Transportation and the Environment in China

by Michael P. Walsh

At first glance, concerns regarding motor vehicle pollution in China seem misplaced. With a population more than four times as large as the United States (1.22 billion versus 268 million) the number of cars, trucks, and buses in China is a mere fraction of that in the United States (less than fourteen million in China versus 210 million in the United States). On a per capita basis, China has one of the lowest vehicle populations in the world, as illustrated in Table 1.

According to Table 1, it is clear that among these countries only India has a lower vehicle ownership density than China. However, to stop at this superficial overview would be very misleading. In recent years, the vehicle population in China has been increasing sharply, with much of this growth taking place in cities. Nationally, the annual growth of vehicles has averaged approximately fourteen percent per year. One result of this rapid growth has been the emergence of serious air pollution problems, especially in cities. Furthermore, the growth in vehicles in China is expected to continue and perhaps even accelerate in coming decades, increasing concerns regarding further environmental degradation. Chinese policymakers have begun to respond to the growing problem of air pollution. For example the government has initiated a public reporting system whereby a growing number of Chinese cities are now routinely reporting their current air quality, as illustrated by the most recent data summarized in Table 2 (following page). As Table 2 shows, several cities have an air pollution index above 400 for total suspended particulates (TSP), which means these cities measured TSP levels above 875 mg/m^3 (micrograms per cubic meter).

Table B illustrates that most Chinese cities already have serious air pollution problems particularly with TSP and nitrogen oxides (NO_x). As this information has become publicly available, citizen pressure has been building to push the government to take action to lower the pollution levels. Strategies are therefore being developed and implemented at both the national and local levels to counteract this problem. Most notably, at the national level, China has completed an environmental technical assistance project, sponsored by a World Bank loan, to develop an Action Plan with the objective of assuring that by 2010 the air quality levels in China's major cities meet the second class of national standards.[1] One trend which could help China attain these national air quality standards has been actions by large cities, particularly Beijing, to develop local pollution control strategies. The purpose of this article is to review and analyze the proposed national Action Plan and recent municipal government actions to alleviate pollution problems in China. To place the Action Plan and local actions in context, I will first outline current information on vehicle use, air quality, and infrastructure investment.

Table 1. Vehicle Ownership Density

Country	Vehicles/ 1000 People
United States	785
Australia	591
Japan	560
Germany	553
Austria	513
Portugal	395
Greece	290
Bulgaria	235
Romania	135
Mexico	135
Chile	105
Venezuela	95
Thailand	73
Egypt	29
China	10
India	8

Source: Data: "World Vehicle Demographics." *Financial Times Automotive World.* (April 1999.)

The Current Situation in China

Vehicle Growth and Roads

The total number of motorized vehicles in China, although very low by Western standards, is growing rapidly and has already risen to about 1.4 million in Beijing and over one million in Guangzhou. For the country as a whole, the number of vehicles in 1998 climbed to about fourteen million cars and trucks and twenty million motorcycles. Much of the growth has been in private passenger cars, especially in recent years. The demand for personal cars in China rose by an average of 28.1 percent over the past five years and is expected to hit one million cars annually by the year 2000.[2] In spite of an almost doubling in the number of public transit vehicles from 1993 to 1997 (see Table 3, following page), the total passengers carried has remained constant across the country's cities, with many actually showing declines.[3]

With regard to driving patterns and average speeds, many existing roads have already reached their maximum capacity and are saturated during long periods of each day. Substantial road building is underway in all large cities and over the past five years, the investment for road infrastructure in the large cities has doubled.[4] The results of this investment are clear in Shanghai, which boasts an impressive improvement in increasing road length, road area, and road area per capita by nineteen percent, forty-two percent, and thirty-nine percent, respectively, between 1991-1997 (See Table 4, following page). However, the expansion in the city's road infrastructure pales in comparison to the vehicle growth that has averaged fifteen percent per year since the mid-1980s.[5]

