means for monitor, compile, and analyze data, which is shared with the EPA.¹⁴⁵ The EPA must approve the equipment used to obtain data.¹⁴⁶ The SIP must also include provisions that the actions within the state will not interfere with surrounding states and their abilities to maintain or achieve attainment.¹⁴⁷ Section 126 of the Clean Air Act allows petitions to be filed if criteria pollutants from one state could potentially take an attainment zone into nonattainment.¹⁴⁸

¹³⁸ See generally *American Trucking Associations, Inc. v. U.S. E.P.A.*, 175 F.3d 1027 (D.C. Cir. 1999), *Whitman v. American Trucking Associations*, 531 U.S. 457 (2001), *American Trucking Associations, Inc. v. E.P.A.*, 283 F.3d 355 (D.C. Cir. 2002), & *American Farm Bureau Federation v. E.P.A.*, 559 F.3d 512 (D.C. Cir. 2009).

¹³⁹ BELDEN, *supra* note 2, at 23.

¹⁴⁰ Clean Air Act § 110, 42 U.S.C. § 7410 (2012).

¹⁴¹ Clean Air Act § 110 (a)(1), 42 U.S.C. § 7410(a)(1) (2012).

¹⁴² Clean Air Act § 110(a)(2)(A), 42 U.S.C. § 7410(a)(2)(A) (2012).

¹⁴³ Clean Air Act § 110(a)(2)(C), 42 U.S.C. § 7410(a)(2)(C) (2012).

¹⁴⁴ Clean Air Act § 110(a)(2)(E), 42 U.S.C. § 7410(a)(2)(E) (2012).

¹⁴⁵ Clean Air Act § 110(a)(2)(B), 42 U.S.C. § 7410(a)(2)(B) (2012).

¹⁴⁶ Clean Air Act § 110(a)(2)(F), 42 U.S.C. § 7410(a)(2)(F) (2012).

¹⁴⁷ Clean Air Act § 110(a)(2)(D), 42 U.S.C. § 7410(a)(2)(D) (2012).

¹⁴⁸ BELDEN, *supra* note 2, at 48.

Petitions are filed with the Administrator and must be addressed within 60 days.¹⁴⁹ A majority of the petitions filed have been for ozone and NO_x and not for particulate matter.¹⁵⁰

Once a SIP has been created, it may be changed under specific circumstances. If the NAAQS are updated, then the SIP may need to be updated to incorporate the new standards.¹⁵¹ If the EPA discovers that an SIP is inadequate to effectively regulate the NAAQS, the agency must require a revised SIP.¹⁵² The EPA may grant an extension up to eighteen months if a state requests additional time to develop and submit a SIP.¹⁵³ The EPA is also tasked with publishing the SIPs on a routine basis.¹⁵⁴ These routine updates include the revisions instituted by the state that must be approved by the EPA.¹⁵⁵ A state may alter the SIP so long as there is reasonable notice and public hearing.¹⁵⁶ If a SIP cannot meet the requisite standards or lacks any of the necessary components, the EPA must institute a Federal Implementation Plan.¹⁵⁷ Any implementation plan, state or federal, has the main objective of correcting ambient air that exceeds the NAAQS proscribed by the EPA.

Areas of nonattainment do not meet the ambient air standards set forth by the EPA.¹⁵⁸ These areas are particular to the regulated pollutant; an area can be in attainment for one NAAQS and in nonattainment for another.¹⁵⁹ To more efficiently observe and manage ambient air, the EPA groups counties into “air quality control regions” (AQCRs).¹⁶⁰ Some AQCRs were

¹⁴⁹ Clean Air Act § 126(b), 42 U.S.C. § 7426(b) (2012).

¹⁵⁰ BELDEN, *supra* note 2, at 48–49.

¹⁵¹ Clean Air Act § 110(a)(2)(H)(i), 42 U.S.C. § 7410(a)(2)(H)(i) (2012).

¹⁵² McCarthy *et al.*, *supra* note 113, at 11.

¹⁵³ Clean Air Act § 110(b), 42 U.S.C. § 7410(b) (2012).

¹⁵⁴ Clean Air Act § 110(h), 42 U.S.C. § 7410(h) (2012).

¹⁵⁵ Clean Air Act § 110(l), 42 U.S.C. § 7410(l) (2012).

¹⁵⁶ Clean Air Act § 110(l), 42 U.S.C. § 7410(l) (2012).

