ACTION PLAN

Strengthening Vehicle Inspection and Maintenance

Chongqing, PRC

RETA 5937

Reducing Vehicle Emissions in Asia

ACTION PLAN

Strengthening Vehicle Inspection and Maintenance in Chongqing, People's Republic of China

Prepared by

Multi-sectoral Action Plan Group

Chaired by

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Contents

Abbreviations

ADB	Asian Development Bank
ADO	Automotive Diesel Oil
CNG	Compressed Natural Gas
CO	Carbon Monoxide
ECE	Economic Commission for Europe
EPB	Environmental Protection Bureau
HC	Hydrocarbon
I/M	Inspection and Maintenance
LPG	Liquified Petroleum Gas
MOC	Ministry of Communication
MAPG	Multi-sectoral Action Plan Group
NDIR	Non-Dispersive Infrared
PM	Particulate Matter
RETA	Regional Technical Assistance Project
RTMB	Road Transport Management Bureau
SEPA	State Environmental Protection Administration
THC	Total Hydrocarbons
TSP	Total Suspended Particulate
USD	United States Dollar

Executive Summary

Scope of the Action Plan

This Action Plan focuses on strengthening vehicle inspection and maintenance (I/M) in Chongqing, People's Republic of China. Chongqing is located in the south west of PRC and is the fourth municipality directly administered by the Central Government.

Background and Rationale

Both motor vehicle growth and economic development have increased rapidly in Chongqing municipality in recent years, where annual vehicle growth is estimated at 15%. In the year 2000, there were approximately 430,000 motor vehicles consisting of 256,000 cars and 170,000 motorcycles. The total number of vehicles in the Chongqing urban area is estimated at 259,000, including 200,000 automobiles.

For many years Chongqing's main air pollution problem was caused by SO_2 emissions, primarily a result of coal burning. To control this pollutant, the Chongqing municipal government implemented a Clean Energy Program in 2000. The program is expected to reduce coal burning by 1.36 million tons per year and in turn reduce SO_2 emissions by seventy-six thousand tons per year.

Air quality monitoring in the Chongqing urban area has revealed that average NO_x concentrations have increased 101.3% in the past five years, an indication that vehicle pollution has increased rapidly during this period. Although pollution from coal burning has been effectively controlled, motor vehicle emissions remain a serious pollution issue for Chongqing.

Process and Approach

MULTI-SECTORAL ACTION PLAN GROUP (MAPG)

To assist in the formulation and subsequent implementation of an action plan to strengthen Chongqing's vehicle inspection and maintenance systems, a Multi-sectoral Action Plan Group (MAPG) was established at the beginning of this RETA project. The MAPG is comprised of key stakeholders, and includes three government agencies related to the I/M program that represent both national and local levels. These agencies are as follows:

The Environmental Protection Sector (State Environmental Protection Administration and Chongqing Environmental Protection Bureau) leads the I/M program, and is responsible for establishing I/M regulations, emissions standards, and unifying supervision and administration.

The Public Security Sector (Ministry of Public Security of PRC, and Chongqing Public Security Bureau) is responsible for new vehicle registration, annual vehicle safety inspections, and on-road emission inspections, which include roadside inspections in cooperation with the EPB.

The Transportation Sector (Ministry of Communications of PRC (MOC) and Chongqing Road Transportation Management Bureau (RTMB), which is under the Chongqing Communications

Commission) is responsible for administration of the vehicle repair industry and administration of commercial vehicle licenses. At both local and national levels there are completed and ongoing projects relevant to the issues addressed in this Action Plan. These include studies on I/M regulations, emissions standards, management systems, and vehicle emissions reduction. The institutions responsible for these studies have been identified as main stakeholders and involved in the MAPG, and include Tsinghua University, the Chinese Research Environmental Academy of Sciences, Chongqing Communications University, etc.

Other MAPG members include representatives from inspection stations, the auto service industry, public transportation companies, etc. All are important stakeholders in the I/M program.

During the course of this project, MAPG members met to discuss the proposed Action Plan and were given opportunities for dialogue and to share their opinions with the I/M program. In addition, members who came from outside Chongqing were able to offer their experience and gain from the process.

Action Plan Components

The Action Plan is composed of two main parts: a review of Chongqing's current situation and an Action Plan to strengthen the I/M system. The main features are described below:

1. REVIEW OF CURRENT SITUATION

- Describes Chongqing's motor vehicle fleet, its composition and technical specifications.
- Reviews Chongqing's ambient air quality and major air pollution problems.
- Describes the status of motor vehicle pollution in the city.
- Reviews the present I/M system, including emission testing standards and methods used in annual vehicle inspections, roadside inspections and commercial vehicle testing; the system's capacity in terms of equipment and manpower; and an analysis of I/M test results from recent years.
- Reviews the present I/M administrative system and its quality control.