Table 2. Compilation of Air Pollution Data for Chinese Cities

City	Air Pollution Index	Chief Pollutant
Beijing	500	TSP
Tianjing	424	TSP
Shijiazhuang	201	TSP
Qinhuangdao	136	TSP
Taiyuan	311	TSP
Huhehaotei	408	TSP
Shenyang	184	TSP
Dalian	70	TSP
Changchun	369	TSP
Haerbin	118	TSP
Shanghai	128	NOx
Nanjing	108	TSP
Suzhou	138	TSP
Nantong	228	TSP
Lianyungang	178	TSP
Hangzhou	152	NOx
Ningbo	82	TSP
Wenzhou	77	TSP
Hefei	82	TSP
Fuzhou	59	TSP
Xiamen	38	-
Nanchang	113	TSP
Jinan	328	TSP

Source: http://www.usembassy-china.org.cn/english/sandt/index.html, which is the webpage for the Environment, Science, and Technology Section of the U.S. Embassy in Beijing.

Air Quality and Pollution from Mobile Sources

One of the challenges for policymakers in China is that air quality monitoring data in Chinese cities are limited, especially in high traffic areas. Based on the available data, however, it is clear that national NO_x air quality standards are currently exceeded across large areas, including, but not limited to, high traffic areas. Before 1992, the annual average concentration of NO_x in Shanghai was lower than 0.05 mg/m^3, which complies with the Class II air quality standards in the People's Republic of China (PRC). But since 1995, the NO_x concentration in Shanghai has increased slowly, from 0.051 mg/m^3 in 1995 to 0.059 mg/m^3 in 1997.[6]

In Beijing, NO_x concentrations within the Second Ring Road that encircles the city center increased from 99 mg/m^3 in 1986 to 205 mg/m^3 in 1997, more than doubling in a decade. Moreover, carbon monoxide (CO) and NO_x concentrations on Beijing's trunk traffic roads and interchanges exceed national environmental quality standards all year round.[7] Recent data also indicate that standards for ozone, formed by the photochemical reaction of NO_x and hydrocarbons (HC), have been exceeded in several metropolitan areas during the last decade.

On average, mobile sources are currently contributing approximately forty-five to sixty percent of the NO_x emissions and about eighty-five percent of the CO emissions in typical Chinese cities.[8] Recent data collected in Shanghai, for example, show that in 1996, vehicles emitted eighty-six percent of the CO, fifty-six percent of the NO_x, and ninety-six percent of the non-methane hydrocarbons (NMHC) of the total air pollution load in the downtown area.[9] In Beijing in recent years, the NO_x concentration shows a clear increasing trend. Annual average NO_x concentrations, average concentrations during the heating season, and those during the non-heating season in 1997 were 133 mg/m^3, 191 mg/m^3, and 99 mg/m^3, respectively. These emissions were seventy-three percent, sixty-six percent, and eighty percent higher than those ten years ago. The annual daily average NO_x concentration in 1998 was 14.3 percent higher than in 1997. Since the amount of coal burned has remained stable for many years, Beijing local authorities attribute the increases in these pollutants to vehicular emissions.[10] Poor vehicle maintenance is one leading cause of mobile source pollution problems. This deficiency in vehicle maintenance is reflected in the high failure rate in the existing, relatively lenient Inspection and Maintenance (I/M) programs. Poor training of inspectors has meant repair workers lack the necessary professional knowledge and expertise in repair and maintenance service of emission equipment.[11] Many vehicles seem to be

Table 3. Public Transit in Chinese Cities

City	Number of Public Transit Vehicles (Standardized Vehicle Equivalents)		Total Passengers Carried (Millions)	
	1993	1997	1993	1997
Beijing	4890	8548	2863	3374
Tianjin	2193	2896	397	536
Shenyang	2406	2359	537	625
Changchun	1031	2249	310	341
Harbin	1344	3139	612	543
Shanghai	8521	16237	5627	2637
Nanjing	2412	2360	500	499
Wuhan	1971	4355	1251	943
Ghangzhou	2338	4611	664	1074
Chongqing	2090	2479	753	502
Chengdu	1408	1618	288	293
Xian	871	1418	355	299
Total of 12 Cities	31,475	52,269	14,156	11,667
Average of 12 Cities	2623	4356	1180	972
Total of 666 Cities	88,606	168,566	27,259	27,348