¹⁵⁷ Clean Air Act § 110(c)(1), 42 U.S.C. § 7410(c)(1) (2012).

¹⁵⁸ Clean Air Act § 107(d)(1)(A)(i), 42 U.S.C. § 7407(d)(1)(A)(i) (2012).

¹⁵⁹ Alec C. Zacaroli, *Meeing ambient Air Standards: Development of the State Implementation Plans*, in THE CLEAN AIR ACT HANDBOOK 43, 43 (Julie R. Domike & Alec C. Zacaroli eds., 3rd ed. 2011).

¹⁶⁰ *Id.*

designated prior to 1970 under the Air Quality Act of 1967.¹⁶¹ Since then, the EPA designated other areas based on the need for attainment and maintenance of NAAQS.¹⁶² Any remaining areas become their own AQCRs, which may be divided into smaller areas.¹⁶³

The AQCRs are given one of three classifications for ambient air quality.¹⁶⁴ An area that meets the NAAQS for a particular pollutant for primary and secondary standards is given a classification of “attainment”.¹⁶⁵ Nonattainment is for any area that exceeds the primary and secondary NAAQS.¹⁶⁶ If there is not enough data to adequately assign an area, it will be listed as “unclassifiable”.¹⁶⁷ The EPA may modify designations after first notifying the state and allowing the state to comment on the modification.¹⁶⁸ States may redesignate any AQCR, but only with EPA approval.¹⁶⁹ Designations remain in effect until redesignation until the EPA makes an official change.¹⁷⁰

Once the EPA has made the NAAQS official, the agency must evaluate the AQCRs to determine which areas are in nonattainment. After years of delay and litigation for the 1997 PM_{2.5} Standards, the EPA finalized the rule in 2004.¹⁷¹ Along with the new regulations for fine particulate matter, the EPA listed the attainment/nonattainment classification for each of the AQCRs.¹⁷² Even while the litigation was proceeding, the EPA began monitoring PM_{2.5} in 1999

¹⁶¹ *Id.*

¹⁶² *Id.* See also Clean Air Act § 107(b)(1), 42 U.S.C. § 7407(b)(1) (2012).

¹⁶³ *Id.*

¹⁶⁴ *Id.* at 44.

¹⁶⁵ Clean Air Act § 107(d)(1)(A)(i), 42 U.S.C. § 107(d)(1)(A)(i) (2012).

¹⁶⁶ Clean Air Act § 107(d)(1)(A)(ii), 42 U.S.C. § 107(d)(1)(A)(ii) (2012).

¹⁶⁷ Clean Air Act § 107(d)(1)(A)(iii), 42 U.S.C. § 107(d)(1)(A)(iii) (2012).

¹⁶⁸ Clean Air Act § 107(d)(1)(B)(ii), 42 U.S.C. § 107(d)(1)(B)(ii) (2012).

¹⁶⁹ Zacaroli, *supra* note 159, at 44.

¹⁷⁰ Clean Air Act § 107(d)(1)(B)(iv), 42 U.S.C. § 107(d)(1)(B)(iv) (2012).

¹⁷¹ National Ambient Air Quality Standards for Particulate Matter, 69 Fed. Reg. 45,592, 45,592 (Jul. 30, 2004) (to be codified at 40 C.F.R. pt. 50). The EPA notes that the PM₁₀ regulations were the only ones affected by the associated litigation and removed that section from the regulation. The PM_{2.5} standard was not changed and is codified under this final rule.

¹⁷² See generally Air Quality Designations and Classifications for the Fine Particles (PM_{2.5}) National Ambient Air Quality Standards, 70 Fed. Reg. 944 (Jan. 5, 2005) (to be codified at 40 C.F.R. pt. 81).

and had all devices up and running by 2001.¹⁷³ The AQCRs were designated after analyzing ambient air quality data from 2001 to 2003.¹⁷⁴ The designations took effect in April 2005.¹⁷⁵ Nearly a year and a half later, the 2006 Standards for fine particulate matter went into effect.¹⁷⁶ Like the 1997 Standards, these were also challenged.¹⁷⁷ The Court upheld the 24-hour PM_{2.5} standards but remanded the annual standard back to the EPA for reconsideration.¹⁷⁸ The annual standards remained active until the EPA “determines how to respond to concerns raised by court’s opinion.”¹⁷⁹

