Appendix 4

Efforts to Limit Diesel Fuel Sulfur Levels

As discussed in Chapter 8, the availability of low-sulfur diesel fuel is imperative for many emissions control strategies. Sulfur in fuel will poison the catalysts that are built into passive DPFs, thus rendering them ineffective. DPFs work ideally with 50 ppm or less sulfur diesel fuel ("low-sulfur diesel"). Thus, nations that have adopted low sulfur requirements for diesel fuel of 50 ppm or less are best positioned to adopt more stringent emission standards for new motor vehicles, and have more flexibility to target emissions from in-use vehicles. Nations with established standards of 500 ppm or less have more limited institutional and technological potential for further reductions. Nations with nominal or no limits on sulfur in diesel fuel are unable to adopt technology-based standards or controls on in-use engines that would offer significant reductions in BC.

Aside from the United States, Canada, Japan, and the European Union, 50 ppm or less sulfur diesel fuel is not common. Only a few metropolitan areas in developing Asia have 50 ppm sulfur diesel available (USAID, 2010a). However, several countries around the world have adopted schedules that require the use of lower sulfur diesel fuel between 2010 and 2015:

- Africa: Morocco established limits of 50 ppm in 2009, and Tunisia will require 50 ppm fuel in 2014-2015.

- Americas and Caribbean: Mexico adopted ULSD (< 15 ppm) in 2009 nationwide, while Chile and Brazil have mandated ULSD in urban areas between 2009 and 2013. Several other nations have established requirements for diesel fuel with 50 ppm sulfur, either nationwide (Columbia 2013, Chile 2010, Uruguay 2010) or in large urban areas (Argentina 2012, Colombia 2010).

- Caucasus and Central Asia: Armenia and Kazakhstan both introduced requirements for 10 ppm diesel fuel in 2010. Georgia adopted national standards for 50 ppm diesel fuel in 2010.

- East Asia and Pacific Islands: Malaysia required 50 ppm diesel fuel in 2010 and is requiring 10 ppm diesel fuel in 2015. Singapore, Malaysia, and the Republic of Korea have established national sulfur standards of 50 ppm in diesel fuel between 2007 and 2010. Thailand is limiting diesel fuel to 50 ppm sulfur in 2012. Malaysia and the Republic of Korea plan to adopt 10-15 ppm sulfur limits between 2010 and 2015.

- Eastern Europe: Ibania and Belarus plan to require 10 ppm sulfur in diesel fuel in 2011-2012. Croatia, Russia, and Turkey have adopted standards of 50 ppm between 2008 and 2010, though numerous fuel grades continue to be sold.

- South Asia: China limits diesel sulfur to 50 ppm in Beijing (2008), Hong Kong, and Macao; diesel fuel in Taiwan is limited to 50 ppm sulfur after 2005 and 10 ppm starting in 2011. For selected urban areas, India is requiring the use of 50 ppm sulfur diesel fuel in 2010.

- Southwest Asia/Middle East: Israel required 10 ppm sulfur in diesel fuel in 2009, while Qatar is requiring it in 2012. Saudi Arabia and Syria will require 50 ppm fuel in 2014-2015.

Numerous other countries have established diesel sulfur limits of 500 ppm prior to 2015, including Azerbaijan, Brazil (outside urban areas), Ecuador, Fiji, India, Malawi, Mozambique, Oman, Pakistan, the Philippines, South Africa, Sri Lanka, Thailand, Vietnam, and Zimbabwe.

Among nations with less stringent standards on fuel sulfur (e.g., 2,000-10,000 ppm) in either all or part of their territory, some have lowered the limits in recent years. For example, outside urban areas, Argentina and Peru are reducing allowable sulfur to 1500 ppm between 2010 and 2012, from levels of 2500-3000 ppm introduced in 2006. Venezuela reduced allowable sulfur from a standard of 5,000 ppm established to a new standard of 2,000 ppm in 2010. Notable among nations of sub-Saharan Africa, Mauritius established a diesel fuel sulfur standard of 2500 in 2001. Moving to lower sulfur levels in these regions is hampered by economic and technical barriers.

Among nations without sulfur standards, some include oil producing nations, such as Egypt, Iran, and Kuwait. Many sub-Saharan African nations lack national sulfur standards. In the former Soviet Union, many central Asian countries base their national standards on Russia's GOST 305/82 standard for diesel fuel (2,000 ppm). Nevertheless, some nations have diesel fuel with sulfur levels that meet the national standards of countries from which they export. For example, diesel fuel in Lesotho, Namibia, Swaziland, and Botswana meets the 500 ppm national standard established in South Africa, from which they import their fuel.