Source: Wu Yong, "Targeting Sustainable Development for Urban Transport," Urban Construction Department of the Ministry of Construction, and Li Xiaojiang, unpublished paper, Chinese Academy of Urban Planning and Design, April 1999.

operating with a rich air fuel mixture, which while producing relatively good drivability and low NO_x emissions, leads to high fuel consumption and excessive CO and HC emissions. Furthermore, the vehicle technology being produced tends to be primarily carburetor-equipped with mechanical rather than electronic controls. Recently collected emissions data in China show that current vehicles are typical of the cars used in the United States in the late 1960/early 1970s.[12]

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In light of the above information on car trends in China, it appears likely that the growth in the overall vehicle population will continue at a high rate for the foreseeable future. As noted in a recent study,

> Credit facilities and installment payments, which China's commercial banks have promised to introduce, are expected to push forward the car-buying momentum. A survey conducted among 600 urban families in Beijing by the China Economic Climate Monitoring Center says that well-to-do families account for eleven percent of the population, families that enjoy a relatively comfortable standard of living represent fifty-three percent, and those that have adequate food and clothing, thirty-four percent. The first category has put car purchases high on their consumer agenda, and the second is expected to have similar lifestyles and hopes within five to ten years. This will spur on the private car sector.[13]

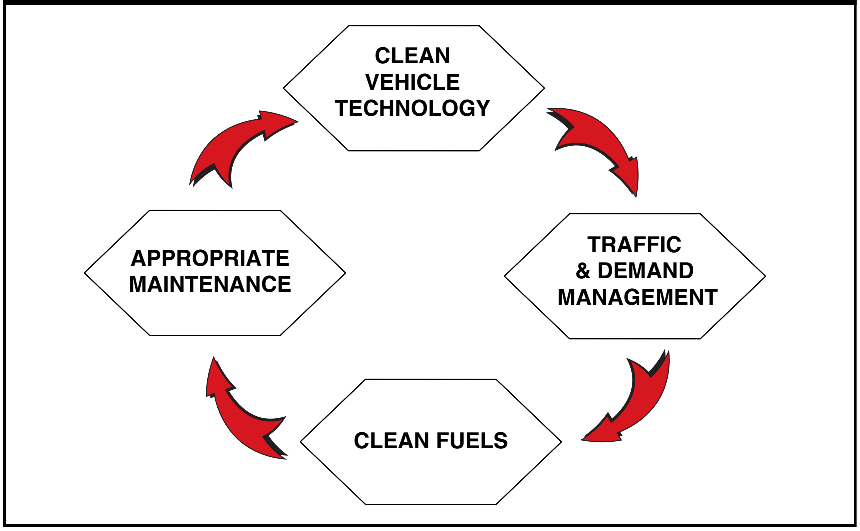
Economic growth and consumers' desires are pushing the growth of vehicle population at a much faster rate than roads are being constructed. The number of roads approaching saturation will likely increase and the period of time when these roads will be overloaded will lengthen, which will result in more frequent and severe air quality peaks in localized areas. This congestion means that national air quality standards for NO_x, CO, and ozone will increasingly be exceeded in many cities. In addition, roadside particulate problems will likely increase, leading to serious health problems. Based on data collected in the World Bank project, it is clear that with the increase in diesel vehicles particulate matter (PM)

Table 4. Paved Road Length and Per Capita Paved Road Area of Shanghai (1991-1997)

Year	Length of Paved Road (Km)	Area of Paved Road (10^4 m^2)	Per Capita Road Area (m^2)
1991	4817.6	6004.8	4.67
1992	5043.2	6386.7	4.95
1993	5105.3	6569.2	5.07
1994	5192.3	6862.2	5.28
1995	5420.3	7399.9	5.69
1996	5599.3	8058.5	6.17
1997	5712.7	8503.2	6.51

"Strategy for Sustainable Development of Urban Transportation and Environment—for a Metropolis with Coordinating Development of Transportation and Environment toward the 21st Century," Shanghai Municipal Government, January 10, 1999.