2. ACTION PLAN TO STRENGTHEN CHONGQING'S I/M PROGRAM

The Action Plan addresses the following main issues:

- Expected developments in strengthening emissions standards for in-use vehicles. It is expected that in the future there will be more differentiation in standards between vehicles of different ages and technical specifications.
- Increases in vehicle air pollution, with assessment and projections from 2000 to 2020.
- Development of an improved I/M system, including annual inspections, roadside testing and special testing of commercial vehicles, etc.
- Specifications of equipment requirements for I/M testing.
- Clarification of the responsibilities and specific roles played by different institutions (government, private sector, etc.) in the future I/M program.
- Capacity building of I/M program staff.
- Strengthening I/M quality control and administration.
- Improvements in I/M data management.

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CHAPTER 1

The Situation in Chongqing City

Chongqing is one of four municipalities directly administered by the Central Government of PRC, and is presently PRC's biggest municipality in terms of area and population. It covers 82,000 square kilometers in the southwest, where it adjoins five other provinces, and includes 43 districts, cities and counties. The Chongqing urban area totals 190 square kilometers with a population of about 2,500,000. In 2000, its GDP was 159,000 million Yuan and per capita income for the total city was 5157 Yuan.

The urban area lies between two large mountains, Tongke Shan and Zhongliang Shan. The relative humidity is about 80% and the annual average wind speed is 1.1-1.7m/s; the geography and climate hinder pollutant diffusion. The urban area is divided into three parts by two rivers, with the west higher than the east. Traffic congestion is caused by the many bends and slopes along the city’s narrow roads, which often reach only seven to ten meters wide. The vehicle fleet has recently increased by 10-15%, and as these vehicles are poorly maintained, their contribution to air pollution is serious.

CHAPTER 2

The Vehicle Fleet and its Development

A. The Road Network in the Chongqing Urban Area

Main roads in the urban area are intersected by highways that run in and out of the urban area. At present, there are three national and eight provincial level highways in the area which have twelve entrances or exits at the edge of the urban area. This results in many vehicles traveling through the urban area and extensive traffic congestion.

Chongqing's traffic system is basically underdeveloped: traffic congestion is widespread and frequent, and the cost of public transport very high. Chongqing's naturally restricted environment results in much costlier road construction than in other Chinese cities, and this has compounded difficulties.

Table 2.1
Road Development in the Chongqing Urban Area

Year	Road Length (km)	Roads per Capita (m^2/person)	National Average
1949	236	2.10	
1984	909	2.71	
1990	1201	3.50	
1997	2318	4.43	
1998	2369	4.62	
1999	2458	4.89	
2000	2553	5.20	7.1

B. The Vehicle Fleet and its Distribution

Chongqing's vehicle fleet is increasing rapidly. By the end of 2000 there were 430,000 vehicles in the municipality, of which automobiles comprised 256,000 units. The vehicle fleet in the urban area is about 259,000, including about 200,000 automobiles.

Also by the end of 2000, sixteen CNG filling stations had been established and more than 2,200 motor vehicles were equipped with CNG. About 1,300 buses in the urban area have been converted to CNG. Figures 2.1 and 2.2 show the vehicle fleet growth in recent years, and the classification of vehicles registered in the urban area is depicted in Figure 2.3.