Through the Partnership for Clean Fuels and Vehicles (PCFV) (*http://www.unep.org/transport/pcfv/*), UNEP continues to work with developing nations to identify opportunities and build capacity to establish lower sulfur levels. For example, the PCFV holds workshops in Africa, Asia, and the Americas, gathering local scientists, engineers, and officials to discuss scientific evidence and economic impacts of how diesel fuel sulfur levels affect cities in developing countries. These meetings follow on PCFV's successful campaign to eliminate lead in gasoline, which recently celebrated the complete phase-out of lead in African gasoline.

Several regional intergovernmental agreements have also been signed by representatives at the ministerial level. In February 2008, environmental ministerial officials from Latin America and the Caribbean in Santo Domingo, Dominican Republic agreed to promote sulfur reduction in fuel throughout the region, with a target goal of 50 ppm. In July 2009, several west and central African environmental ministers signed a regional framework agreement on air pollution, including goals to adopt 3500 ppm fuel sulfur limits by the end of 2011, with a goal of 50 ppm fuel by 2020. Though non-binding on governments, these agreements suggest that there is significant impetus to reduce sulfur levels in fuels used in the developing world.

In addition to governmental and intergovernmental efforts to reduce diesel fuel sulfur levels, several private sector initiatives also exist. Vehicle industries around the world have recognized the value of reduced sulfur for enabling lower-emissions vehicles and high-efficiency combustion technologies. In 2002, vehicle and engine manufacturers from the United States, Europe, and Japan published a report on worldwide fuels harmonization, which promoted lower sulfur levels in gasoline and diesel fuel. More recently, the African Refiners Association has developed a set of "AFRI" fuel specifications (AFRI-1 through AFRI-4) as a developmental pathway for African development of ≤50 ppm sulfur.

Table A4-1 gives recent information on national standards for on-road diesel sulfur limits, and estimates of current sulfur levels. In addition to the efforts described above, Chapter 8 also mentions the limits on sulfur content of marine fuel being phased in under requirements from the IMO. Table A4-2 provides details regarding the fuel sulfur levels allowed for C3 marine fuel within ECAs and globally outside of ECAs, and the schedule for phase-in of tighter limits on sulfur content of this fuel. For this table, the Global and ECA fuel standards shown are the maximum fuel sulfur levels allowed under MARPOL Annex VI for ships with engines over 130 kW.[1] The date on which the ECA requirements become enforceable for a specific geographic area depends on the date the treaty amendment incorporating the ECA enters into force.

[1] MARPOL is an abbreviation of "marine pollution," and is the acronym used to refer to the International Convention on the Prevention of Pollution from Ships.

Table A4-1. International Regulations and International Agreements on Diesel Fuel Sulfur Levels (in ppm). (Source: U.S. EPA)

Region	Country	Year																					Current Maximum Level
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Americas and Caribbean	Mexico (National)	?	?	?	?	?	?	500	500	500	15	15											
	Mexico (Northern)	?	?	?	?	?	?	300	15	15	15	15											
	Argentina (Urban)	?	?	?	?	?	?	1500	1500	1500	1500	(500)	(500)	50									50
	Argentina (Non-Urban)	?	?	?	?	?	?	2500	2500	2500	2500	2500	2500	1500									1500
	Barbados	No existing or planned standards.																					(5000)
	Bolivia	?	?	?	?	?	?	?	?	?	?	(2000)											5000
	Brazil (Non-Urban)	?	3500	3500	3500	3500	3500	3500	3500	3500	3500	1800	1800	1800	1800	500							2000
	Brazil (Metropolitan)	?	2000	2000	2000	2000	500	500	500	500	50	50	50	50	10								50
	Chile (National)	?	?	?	?	?	?	350	350	350	350	50											50
	Chile (Santiago)	?	?	?	?	?	?	50	50	50	50	10											10
	Colombia (National)	?	?	?	?	?	?	2500	2500	2500	2500	500			50								500
	Colombia (Bogota)	?	?	?	?	?	?	?	?	?	?	50											
	Costa Rica	No existing or planned standards.																					(500)
	Cuba	No existing or planned standards.																					(8000)
	Dominican Republic	No existing or planned standards.																					7500
	Ecuador (National)	?	?	?	?	?	?	?	(500)	500	500	50											
	Ecuador (Urban)	?	?	?	?	?	?	5000															500
	Ecuador (Non-Urban)	?	?	?	?	?	?	7000															
	El Salvador	?	?	?	?	?	?	?	?	?	?	500											
	Guatemala	?	?	?	?	?	?	?	?	?	?	(500)											5000
	Honduras	?	?	?	?	?	?	?	?	?	?	(500)											5000
	Panama	?	?	?	?	?	?	?	?	?	?	(1000)											5000
	Peru (Urban)	?	?	?	?	?	?	1500	1500	1500	1500	50											