Figure 1. Elements of a Comprehensive Vehicle Pollution Control Strategy



and NO_x will also rise. Since diesel particulates have been identified as a likely human carcinogen, this risk will increase as well. The World Bank data stress that based on the vehicle growth projections, it can be concluded that a successful program to reduce air pollution and its local and regional effects will depend on the success in controlling mobile emissions sources.[14] In light of these dangerous pollution trends, the National Environmental Protection Administration—now upgraded to the State Environmental Protection Administration (SEPA)—undertook a study of national and local plans, which could help alleviate the growing emissions from mobile sources. The SEPA study and its conclusions are presented below. This article then concludes with examples of recent municipal government actions to control vehicle emissions.

SEPA Technical Plan To Address Vehicle Pollution

Generally, the goal of a motor vehicle pollution control program is to reduce emissions from motor vehicles in-use to the degree necessary to achieve healthy air quality as rapidly as possible or, failing that for reasons of impracticality, to the practical limits of effective technological, economic, and social feasibility. Achievement of this goal generally requires a comprehensive strategy encompassing emissions standards for new vehicles, clean fuels, and programs designed to assure that vehicles are maintained in a manner that minimizes their emissions. Finally, to complete this comprehensive strategy, an effective program for traffic and demand management that limits the demand for and use of all vehicles must be formulated. Ideally, to be politically feasible, these emission reduction goals should be achieved in the least costly manner. Figure 1 illustrates the elements of a comprehensive vehicle pollution control strategy.

Standards for permissible levels of exhaust and evaporative emissions from motor vehicles should be based on a realistic assessment of costs and benefits keeping in view the technical and administrative feasibility of proposed countermeasures. Technological approaches to achieve the desired emission standards may include fitting new vehicles with emission control devices, such as catalytic converters or particulate traps, requiring such devices to be retrofitted to existing vehicles, and modifying fuels or requiring the use of alternative fuels in certain vehicles. Emissions may also be reduced through traffic and demand management strategies and policy instruments, such as higher taxes for vehicles that will be driven in high pollution areas during rush hours. However, many of the potential benefits of these countermeasures will be squandered if regulatory and economic instruments do not create the incentives for vehicle owners, manufacturers, and fuel suppliers to comply with the standards and change their behavior to achieve the desired goals. A key element of the overall strategy, therefore, must be effective enforcement to ensure maximum compliance with standards.

To develop a national strategy for addressing vehicle pollution, SEPA, with support from the World Bank, pulled together a team of experts from a variety of government agencies and technical institutes and universities to study the vehicle pollution issues. Taking Beijing and Guangzhou as typical cities, the study analyzed the main reasons for the serious vehicular pollution in China. The study determined the average emission rates for the existing vehicle fleet and its contribution to urban air pollution and predicted the future vehicular development and pollution. Another important component of the study was a comparative analysis of foreign experiences on controlling vehicle emission pollution and evaluated the feasibility and cost-effectiveness of implementing the internationally-advanced technologies and management systems in China. Finally, the study defined the vehicular emission control targets and corresponding technology and management strategy.

Emissions Standards for New Vehicles

To determine the appropriate national emissions standards to adopt in China, estimates were made by World Bank and SEPA analysts regarding the potential emissions reductions that such standards could achieve. The costs and cost-effectiveness of these standards were evaluated and compared. The costs of various standards to reduce NO_x are presented in Table 5. Most of the strategies considered for new vehicles were based on European regulations, for China had previously adopted the first generation of European emissions standards. Moreover, the largest car manufacturer in China is a European company—Volkswagen. The important exception was the inclusion of Japanese and Taiwanese strategies for motorcycles. These strategies were considered, because most motorcycles in China are manufactured in Japan and Taiwan.