Figure 2.1
Vehicle Fleet Growth, 1997–2000

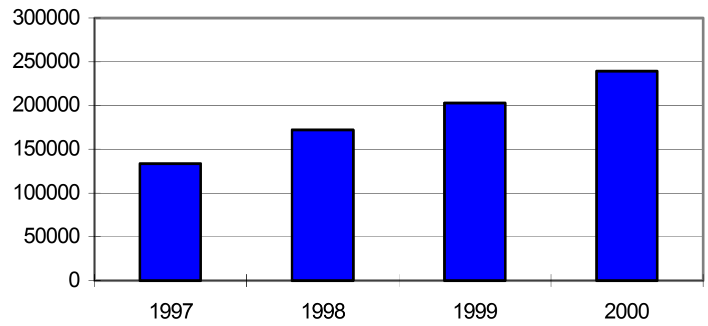


Figure 2.2
Motorcycle Fleet Growth 1997–2000

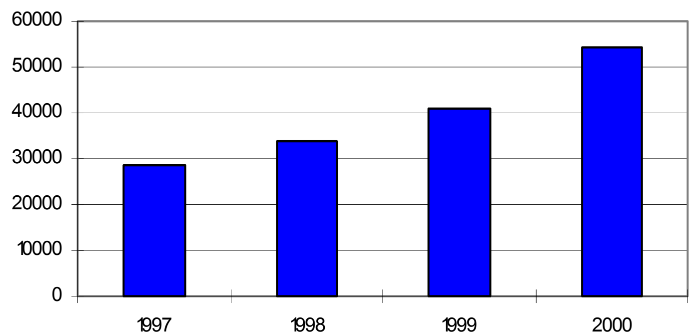
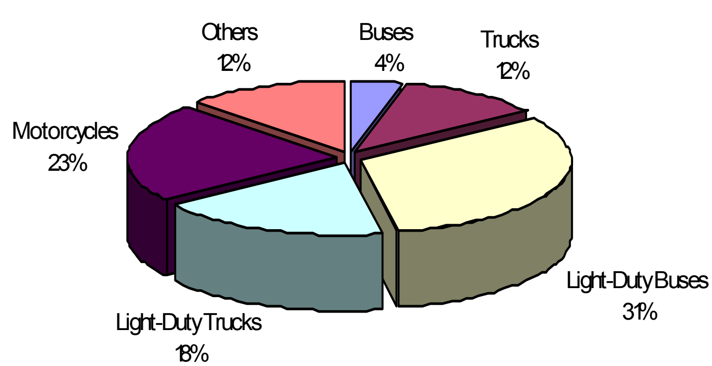


Figure 2.3
Vehicle Distribution in Chongqing (2000)



Source: Chongqing Statistical Bureau and Chongqing Public Security Bureau Vehicle Management Institute.
Bus=passenger vehicle of GVW>3500kg; Little bus=passenger vehicle of GVW ≤ 3500kg; Truck: cargo vehicle of GVW>3500kg; Little truck: cargo vehicle of GVW≤ 3500kg; Others= special vehicles, including army vehicles and other unknowns

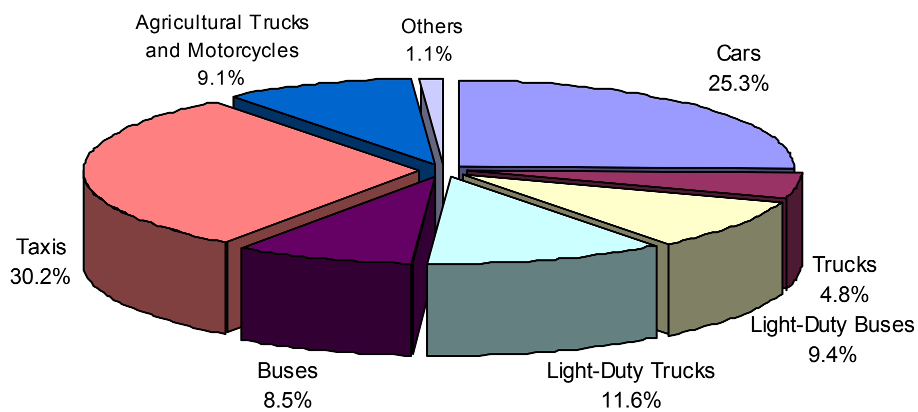
The classification of road vehicles is given in Table 2.2 and Figure. 2.4. The percentage of different vehicle classes reflects the proportion of mileage driven by each. Taxis and commercial vehicles on main roads are a high percentage and although their actual number is low, they contribute a high percentage of total emissions. A program to reduce mobile emissions should place greater emphasis upon these vehicle types.

Table 2.2
Driving Flows in the Urban Area by Vehicle Type

Type	Percent
Cars	25.3
Taxis	30.2
Light-Duty Buses	9.4
Light-Duty Trucks	11.6
Buses	8.5
Medium and Large Trucks	4.8
Agricultural Trucks and Motorcycle	9.1
Others	1.1
Total	100

Note: Others= includes special types of vehicles; Light-duty buses= less than 19 passengers; Cars: excludes taxis

Figure 2.4
Classification of Vehicles on Urban Area Roads



CHAPTER 3

Air Quality in Chongqing

A. Current Air Quality

The National Environmental Air Quality Standard (GB 3095-1996) requires urban and rural areas to conform to the Class II limited values as given in Table 3.1 below.

Table 3.1

National Air Quality Standards – Class II

Item	SO_2	NO_x	TSP
Annual average limit	0.06 mg/m^3	0.05 mg/m^3	0.2 mg/m^3
Daily average limit	0.15 mg/m^3	0.1 mg/m^3	0.3 mg/m^3

The urban area air quality reached or exceeded the Class II national standard 46.2% times in 1999 and increased to 51.1% times in 2000**.** The concentrations of several pollutants in the urban area are listed in following tables and figures.