With the promulgation of any new ambient air standards, the EPA must, within two years, determine the classification of the AQCRs.¹⁸⁰ Upon first designation under the 1997 PM_{2.5} Standards, 39 areas were in nonattainment.¹⁸¹ As of January 2015, there are 14 areas in nonattainment for the 1997 PM_{2.5} Standards.¹⁸² Within those 14 areas are 79 counties, which impacts nearly 38.6 million people.¹⁸³ For the 2006 PM_{2.5} Standards, 22 areas are in nonattainment, which affects just over 42 million people in 68 counties.¹⁸⁴ When the 2006 PM_{2.5} Standards were enacted, the EPA designated 31 areas as being in nonattainment¹⁸⁵ so in nearly five years, nine areas have achieved redesignation from nonattainment to attainment. For the

¹⁷³ Air Quality Designations and Classifications for the Fine Particles (PM_{2.5}) National Ambient Air Quality Standards, 70 Fed. Reg. at 946.

¹⁷⁴ *Id.*

¹⁷⁵ Air Quality Designations for the 2006 24-Hour Fine Particle (PM_{2.5}) National Ambient Air Quality Standards, 74 Fed. Reg. 58,688, 58,690 (Nov. 13, 2009) (to be codified 40 C.F.R. pt. 81).

¹⁷⁶ *Id.*

¹⁷⁷ *Id.*

¹⁷⁸ *Id.*

¹⁷⁹ *Id.* at 56,689.

¹⁸⁰ Clean Air Act § 107(d)(1)(B)(i), 42 U.S.C. § 107(d)(1)(B)(i) (2012).

¹⁸¹ ROBERT ESORTHY, CONG. RESEARCH SERV., RL 32431, PARTICULATE MATTER (PM_{2.5}): IMPLEMENTATION OF THE 1997 NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) CRS-10 (2007).

¹⁸² PM-2.5 (1997) NONATTAINMENT AREA SUMMARY, <http://www.epa.gov/airquality/greenbook/qsum.html> (last updated Jan. 30, 2015).

¹⁸³ *Id.*

¹⁸⁴ *Id.*

¹⁸⁵ Air Quality Designations for the 2006 24-Hour Fine Particle (PM_{2.5}) National Ambient Air Quality Standards, 74 Fed. Reg. at 58,690.

2012 primary PM_{2.5} standard, the EPA released the AQCR designations in January 2015.¹⁸⁶ Fourteen areas in six states are considered in nonattainment under the 2012 standards, but some places have not been yet given an official designation so the number of areas of nonattainment for the 2012 standard could still increase.¹⁸⁷ Three areas were deemed “unclassifiable” because there was not enough information from the 2011 to 2013 observations to make a classification; this includes the entire state of Illinois.¹⁸⁸ Ten areas were deferred due to lack of sufficient data, and the EPA needs additional observation time before addressing eight places in Georgia, the entire state of Tennessee, and the entire state of Florida.¹⁸⁹

F. New York City Metro Area Achieving Attainment for PM_{2.5}

In the initial designations by the EPA, the New York metropolitan area (NYMA) was designated in nonattainment for the 1997 annual standard and the 2006 24-hour standard for PM_{2.5}.¹⁹⁰ The area includes all five counties of New York City, all of Long Island, and surrounding counties in New Jersey and southern Connecticut.¹⁹¹ Monitoring of PM_{2.5} began in 1999, and the air quality designation was based on observations from 2001 to 2003.¹⁹² The designations for the 1997 annual standard went into effect on April 5, 2005.¹⁹³ For the 2006 24-hour standard, the NYMA’s nonattainment designation went into effect on December 14,

¹⁸⁶ Air Quality Designations for the 2012 Primary Annual Fine Particle (PM_{2.5}) National Ambient Air Quality Standards (NAAQS), 80 Fed. Reg. 2206, 2207 (Jan. 15, 2015) (to be codified 40 C.F.R. pt. 81).

¹⁸⁷ *Id.*

¹⁸⁸ *Id.* at 2207.

¹⁸⁹ *Id.*

¹⁹⁰ Air Quality Designations and Classifications for the Fine Particles (PM_{2.5}) National Ambient Air Quality Standards, 70 Fed. Reg. at 991; *see also* Air Quality Designations for the 2006 24-Hour Fine Particle (PM_{2.5}) National Ambient Air Quality Standards, 74 Fed. Reg. at 58,696.

¹⁹¹ *Id.*

¹⁹² Air Quality Designations and Classifications for the Fine Particles (PM_{2.5}) National Ambient Air Quality Standards, 70 Fed. Reg. at 946.