It can be seen that all but the last three strategies considered would cost less than U.S. $2000 per ton of NO_x reduced. Keeping emission costs below U.S. $2000 indicates a very cost-effective level based on international experience. From this broad analysis, several potential scenarios were developed in the World Bank/SEPA study to represent packages of measures for all categories of new vehicles. In selecting strategies to be adopted, several factors were taken into account, including the following:

- Air quality need;
- Potential effectiveness of the measure;
- Cost of the measure, including

Table 5. Cost Effectiveness of Various New Vehicle Emission Strategies

Vehicle Type	Strategy	Tons NO_x Reduced[a]	Cost	Cost Effectiveness[b] (US$/Ton)
HDDV	EU2	2.2487	$946	$421
Jeep	96/69	0.8602	$42	$49
LDDV	94/12	0.7694	$396	$515
LDGV	94/12	0.704	$382	$543
Jeep	93/59	0.6993	$139	$199
LDDV	91/441	0.6239	$100	$160
LDGT2	96/69	0.5859	$370	$632
LDGV	91/441	0.5714	$394	$690
LDDT	96/69	0.5037	$370	$734
HDDV	EU1	0.4814	$721	$1,498
Mini Vehicle	96/69	0.4468	$316	$706
LDGT2	93/59	0.4449	$385	$866
LDDT	93/59	0.4061	$100	$246
Mini Vehicle	93/59	0.347	$344	$992
MC	Japan	0.1893	$216	$1,142
MC	Taiwan 91	0.1884	$224	$1,190
HDGV	EU2	0.1183	$322	$2,726
MC	Taiwan 94	0.0658	$309	$4,699
HDGV	EU1	0.0219	$416	$18,995

Source: "China's Strategies for Controlling Motor Vehicle Emissions," Summary Report, December 1997.
[a]Relative to current requirements. [b] In making this estimate, all other benefits of the standards were ignored. The entire costs were ascribed to NO_x control even though in most cases, substantial CO and/or HC reductions would also occur. HD-Heavy Duty, LD-Light Duty, DV-Diesel Vehicle, GV-Gas Vehicle, GT2-Heavy Duty Gas Vehicle; MC-Motorcycle

hardware, maintenance, and fuel economy;
- Overall cost effectiveness; and,
- Technical feasibility.

Considering each of the above factors, the choice of standards that promote the lowest emissions in new vehicles were narrowed down to the two scenarios summarized in Table 6. The options for final consideration were:

• **Scenario 2:** Adopting the standards which were introduced in Europe in 1992 followed four years later by the new 1996 European standards and completing enforcement by 2000.

• **Scenario 4:** Adopting the standards introduced in Europe in 1996 and completing enforcement by 2002.

Analysts at SEPA determined that both scenarios are very cost effective (See Table 7). After considering all these factors, as well as the technological capability of the domestic vehicle industry, SEPA and its support team recommended Scenario 2 as the minimum requirement for new vehicles. However, SEPA will consider Scenario 4 as an alternative and provide fiscal incentives to encourage Scenario 4 vehicles and engines. In addition to these emission regulations for new vehicles, the report specified some regulations that SEPA should issue for limiting emissions in existing vehicles.

Table 6. Proposed Scenarios for New Vehicles in China

Scenario	Vehicle Type	2000	2002	2005
2	Passenger Cars	91/441		94/12
	Light Duty Vehicles	93/59		96/69
	Heavy Duty Vehicles	Euro 1		Euro 2
	Motorcycles	ECE 40.01		Japan
4	Passenger Cars		94/12	
	Light Duty Vehicles		96/69	
	Heavy Duty Vehicles		Euro 2	
	Motorcycles		Japan	

Source: "China's Strategies for Controlling Motor Vehicle Emissions," World Bank Summary Report, December 1997.