Table 3.2

SO_2 Concentrations

Year	Range of Daily Average	Annual Average (mg/m^3)	Unattainment Rate for Daily Average (%)	Maximum Daily Average Over Standard (Times)
1996	0.016-1.711	0.321	79.5	10.41
1997	0.009-0.900	0.207	67.3	5.10
1998	0.016-0.576	0.183	53.9	2.80
1999	0.016-0.752	0.171	48.6	4.00
2000	0.001-0.613	0.156	46.4	3.09

Table 3.3

TSP Concentrations

Year	Range of Daily Average	Annual Average (mg/m^3)	Unattainment Rate for Daily Average (%)	Maximum Daily Average Over Standard (Times)
1996	0.031-0.838	0.181	11.1	1.79
1997	0.030-0.890	0.199	16.0	2.00
1998	0.037-0.842	0.234	25.6	1.80
1999	0.031-0.688	0.204	18.1	1.30
2000	0.030-0.814	0.248	31.0	1.71

Table 3.4

NO_x Concentrations

Year	Range of Daily Average	Annual Average (mg/m^3)	Unattainment Rate for Daily Average (%)	Maximum Daily Average Over Standard (Times)
1996	0.004-0.262	0.041	3.1	1.62
1997	0.009-0.239	0.066	17.9	1.40
1998	0.006-0.247	0.056	9.8	1.50
1999	0.009-0.317	0.062	16.3	2.20
2000	0.003-0.368	0.068	19.6	2.68

Source:Chongqing Environment Scientific Research Institute

SO_2 LEVELS

Historically, the dominant source of pollution in Chongqing has been from coal burning. In recent years, the government succeeded in promoting conversion from coal to natural gas as an energy source, resulting in a decrease in SO_2 levels. However, the average annual concentration of SO_2 still exceeded the standard and remained the area's major pollutant. To further reduce SO_2 at the beginning of 2000, the Chongqing government decided to replace 1153 coal fueled boilers and 1500 water boilers with cleaner fuels such as natural gas, oil, and electricity. As of June 30, 2001, all goals were met. The quantity of coal burned been has been reduced by about 1.36 million tons per year, and SO_2 emissions reduced by about 760,000 tons per year.

This project clearly improved the urban air quality. In the third quarter of 2001, the daily average value for SO_2 met the Class II national standard. SO_2 decreased by 53.2 percent of the 2000 level and 62.8 percent of the 1999 level, compared to the same time period in previous years. Figure 3.2 demonstrates this downward trend over the years, an indication that the Chongqing municipal government's Clean Energy Program has proven effective in reducing SO_2 pollution**.** It is anticipated that SO_2 levels will continue to show this trend for the foreseeable future.

Figure 3.1

SO_2 Annual Average Daily Concentration

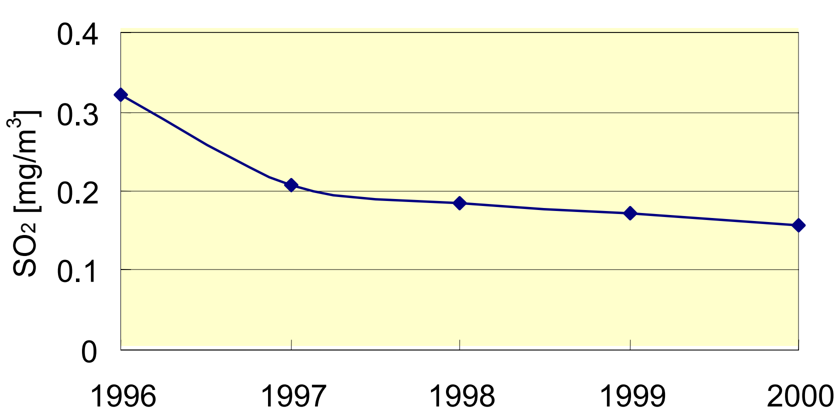
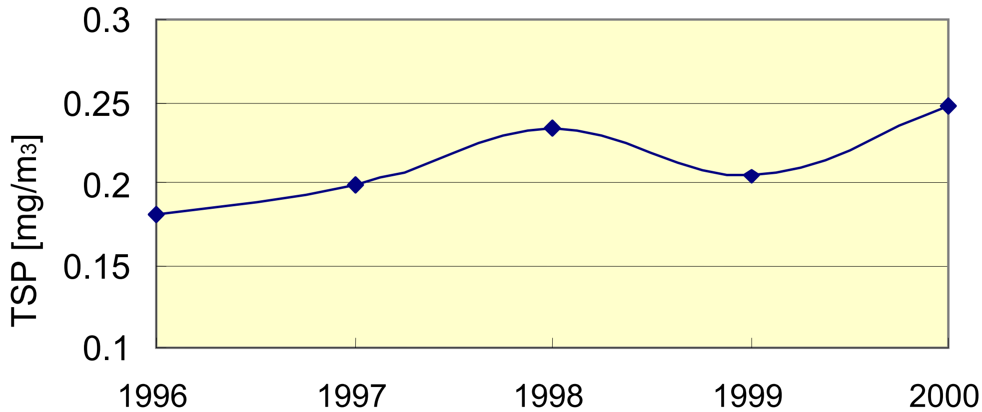