¹⁹³ Air Quality Designations and Classifications for the Fine Particles (PM_{2.5}) National Ambient Air Quality Standards, 70 Fed. Reg. at 951.

2009.¹⁹⁴ The assessments for determining attainment for the 2006 standard were based on observations from monitoring data from 2006 to 2008.¹⁹⁵ For all areas listed in nonattainment, compliance must be achieved within five years from the date of designation.¹⁹⁶ Therefore, the 1997 annual standard must be complied with by April 5, 2010, and the 2006 24-hour standard by December 14, 2014.

The state of New York was required to submit its State Implementation Plan (SIP) for achieving attainment of the 1997 annual standard by April 5, 2008.¹⁹⁷ As per the stipulations of the Clean Air Act, the SIP addressed how the state would work to achieve attainment,¹⁹⁸ and effective implementation of numerous federal and state regulations would be necessary to achieve the goal.¹⁹⁹ New Jersey and Connecticut were also required to submit SIPs for the portion of the AQCR within their respective borders.²⁰⁰ Cooperation between the three states involved with the NYMA region was essential to the area achieving attainment.

The NYMA demonstrated compliance with the 1997 annual PM_{2.5} standards by the April 2010 deadline.²⁰¹ The EPA declared the region in attainment after ambient air monitoring data reflected compliance with the standard during the 2007 to 2009 observation period.²⁰² For the 2006 24-hour standard, the NYMA had until December 14, 2014, to comply with the NAAQS

¹⁹⁴ Air Quality Designations for the 2006 24-Hour Fine Particle (PM_{2.5}) National Ambient Air Quality Standards, 74 Fed. Reg. at 58,688.

¹⁹⁵ *Id.*

¹⁹⁶ Clean Air Act § 172(a)(2)(A), 42 U.S.C. § 7502(a)(2)(A) (2012).

¹⁹⁷ EXECUTIVE SUMMARY – STATE IMPLEMENTATION PLAN FOR THE ANNUAL PM_{2.5} STANDARD, <http://www.dec.ny.gov/chemical/60592.html> (last visited Apr. 22, 2015).

¹⁹⁸ *Id.*

¹⁹⁹ CONTINGENCY MEASURES – STATE IMPLEMENTATION PLAN FOR THE ANNUAL PM_{2.5} STANDARD, <http://www.dec.ny.gov/chemical/60562.html> (last visited Apr. 22, 2015).

²⁰⁰ Clean Air Act § 110, 42 U.S.C. § 7410 (2012).

²⁰¹ Approval and Promulgation of Air Quality Implementation Plans; New York, New Jersey, and Connecticut; Determination of Attainment of the 1997 Fine Particle Standard, 75 Fed. Reg. 69,589, 69,590 (Nov. 15, 2010) (to be codified 40 C.F.R. pt. 52).

²⁰² *Id.* at 69,589.

set by the EPA.²⁰³ The NYMA achieved compliance nearly two years ahead of schedule by demonstrating ambient air quality that was consistently under the limit of the NAAQS “for the 2007-2009, 2008-2010, and 2009-2011 monitoring periods”.²⁰⁴

Nine years after designation as nonattainment for PM_{2.5}, the NYMA was officially redesignated in April 2014.²⁰⁵ New York State submitted the redesignation request following the procedure outlined in the Clean Air Act for redesignation.²⁰⁶ The redesignation request applies to both the 1997 annual standard and the 2006 24-hour standard for PM_{2.5}.²⁰⁷ Following the approval by the EPA, the state had to submit a Maintenance Plan in lieu of a State Implementation Plan to ensure continued compliance with the PM_{2.5} standards.²⁰⁸ The maintenance plan, much like the SIP, provided details of the monitoring network, the data collected by the monitoring stations, the sources of PM_{2.5}, and the federal and state measures in place to reduce emissions.²⁰⁹

The monitoring network is comprised of a series of observation stations of State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Systems (NAMS).²¹⁰ Two types of audits to verify effectiveness and validity of ambient air monitoring data: performance

²⁰³ New York Department of Environmental Conservation, *Redesignation Request and Maintenance Plan for the 1997 Annual and 2006 24-Hour PM_{2.5} NAAQS: New York—Northern New Jersey—Long Island, NY—NJ—CT Nonattainment Area 3*, (February 2013).