Proposed Measures for In-Use Vehicles

In addition to setting emission standards for new cars, the World Bank/SEPA study highlighted four main areas for controlling emissions in existing vehicles:

• **Inspection and Maintenance** (I/M): Analysis indicated that creating a well-functioning I/M program could be one of the most cost-effective options considered and one that could have a rapid impact. After 2002, a loaded mode test procedure, the ASM test, will be adopted for catalyst-equipped vehicles and 100 percent of the vehicles will be required to be tested and 100 percent will need to pass the test in order to be driven. In combination with new vehicle standards, this I/M program will better enable the national NO_x targets to be met.

• **Retrofit Programs:** The study also concluded that national retrofit regulations should be issued for two primary reasons: 1) to assure that retrofit programs being introduced around the country are adequately considering important factors such as fuel quality and vehicle maintenance; and 2) to assure that retrofits actually achieve the claims made by retrofit companies. The final report recommends that a performance standard be used as a basis for approving systems.

• **Fuel Programs:** The study team also recommended that SEPA should issue regulations regarding the quality of fuels and fuel additives and enforce these standards and specifications in the fuel distribution system.

• **Non-Technical Measures:** In addition to technical measures outlined above, cost-effective, non-technical measures, such as traffic controls or tax incentives for cleaner vehicles or fuels should also be developed. These types of measures should be implemented locally. However, national support through technical investigations, financing, and necessary legislation will be needed to facilitate cooperation at the local level. Notably, local representatives from Guangzhou and Beijing were very involved in designing this component.

Table 7. Cost Effectiveness of the Scenarios

Scenario	Cumulative NO_x Reduction (10^4 tons)	Cumulative Costs (10^6 \$)	Cost-Effectiveness (\$/Ton)
2	97	441	450
4	120	389	320

Source: "China's Strategies for Controlling Motor Vehicle Emissions," World Bank Summary Report, December 1997.

Table 8. Projected Overall Vehicle Emissions in 2010

Vehicle Category	HC	CO	NO_x
LDGV	36.8%	52.1%	47.1%
LDGT1	13.5%	17.2%	15.3%
LDGT2	10.7%	13.5%	13.4%
HDGV	2.9%	3.3%	6.6%
HDDV	1.8%	1.0%	11.9%
MC	30.4%	7.9%	0.8%
JEEP	3.8%	5.0%	4.8%

Source: "China's Strategies for Controlling Motor Vehicle Emissions," World Bank Summary Report, December 1997.

Potential Impact of Proposed Standards and Programs

Even after adoption of the new and in-use management and technical measures noted above, the air pollution problems in China's major cities will not be completely solved. While emissions would be much lower without controls, ambient NO_x levels are still projected to remain higher than the targets. Specifically, while area-wide CO problems should be eliminated, it is expected that even with the implementation of emission standards, levels near roadways will still be unhealthy. Furthermore, ozone and PM levels will likely worsen from today's levels without focused efforts to address their emissions and precursors. In the future, to address these remaining problems it will be important to focus on those vehicle categories for which additional control measures appear feasible and potentially effective. In this regard, it is useful to understand the relative importance of the various vehicle categories to projected overall vehicle emissions in 2010 as summarized in Table 8 above.

Based on the data presented in Table 8, it is clear that light duty gasoline fueled cars and trucks will need to remain a primary focus of control efforts in the future. In this regard, it is important for Chinese planners to remain abreast of technological advances and other developments around the world. Therefore, after the standards contained in the Action Plan are implemented, it will be valuable for SEPA to analyze the potential feasibility and cost effectiveness of utilizing the even more stringent Euro 3 requirements in China. Notably, these Euro 3 requirements are going to be introduced in Europe in the year 2000.

Progress on Implementing the Action Plan—Municipal Government Leadership

China has moved rapidly and aggressively to implement the Action Plan strategy. What is striking has been the strong push by large municipal governments to implement these strategies ahead of schedule and at times adopt standards stricter than those in the Action Plan. Below is an overview of five areas in which progress is being made at both the national and municipal level.