Figure 3.2
Annual Average Daily Concentration



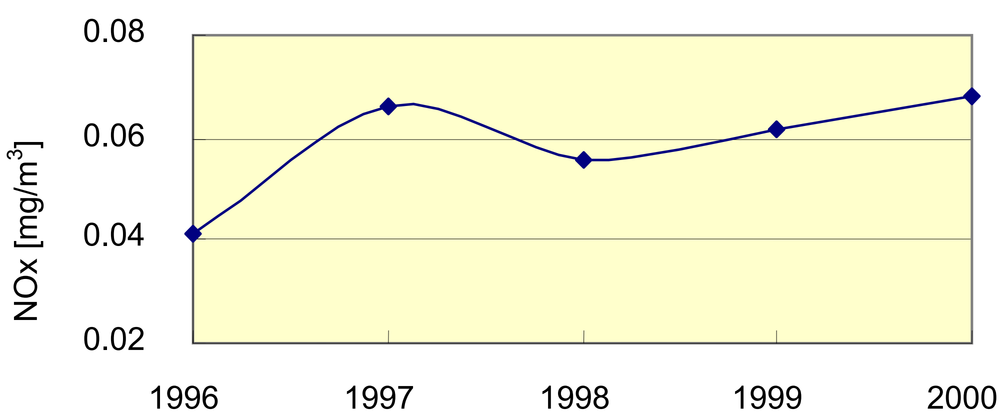
TSP LEVELS

The construction industry developed rapidly in Chongqing throughout 1997-2000 and this aggravated dust pollution in the urban area. As a result, the TSP pollution level has shown a poor trend as demonstrated in Table 3.3. It is likely that when construction slows, TSP pollution will decline.

NO_x LEVELS

Table 3.4 and Figure 3.3 reveal that NO_x emissions have increased rapidly in recent years. NO_x exceeded the national standard 72 days in 2000, an indicator that this pollutant has become more severe with the recent high vehicle growth rate.

Figure 3.3
NO_x Annual Average Daily Concentration



In the ninth five year plan period, the concentration of NO_x was 0.061 mg/m^3 and the percent over standard for daily average value was 14.4%. The peak in daily average value occurred in 2000. Compared with the levels in the last five year plan period, the average concentration increased 101.3% and the percent over standard for daily average value increased 13.4%. This shows that the concentration has increased continuously with the concomitant growth in the vehicle fleet.

The above analysis indicates that vehicle pollution will become increasingly serious for several pollutants, and that the program emphasis must be diverted towards reinforcing vehicle emissions and enhancing controls.

B. Roadside Air Quality

In May 1998 and May 1999, the EPB tested air quality at a few main roads in the Chongqing urban area. The results are listed in Table 3.5, and when compared with Table 3.4 show that NO_x concentrations beside main roads is nearly ten times the average density. Further comparison with Table 3.3 reveals that the TSP concentration is also much higher at main roads. These results indicate that roadside pollutants are a significant threat to those living or working near main roads, and that such pollutants come mainly from vehicles.

Table 3.5

Air Quality Test Results from Main Roads (mg/m^3; Pb: $\mu g/m^3$)

	Daily Average Concentration			
	Range		Average	
Pollutant	**May 1998**	**May 1999**	**May 1998**	**May 1999**
CO	3.12 - 19.0	0.62 - 27.1	9.70	6.59
NO_x	0.03 - 3.74	0.10 - 1.94	0.67	0.54
THC	4.3 - 6.8	2.16 - 6.58	5.34	3.30
TSP	0.29 - 2.49	0.17 - 2.08	0.86	0.97
Pb	0.13 - 1.92	0.10 - 1.86	0.99	0.83

C. Contribution of Vehicle Emissions to Chongqing's Air Pollution

Chongqing is an industrial city and its main metallurgical and chemical industries have yet to control their emissions. The gases they emit constitute a large proportion of the city's total pollution load, and mobile source pollution has remained low in comparison. In some areas of the city, however, the contribution from mobile sources has reached a very high level. According to report results,[1] average emissions beside six main roads are 85.8% for CO and 86.3% for NO, levels which are no less than Beijing's and Shanghai's. The contribution of vehicle emissions to air pollution in various districts is given in Table 3.6. The data indicate that vehicle emissions in Chongqing are a very serious pollution issue, and countermeasures must be implemented as soon as possible.