Region	Country	Year																					Current Maximum Level
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Americas and Caribbean	Peru (Non-Urban)	?	?	?	?	?	?	3000	3000	3000	3000	1500											
	Uruguay	?	?	?	?	?	?	8000	8000	8000	8000	50											
	Venezuela	?	?	?	?	?	?	5000	5000	5000	5000	2000											5000
East Asia, Australia, and Pacific Islands	Australia	?	?	?	500	500	500	50	50	50	10												10
	Cambodia	2000	?	?	?	?	?																1500
	China (National)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	350											
	China (Beijing)	?	?	?	?	?	?	?	?	50	50	50	50	10									
	China (Hong Kong)	500	50	50	50	50	50	50	50	50	50	50											
	Fiji	?	?	?	?	?	?	?	500														
	Indonesia	5000	5000	5000	5000	5000	5000	5000	~~3500~~	~~3500~~	~~3500~~	(500)											4000
	Japan	100	100	100	100	100	50	50	50	50	50	50											
	Malaysia	3000	3000	(500)	(500)	(500)	(500)	(500)	(500)	(500)	(500)	50	50	50	50	50	10						
	Nepal	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000											500
	Philippines	?	?	?	?	?	?	?	?	?	?	500											
	Republic of Korea	500	500	500	500	500	500	500	500	500	500	50											
	Singapore	500	500	500	500	500	500	500	50	50	50	50											
	Thailand	500	500	500	500	500	500	500	500	500	500	500	500	50									
	Vietnam	10000	10000	2000	2000	2000	500	500	500	500	500	500											
Eastern Europe, Caucasus, and Central Asia	Albania	?	?	?	?	?	?	?	?	?	?	350	150	10									2000
	Belarus	?	?	?	?	?	?	?	?	?	?	50	10										350
	Bosnia & Herzegovina	?	?	?	?	?	?	?	?	?	?	350											350
	Croatia	?	?	?	?	?	?	?	?	?	50	50	50	10									
	Russia	?	?	?	?	?	?	?	?	500	350	50											
	Turkey	?	?	?	?	?	?	?	?	50/ 1000	50/ 1000	50/ 1000											
	Armenia	?	?	?	?	?	?	?	?	350	50	10											
	Azerbaijan	?	?	?	?	?	?	?	?	?	?	2000	2000	2000	2000	2000	500						
	Georgia	?	?	?	?	?	?	?	?	?	350	50											
	Kazakhstan	?	?	?	?	?	?	?	?	2000	2000	10											
	Kyrgyzstan	?	?	?	?	?	?	?	?	(350)	(350)	(350)											2000- 5000
	Serbia	?	?	?	?	?	?	?	?	?	10000	(350)											10000
	Uzbekistan	?	?	?	?	?	?	?	?	?	?	5000											400- 2000

Region	Country	Year																				Current Maximum Level
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
South Asia	Afghanistan	No existing or planned standards.																				
	Bangladesh	?	?	?	?	?	?	5000															
	India	2500	2500	2500	2500	2500	500	500	500	500	500	350											
	India (Selected Areas)						350	350	350	350	350	50											
	Nepal	10000	10000	10000	10000	10000	10000	(500)	(500)	(500)	(500)	(500)	(350)										
	Pakistan	?	?	?	?	?	?	?	?	?	?	?	?	500									
	Sri Lanka	10000	10000	10000	3000	?	?	?	?	?	?	500											
Southwest Asia and North Africa	Algeria	No existing or planned standards.																				900
	Bahrain	?	?	?	?	?	?	?	?	?	?	(500)											500
	Egypt	?	?	?	?	?	?	?	?	?	?	(5000)											10000
	Iran	?	?	?	?	?	?	?	?	?	?	(5000)											10000
	Iraq	?	?	?	?	?	?	?	?	?	?	(10000)											25000
	Israel	?	?	?	?	?	?	?	?	?	10												10
	Jordan	?	?	?	?	?	?	?	?	?	?	350											(7000-10000)
	Kuwait	?	?	?	?	?	?	?	?	?	(50)	(50)	(50)	(50)	(10)								2000
	Lebanon	No existing or planned standards.																					(5,005,000)
	Libya	?	?	?	?	?	?	?	?	?	?	(1000)											1500
	Morocco	?	?	?	?	?	?	?	?	?	50	50											50
	Oman	?	?	?	?	?	?	?	?	(50)	(50)	(50)											500
	Palestinian territories	No existing or planned standards.																					(10000)
	Qatar	?	?	?	?	?	?	?	?	?	?	500	500	10									500
	Saudia Arabia	?	?	?	?	?	?	?	?	?	?	?	?	?	?	50							5000
	Syria	?	?	?	?	?	?	?	?	?	(50)	(50)	(50)	(50)	(50)	(50)	50						7000
	Tunisia	?	?	?	?	?	?	10000	350	350	10												5000
	United Arab Emirates	?	?	?	?	?	?	?	?	?	(50)/ 500												350
	Yemen	No existing or planned standards.																					10000
Sub-Saharan Africa	Angola	?	?	?	?	?	?	3000															
	Benin	No existing standards.											3500	3500	3500	3500	3500	3500	3500	3500	3500	50	(10000)
	Botswana	No existing or planned standards.																					(500)
	Burkina Faso	No existing standards.											*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	(5000)
	Burundi	No existing or planned standards.																					(5000)
	Cameroon	?	?	?	?	?	?	?	?	?	?	5000											5000