• **Unleaded Gasoline:** In March 1997, the decision was made to phase out the production and sale of leaded gasoline across the entire country by 1 July 2000. By July 1997, Beijing had already stopped sales of leaded fuel in the city center and by October the ban had spread to Shanghai and Guangzhou.

• **New Vehicle Standards:** In 1998, the State Council decided to introduce Euro 1, catalyst-based emission standards for all new cars sold in the country as of 1 April 2000. Beijing again took the lead by phasing in these European auto standards that require all new cars to be equipped with catalysts as of 1 January 1999, one year ahead of the national schedule. Of the 64,000 new vehicles sold in Beijing since the beginning of 1999, 46,000 cars comply with the Euro 1 standards and the remaining 18,000 vehicles not meeting these standards are motorcycles, agricultural tractors, and trucks. To regulate these vehicles, Beijing will implement more stringent exhaust standards (Euro 1) for both Heavy Duty Gas Engines (HDGE)[15] and Heavy Duty Diesel Engines (HDDE) with steady state mode test methods, and to agricultural transport vehicles using the free acceleration mode. The standards were put in force by 1 June 1999.

Furthermore, the government of Beijing has a plan to retrofit 14,000 taxis to become dual fuel vehicles gasoline (Liquefied Petroleum Gas—LPG). Among them, 10,000 taxis should be finished before the middle of September 1999 and the remainder by the end 1999. The city government also requires taxi companies with more than 300 taxis must build their own LPG refueling stations. Notably, some public buses will also be changed to use dual fuel. The government wants to change the diesel buses in downtown—inside the second circle road—into gasoline buses, because some national leaders consider the diesel engine to be the worst pollutant source. Notably, the Shanghai municipal government and numerous other large cities are pursuing retrofit strategies as well. This rapid and progressive work by city governments on emission control standards is linked to the publicizing of air quality data in Chinese cities, which has led to public pressure on local authorities to address the problem.

Table 9. SEPA Proposed Schedule for Heavy Duty Standards

	Certification	Production
Euro 1 Standards	July 1, 2000	July 1, 2001
Euro 2 Standards	January 1, 2003	July 1, 2004

Nationally, SEPA is planning to introduce heavy duty standards according to the data presented in Table 9. It should be noted that the State Supervision Bureau (SSB) is in a dispute with SEPA over which organization has authority to issue new vehicle standards. The SSB would most likely delay the introduction of Euro 2 standards until 2005 for certification and delay production standards until 2006.

• **Vehicle Retrofit:** In early March 1999, the Beijing Environmental Protection Bureau (EPB) had a meeting with car manufacturers from all around the country and informed them that all manufacturers whose vehicles had been sold in Beijing should be responsible for the pollution of these vehicles. As a result of the discussions, all domestically produced cars sold in Beijing, which were manufactured between 1995 and 1998, must be retrofitted with a vehicles manufacturer developed kit designed to meet the Euro 1 standards. For cars with carburetors, this means installing a three-way catalyst, an oxygen sensor, an air injector, and an electronic control unit to manage the air-fuel ration at a cost of approximately $375 per vehicle. The scope of the cars needing to be retrofitted, will be the total cars registered between 1 January 1995 and 31 December 1998. Manufacturers were required to finish the work by December 1999. Approximately 80,000 vehicles have been retrofitted to date in Beijing with estimated emissions reductions averaging about seventy percent. When completed, approximately 200,000 vehicles will be retrofitted. Similar programs are going on in other cities.

• **Fuel Conversions:** Orders have been placed for 300 new Cummins Compressed Natural Gas (CNG) engines to be installed in existing buses, replacing diesel engines. No more buses with diesel engines are planned to be purchased and new regulations will require that new buses and taxicabs are fueled by CNG or have the capacity to be dual-fueled (LPG and unleaded gasoline). Approximately 15,000 vehicles have been converted to CNG or dual-fuel as of November 1999 and it is expected that this exceeded 17,000 by the end of 1999. Diesel to CNG conversions are estimated to result in about ten to twenty percent less CO and HC emissions. The Beijing Environmental Protection Bureau has also apparently decided to ban the sale of diesel vehicles altogether in Beijing.