[1] Chongqing Environmental Protection Bureau

Table 3.6
Contribution of Vehicle Emissions to Air Pollution (%)

District	CO	NO_x
Yu Zhong District	74.35	60.56
Jiang Bei District	44.97	52.92
Nan An District	31.68	44.38
Sha Ping Ba District	37.55	40.86
Jiu Long Po District	22.89	36.09
Da Du Kou District	26.81	47.27

Source: Chongqing Environmental Protection Bureau

CHAPTER 4

The Current Vehicle Pollution Control Program in PRC

A. National Emissions Standards for New Vehicles

So far, nineteen National Standards for motor vehicle emissions control have been issued by the State Environmental Protection Administration. These include sixteen automobile emissions standards and three motorcycle emissions standards. The vehicle emission control standards of PRC refer to European, American and Japanese motor vehicle emissions regulations. The present level for emissions reduction is equivalent to the level in Europe in the early 1990s.

1. LIGHT-DUTY VEHICLES

In 1990, PRC started to implement ECE 1503 for light-duty vehicles and crankcase emissions control for gasoline vehicles. In 1993, a fuel evaporation standard (trap method) was issued, and implemented from 1995. In 1999 new limits and measurement methods for emissions from light-duty vehicles equivalent to EEC/93/59 and EC/96/69 were issued, and became effective in 2000. The detailed standards and effective dates are shown in Table 4.1.

Table 4.1
Emissions Standards for Light-duty Vehicles

<table>
<tr><th rowspan="2">Vehicle Type</th><th colspan="2">Tailpipe Mass Emissions</th><th colspan="2">Fuel Evaporation</th><th rowspan="2">Crankcase Emissions Effective Date</th></tr>
<tr><th>Standard Equivalent to (test procedure)</th><th>Effective Date</th><th>Standard</th><th>Effective Date</th></tr>
<tr><td>Light-duty Vehicles</td><td>ECE 1503 (ECE 1504)</td><td>Jul. 1, 1990</td><td rowspan="3">2 g/test (Trap method)</td><td rowspan="3">Jul. 1, 1995</td><td rowspan="5">Jan. 1, 1990</td></tr>
<tr><td>Cars</td><td>91/441/EEC (Euro 1)</td><td>Jan. 1, 2000</td></tr>
<tr><td>Light trucks</td><td>93/59/EEC (Euro 1)</td><td>Oct. 1, 2000</td></tr>
<tr><td>Cars</td><td>94/12/EC (Euro 2)</td><td>Jul. 1, 2004</td><td rowspan="2">2 g/test (SHED)</td><td>Jul. 1, 2004</td></tr>
<tr><td>Light trucks</td><td>96/69/EC (Euro 2)</td><td>Jul. 1, 2005</td><td>Jul. 1, 2005</td></tr>
</table>

2. HEAVY-DUTY GASOLINE VEHICLES

Heavy-duty gasoline vehicles still play an important role in the medium vehicle category due to historical reasons. In 1993, an emissions standard for gasoline vehicle engines was issued to control emissions from heavy-duty gasoline vehicles. Crankcase emissions and evaporated fuel emissions control were introduced in 1990 and 1996, respectively. The detailed information is shown in Table 4.2.

Table 4.2
Emissions Standards for Heavy-duty Gasoline Vehicles

Tailpipe Mass Emission[2] Limits (g/kW) CO	Tailpipe Mass Emission[2] Limits (g/kW) $HC+NO_x$	Effective Date	Fuel Evaporation Standard	Fuel Evaporation Effective Date	Crankcase Emissions Effective Date
54	22	Jan. 1, 1995	4 g/test (Trap method)	Jul. 1, 1996	Jan. 1, 1990
34	14	Jan. 1, 1998			

* Test procedure: US 9 Steady Mode.

A more stringent emissions standard has been developed and approved by SEPA, and is expected to be issued soon. It will still use the US 9 steady mode test procedure but with stricter limits; to meet these, the electronic fuel injection (EFI) engine and catalytic converter will be required.

3. HEAVY-DUTY DIESEL VEHICLES

PRC started to control smoke from new heavy-duty diesel vehicles in 1985. This promoted improvements to diesel engine quality, but without obvious modifications until the Euro 1 standard became effective in the year 2000. The detailed emissions standard for heavy-duty diesel vehicles is shown in Table 4.3.

Table 4.3
Emissions Standards for Heavy-duty Diesel Vehicles

Tailpipe Mass Emission: Standard Equivalent to		Tailpipe Mass Emission: Effective Date	Full Load Smoke: Standard	Full Load Smoke: Effective Date	Free Acceleration Smoke: Standard	Free Acceleration Smoke: Effective Date
	—	—	4.5 Rb	Apr. 1, 1984	5.0 Rb	Apr. 1, 1984
91/542/EEC	1st phase (Euro 1)	Sep. 1, 2000			4.0 Rb	Jul. 1, 1995
	2nd phase (Euro 2)	Sep. 1, 2003				

4. MOTORCYCLES

PRC has the largest motorcycle manufacturing industry in the world. Motorcycle emissions control began in the mid 1980s when the country issued its first motorcycle idle emissions standard. A decade later, the mass emissions standard equivalent to ECE No. 40 was implemented in PRC, but the limits were so loose that most motorcycles could meet the standard without much improvement. However, the idle emissions standard revised in 1993 is slightly more stringent and has required manufacturers to improve their vehicles. The detailed standards and effective dates are shown in Table 4.4 and 4.5. A newly revised motorcycle and moped emissions standard will be issued soon, and Euro 1 and 2 will be followed.