²⁰⁴ Approval and Promulgation of Air Quality Implementation Plans; New York State; Redesignation of Areas for 1997 Annual and 2006 24-Hour Fine Particulate Matter and Approval of the Associated Maintenance Plan, 79 Fed. Reg. 21,857, 21,857 (Apr. 18, 2014) (to be codified at 40 C.F.R. pt. 52).

²⁰⁵ *Id.*

²⁰⁶ Clean Air Act § 107(d)(1)(B)(iv), 42 U.S.C. § 107(d)(1)(B)(iv) (2012).

²⁰⁷ Approval and Promulgation of Air Quality Implementation Plans; New York State; Redesignation of Areas for 1997 Annual and 2006 24-Hour Fine Particulate Matter and Approval of the Associated Maintenance Plan, 79 Fed. Reg. at 21,857.

²⁰⁸ *Id.*

²⁰⁹ New York Department of Environmental Conservation, *supra* note 203.

²¹⁰ *Id.*

audit and systems audit.²¹¹ Performance audit “checks the accuracy of the field monitoring equipment” and systems audit checks “the entire operation of the monitoring program.”²¹²

The design value for the AQCR is calculated from the data and reflects the greatest value of concentration of the pollutant in the area.²¹³ The design values for 2009 was based off the observations from 2007 to 2009, and the design values for 2010 from the 2008 to 2010 observations.²¹⁴ Because the nonattainment area includes counties in other states, the New York Department of Environmental Conservation had to incorporate the ambient air qualities of those surrounding states, including the monitoring data and the resultant design values.²¹⁵ Collectively, the design values reflected an overall trend toward declining emissions of PM_{2.5}.²¹⁶ Even though the NYMA is in attainment, New York must continue to utilize the monitoring network to verify continued compliance, and if the area violates the standards, the SIP must be revised to address the path to attainment once more.²¹⁷

Fine particulate matter can emerge from stationary as well as mobile sources, and as such, the regulations for PM_{2.5} must apply to the various potential sources. Additionally, because PM_{2.5} is a resulting byproduct of the decomposition of other atmospheric constituents, PM_{2.5} can also be reduced through rules focusing on SO₂, NO_x, and VOCs.²¹⁸ These methods of reducing PM_{2.5} in the atmosphere include federal trading programs for NO_x, Acid Deposition Reduction Program, and the Clean Air Interstate Rule (CAIR).²¹⁹ Presently, CAIR is under review by the EPA following litigation so “states are not able to permanently rely upon the emissions

²¹¹ *Id.*

²¹² *Id.*

²¹³ DESIGN VALUES, <http://www.epa.gov/airtrends/values.html> (last visited Apr. 22, 2015).

²¹⁴ New York Department of Environmental Conservation, *supra* note 203.

²¹⁵ *Id.*

²¹⁶ *Id.*

²¹⁷ *Id.*

²¹⁸ *Id.*

²¹⁹ *Id.*

reductions expected under CAIR”.²²⁰ New York has also imposed rules on stationary sources, including limiting VOCs under Architectural and Industrial Maintenance and using Reasonably Available Control Technology (RACT) for major facilities, particularly for NO_x.²²¹ Recently adopted measures include federal mandates to target emissions of SO₂, NO_x, and VOCs, and these rules are buttressed with the New York state rules requiring Best Available Retrofit Technology, which encompasses a myriad of tactics through “unit shutdown, emission caps, add-on control technology, and process modification”.²²² New York also requires low-sulfur heating fuel used in all residential, commercial, and industrial heating.²²³ Mobile source are mostly handled through vehicle inspection and maintenance.²²⁴ New York features both a Vehicle Inspection Program and a Metropolitan Area Enhance Inspection/Maintenance Program.²²⁵ Federally, programs related to gasoline content, cleaner diesel fuel, and controlling of emissions on nonroad diesel engines contribute to the declining emissions of PM_{2.5} in the NYMA.²²⁶

All of these measures will continue to limit PM_{2.5} and reduce the negative impact of the aerosol in the region, which is essential to maintaining the designation of attainment. As part of the redesignation process and the maintenance plan, New York must demonstrate an intention to continue to comply with the NAAQS for at least ten years, and after eight years following redesignation, the state must again evaluate the PM_{2.5} concentrations and active measures to reduce the substance in order to maintain attainment for an additional ten years.²²⁷ Crucial to the

²²⁰ *Id.*, referencing *State of North Carolina v. EPA*, U.S. Court of Appeals (DC Cir., July 11, 2008).