Region	Country	Year																					Current Maximum Level
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Sub-Saharan Africa	Cape Verde	No existing or planned standards.																					(3000)
	Central African Republic	No existing or planned standards.																					(3000-5000)
	Chad	No existing standards.											3500	3500	3500	3500	3500	3500	3500	3500	3500	50	5000
	Côte d'Ivoire	?	?	?	?	?	?	?	?	?	?	5000	3500	3500	3500	3500	3500	3500	3500	3500	3500	50	5000
	Dem. Rep. of Congo												*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	(5000)
	Djibouti	?	?	?	?	?	?	?	?	?	?	5000											5000
	Equitorial Guinea	No existing or planned standards.																					(5000-8000)
	Eritrea	?	?	?	?	?	?	?	?	?	?	7000											7000
	Ethiopia	?	?	?	?	?	?	?	?	?	?	(5000)											10000
	Gabon	No existing or planned standards.																					(8000)
	Gambia	No existing or planned standards.																					
	Ghana	?	?	?	?	?	?	?	?	?	?	5000	3500	3500	3500	3500	3500	3500	3500	3500	3500	50	5000
	Guinea	No existing standards.											*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	(5000)
	Guinea Bissau	No existing or planned standards.																					(5000)
	Kenya	?	?	?	?	?	?	?	?	(5000)													10000
	Liberia	No existing standards.											*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	(5000)
	Madagascar	?	?	?	?	?	?	?	?	?	?	5000											500
	Malawi	?	?	?	?	?	?	?	?	500													500
	Mali	No existing standards.											3500	3500	3500	3500	3500	3500	3500	3500	3500	50	(10000)
	Mauritania	No existing or planned standards.																					(5000)
	Mauritius	?	2500																				2500
	Mozambique	?	?	?	?	?	?	?	?	500													500
	Namibia	No existing or planned standards.																					(500)
	Niger	?	?	?	?	?	?	?	?	?	?		*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	10000
	Nigeria	?	?	?	?	?	?	?	?	?	?	(1330)											5000
	Republic of the Congo	?	?	?	?	?	?	?	?	?	?	(1000)	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	10000
	Senegal	?	?	?	?	?	?	?	?	?	?												5000
	Sierra Leone	No existing standards.											3500	3500	3500	3500	3500	3500	3500	3500	3500	50	(5000)
	South Africa	?	?	?	?	?	?	500	-50														500
	Tanzania	?	?	?	?	?	?	?	?	?	?	5000											5000
	Togo	?	?	?	?	?	?	?	?	?	?	10000	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*3500*	*50*	10000
	Uganda	?	?	?	?	?	?	?	?	?	?	5000											5000

Region	Country	Year																					Current Maximum Level
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
	Zambia	?	?	?	?	?	?	?	?	?	?	7500											7500
	Zimbabwe	?	?	?	?	?	?	?	?	500													

Notes:

1. Parentheses indicates that fuel of a given sulfur level is available or sold in that country, though the national standard may differ.
2. Strikethrough numbers indicate that fuel with sulfur in excess of the local standard is commonly sold.
3. Gray-shaded numbers indicate intergovernmental agreement on future standards.
4. Underlined numbers refer to agreements made by national ministerial-level officials.
5. Italicized numbers refer to agreements made by national officials below ministerial level.

Source Material:

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Table A4-2. International Fuel Sulfur Limits for C3 Marine Fuel, by Target Year. (Source: U.S. EPA)

Global		ECA	
2004	45,000 ppm	2005	15,000 ppm
2012	35,000 ppm	2010	10,000 ppm
2020	5,000 ppm	2015	1,000 ppm