[2] The test procedure is US9 Steady Mode

Table 4.4
Mass Emissions Standard for Motorcycles

Vehicle Type	Tailpipe Mass Emission	
	Standard Equivalent to	Effective Date
Motorcycles	ECE 40 (0 series)	Jan. 1, 1996

Table 4.5
Idle Emissions Standard for Motorcycles

Vehicle Type	Effective Date	CO, %	HC (ppm)	
			Four-stroke	Two-stroke
Motorcycles	Mar. 1, 1994	5.0	2000	7800
	Jan. 1, 1996	4.5	1800	7000

B. Conventional Fuels

1. GASOLINE

In 1995, the amended Law of the People's Republic of China on the Prevention and Control of Air Pollution stipulated a leaded gasoline phase-out for vehicles. The newly-revised Air Law (2000) stated that premium fuel production and the reduction of hazardous materials in fuel should be encouraged and supported.

(a) Leaded Gasoline Phaseout

In September 1998, PRC's State Council released a circular detailing two steps to phase out leaded gasoline throughout the country:

- The first step would be initiated from July 1, 1999 in the major environmental protection cities (46 cities).
- The second step would begin on January 1, 2000 and require all refineries in China to produce unleaded gasoline, with a nationwide ban on leaded gasoline from July 1, 2000.

All gasoline sold in PRC now qualifies as unleaded. The phaseout of leaded gasoline has created the appropriate conditions to implement new emissions standards and adopt EFI with 3-way catalytic converter technology.

(b) Improve Gasoline Components and Reduce Toxic Emissions

To improve gasoline components and reduce toxic emissions, the Hazardous Materials Control Standard for Motor Vehicle Gasoline was issued by SEPA in June, 1999 and came into effect in January, 2000. Limits were set for nine hazardous materials as detailed in Table 4.6, and detergent must be added to gasoline. The limit for olefin was first implemented in the three major cities of Beijing, Shanghai, and Guangzhou, and will be applied to the whole country in the year 2003.

Table 4.6
Gasoline: Hazardous Materials Control Limits

Item	Limit
Benzene (vol. %, max)	2.5
Olefins (vol. %, max)	35
Aromatics HC (vol. %, max.)	40
Manganese (g/l, max.)	0.018
Lead (g/l, max.)	0.013
Sulfur (% Mass, max.)	0.08
Phosphorus (g/l, max.)	0.0013
Iron	Non-detectable
Copper	Non-detectable

2. DIESEL FUELS

There is currently no specific light diesel for automobile use, as all diesel is the same quality as used for automobiles and other machinery. One third of light diesel consumed in PRC is used by automobiles, and the remainder for agricultural vehicles, tractors, ships and marine, railway trains, mining, construction machinery, power generation and other civil machinery, etc. Although the implementation of a new standard (GB 252-2000) will improve diesel fuel quality (especially the cetane number, sulfur content, oxidation stability, etc.), the improvements in fuel quality to produce diesel fuel recommended for use by automobiles because the high sulphur content causes high particulate emissions. Other quality problems can also result from the low cetane number (40-45). To improve the quality of diesel oil for automobiles, Automobile Diesel Specifications have been proposed and will be issued this year. The key specifications relative to emissions are shown in Table 4.7.

Table 4.7
Proposed Automobile Diesel Specifications

Item	Limits
Cetane Number, min	49
Sulfur, %(m/m), max	0.05
Oxidation stability, total insoluble matter, mg/100ml, max.	2.5
Density@20°C, kg/m3	816.5~856.6

C. Alternative Fuels

PRC's newly revised Air Law (2000) also promotes the production of clean vehicles which consume clean fuel. The Chinese government is making a great effort to develop such vehicles; these efforts are important for adjusting energy structure, improving air quality in urban areas, and developing PRC's sustainable auto industry. LPG and CNG vehicles have been developed in many cities and by the end of 2000, there were more than 80,000 gas vehicles and 228 gas stations to serve them. Both hybrid electric and fuel cell technology vehicles have been encouraged and are developing quickly.