• **Other:** The Beijing Environmental Protection Bureau is actively pursuing loaded emission testing capability for the I/M program, as are other cities in China. The I/M program is the primary enforcement tool for vehicle retrofits and alternate fuel conversions, as well as for the overall maintenance of the vehicle fleet. Another new policy recently introduced by the Beijing Environmental Protection Bureau (EPB) is the requirement to force the retirement of vehicles that have accumulated more than 500,000 kilometers in use. This policy led to the scrapping of approximately 58,000 vehicles, mainly taxis, by the end of 1999.

On 1 June 1999, SEPA issued new control standards for motor vehicle gasoline designed to minimize hazardous risks of benzene, olefins, aromatics, lead, and other chemicals. In addition, detergents which could clean deposits effectively will be required to be added to motor vehicle gasoline. For olefins, the requirements were implemented in Beijing, Shanghai, and Guangzhou as of 1 July 1999 and will be mandatory for the entire country after 1 January 2003. The Beijing EPB is also trying to work with the Petroleum Ministry on further improvements of fuel quality, especially as it pertains to detergents. Currently the Beijing EPB and the Petroleum Ministry are developing Stage I vapor controls at service stations. In the year 2000, a pilot program to raise money to fund pollution control work has been set up in approximately thirty major cities. This pilot project requires the levy of a 300 to 600 Renminbi pollution fee on all vehicles and the funds will be dispersed to local governments to use as they see fit to remedy vehicle pollution in their area.

Conclusion

The vehicle population in China has been growing rapidly over the past decade and will likely continue to do so for the foreseeable future. Without significant effort to constrain the environmental damage that these vehicles can cause, already serious air pollution problems will become critical. To prevent further severe air pollution, the Chinese government—with funding provided by the World Bank—has developed a national strategy for reducing motor vehicle pollution. Key components of the strategy include unleaded gasoline, tight standards on all categories of new vehicles, and a substantially upgraded I/M program. Institutional improvements to enable the strategy to be implemented have also been developed. A great deal of additional work will be needed but it is believed that the work carried out to date under this project provides a good basis upon which to build in the future. Several important elements of the strategy have now been implemented and most notably have been the additional controls that municipal governments are introducing to complement the national strategy.

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Endnotes

[1] "China's Strategies for Controlling Motor Vehicle Emissions," World Bank Summary Report, December 1997.

[2] "Private Car Purchases on the Rise in China," *China Auto*, 9:1 (January/February 1999).

[3] "Targeting Sustainable Development for Urban Transport," Wu Yong, Urban Construction Department of the Ministry of Construction, and Li Xiaojiang, Chinese Academy of Urban Planning and Design, April 1999.

[4] "Strategy for Sustainable Development of Urban Transportation and Environment—for a Metropolis with Coordinating Development of Transportation and Environment toward the 21st Century," Shanghai Municipal Government, January 10, 1999.

[5] Ibid.

[6] Ibid.

[7] "Urban Transport and Environment in Beijing," Beijing Municipal Environment Protection Bureau, Beijing Municipal Public Security and Traffic Administration Bureau, and Beijing Urban Planning, Design and Research Academy, January 15, 1999.

[8] "China's Strategies for Controlling Motor Vehicle Emissions," December 1997.

[9] "Strategy for Sustainable Development of Urban Transportation and Environment," January 10, 1999.

[10] "Urban Transport and Environment in Beijing," January 15, 1999.

[11] Ibid.

[12] "China's Strategies for Controlling Motor Vehicle Emissions," December 1997.

[13] *China Auto*.

[14] "China's Strategies for Controlling Motor Vehicle Emissions, "World Bank Summary Report", December 1997.

[15] Since all heavy-duty engines in Europe are diesel, the gasoline-fueled engine standards will be set to United States 1982 requirements.