²²¹ *Id.*

²²² *Id.*

²²³ *Id.*

²²⁴ *Id.*

²²⁵ *Id.*

²²⁶ *Id.*

²²⁷ *Id.*

maintenance plan is the final requirement for redesignation of providing the EPA with the contingency plan for correcting any violations that may occur after redesignation.²²⁸

One step in the process of maintaining attainment is creating an emissions inventory to understand the sources of PM_{2.5} and to evaluate the effectiveness of rules intended to reduce PM_{2.5}.²²⁹ These inventories are often created through a combination of observations from the data monitoring network and models simulating the progression of emissions. Emissions from new and future projects are incorporated into the models so that the emissions from those projects may be mitigated from the start so as to not disrupt the established attainment.²³⁰ For example, the Tappan Zee Hudson River Crossing Project will result in a cornucopia of emissions that will impact the NYMA, and the estimated construction emissions have been considered as part of the SIP and the maintenance plan.²³¹ Future rules and regulations have been proposed that will continue to promote reductions of PM_{2.5} in the NYC metro area.²³² These regulations include rules on fuel composition and use, including sulfur limitations, distributed generation for electricity sources, and rules for gasoline dispensing sites and emissions from transport vehicles.²³³

The next set of PM_{2.5} standards (2012 standards) were made official by the EPA in early 2013.²³⁴ After the requisite three years of observations, the EPA designated which areas were in nonattainment for the new standard.²³⁵ The NYMA was found to be in attainment for the newest

²²⁸ *Id.*

²²⁹ *Id.*

²³⁰ *Id.*

²³¹ *Id.*

²³² *Id.*

²³³ *Id.*

²³⁴ National Ambient Air Quality Standards for Particulate Matter, 78 Fed. Reg. at 3086.

²³⁵ Air Quality Designations for the 2012 Primary Annual Fine Particle (PM_{2.5}) National Ambient Air Quality Standards (NAAQS), 80 Fed. Reg. at 2207.

standard thus making the area is in attainment for all three standards of PM_{2.5}, both annual and 24-hour standards.²³⁶

G. Conclusions

The United States currently has regulated PM_{2.5} to a level slightly above the WHO suggested levels. Perhaps in coming years, the United States will ratchet back the present standards to those of the WHO, but for now, the standards work well to limit exposure to PM_{2.5}. The New York metro area is home to millions of people who suffered at the hands of poor air quality, but through a series of regulations and national measures to reduce emissions, the concentration of PM_{2.5} is below the federally mandated level.

China is making progress is improving air quality. Just a few years ago, the topic of PM_{2.5} and its negative health impacts was hardly ever discussed. Now, air quality is constantly in the news and the country broadcasts the data from the air quality monitors. China should look to maintain current monitoring and increase monitoring of air quality because tackling the problem of air quality requires knowing the extent of the problem and the sources emitting the most.

Another added benefit of air quality data being public is the citizens of China are aware of the quality of their environment. Persistent outrage from harmed citizens will hopefully inspire China to further restrict the allowable levels of PM_{2.5} concentrations and be vigilant about enforcement. This includes penalizing violators to a sufficient degree so as to provoke compliance from the majority. Additionally, any funding generated from the fines collected should be used to assist others comply with the laws to improve air quality.

Measures addressing PM_{2.5} pollution cannot focus solely on one location. The ease with which PM_{2.5} is transported through the atmosphere requires regional compliance. As the

²³⁶ *Id.*

measures in Beijing effect positive reactions to the air quality, the industries cannot simply be relocated outside the bounds of the city. The entire region must be considered. This will require municipal governments to work together for siting construction of new plants and for retrofitting existing plants. Similarly, motor vehicle usage within the region should be considered as a whole to reduce emissions of $PM_{2.5}$. National level measures of fuel quality and requirements for retrofitting the existing fleet where possible will help alleviate local emissions of $PM_{2.5}$ and other pollutants. Beyond that, Beijing's plan to remove older vehicles should continue in the years to come.

The quick fixes used during the Olympics in 2008 and "APEC Blue" in November 2014 are merely temporary solutions to a much larger problem. Any measures to reduce emissions of $PM_{2.5}$ must be easily implemented as quickly as possible but have the staying power to provide long-term protection. Much of the requisite technology exists. The key is starting with what is most feasible to cut emissions as quickly as possible. As better solutions become more prevalent, they should be considered and applied. Air quality is a major concern in Beijing, but hopefully some day soon, Beijing will tell a success story much like New York.