Ethanol is also being promoted as a fuel source in PRC, a major agricultural country with an overproduction of grain in some areas. To consume this excess grain and increase farmers' incomes, ethanol production from grain will be promoted. As an alternative fuel, ethanol will be added to gasoline in small percentages (such as 5%, 10% or 15%) to help save fuel oil resources and reduce CO and HC vehicle emissions. Related feasibility research on ethanol gasoline application and demonstration programs is underway. During its tenth five-year plan, the Chinese government will continue to support the Clean Vehicle Action Program to promote the sustainable development of PRC's auto industry.

D. Mandatory Scrappage

The Chinese government began to implement a mandatory scrappage policy in 1986 to maintain vehicle safety, reduce emissions from old vehicles and promote advanced technology development in China's automobile industry. The main items regulated in the vehicle scrappage standard (2000 version) are shown in Table 4.8. If a vehicle can still pass inspection when it reaches its service limit, however, its service life can be prolonged.

Table 4.8

Vehicle Scrappage Standards

Vehicle Type	Service Limits	Remark
Light-duty passenger cars (9 seats and below)	500,000 km (or 15 years)	Whichever limit occurs first
Taxis	500,000 km (or 8 years)	
Buses (10 seats and up)	500,000 km (or 10 years)	
Light-duty trucks	400,000 km (or 10 years)	
Heavy-duty trucks	500,000 km (or 10 years)	

E. Inspection and Maintenance

In 1985, PRC issued its first group of motor vehicle emissions standards. In order to enforce these standards and control emissions from in-use vehicles, an inspection and maintenance (I/M) program was implemented. This was based on successful experiences in other countries, where regular inspection and maintenance promoted the service life of in-use vehicles, reduced emissions and saved energy. PRC's I/M program has been widely developed throughout the country.

CHAPTER 5

The I/M System in Chongqing

A. Emissions Standards for In-Use Vehicles

There are emissions standards for the three different categories of in-use vehicles (gas vehicles, diesel vehicles, and motorcycles), with standards and tests as detailed in Table 5.1.

Table 5.1
Emissions Standards for In-Use Gasoline Vehicles*

Vehicle Type	Gasoline Vehicles: Standard Limit CO (%)	HC (ppm) 4-stroke	HC (ppm) 2-stroke	Standard	Measurement Method
In-use light duty vehicles made before 1 July 1995	4.5	1200	8000	GB14761.5[3]	Idle speed GB/T3845
In-use heavy duty vehicles made before 1 July 1995	5.0	2000	9000		
In-use light duty vehicles made after 1 July 1995	4.5	900	7500		
In-use heavy duty vehicles made after 1 July 1995	4.5	1200	8000		

*Date of effect: 1 May 1994

Table 5.2
Emissions Standards for In-Use Diesel Vehicles*

	Diesel Vehicles: Standard Limit Smoke (FSN)	Standard	Measurement Method
In-use vehicles made before 1 July 1995	5.0	GB14761.6[4]	Free Acceleration GB/T3846
In-use vehicles made after 1 July 1995	4.5		

FSN = filter smoke number
*Date of effect: 1 May 1994

[3] Emissions standard for Pollutants at Idle Speed from Petrol Vehicle Engines
[4] Emissions standard for Smoke Free Acceleration from Diesel Vehicle Engines

Table 5.3
Emissions Standards for In-Use Motorcycles

Vehicle Type	Motorcycles				
	Standard Limit			Standard	Measurement Method
	CO (%)	Idle Speed HC (ppm) 4-stroke	Idle Speed HC (ppm) 2-stroke		
In-use motorcycles made before 96.1.1	5.0	2500	9000	GB14621	GB/T5466
In-use motorcycles made after 96.1.1	4.5	2200	8000		

*Date of effect: 94.5.1
Note: Light Duty Vehicles=GVW≤3500kg; Heavy Duty Vehicle= GVW>3500kg; Motorcycles= GVW≤400kg, engine displacement >50ml, max speed≥50km/h.

B. The Test System for Chongqing's In-use Vehicles

The in-use tests deployed in Chongqing consist of three parts:

I. Annual test;
II. Roadside test;
III. Commercial vehicle test.

The respective management departments for these three tests are the Public Security Bureau, Transport Commission, and Environmental Protection Bureau.

1. ANNUAL TEST

The vehicle management department of the Municipal Public Security Bureau commissioned some social enterprises capable of conducting the tests, including safety and emission tests. Only vehicles that pass are given a Certificate of Environment, which is valid for one year.

At present, there are eight test sites comprising ten automobile test lines and six motorcycle test lines. There are four test sites in the urban area with five automobile test lines (one line at each site, with one moveable line) and four motorcycle test lines. The sizes of these test sites vary but most test all items, which include horn, brakes, emissions, speed indicator, lights, side-slip, appearance, etc.

2. ROADSIDE TEST

In 1990, the Management Regulation for Prevention and Control of Vehicle Pollution was implemented by six ministries and commissions, and first executed in Beijing. In response to direction from the central government, in 1992, the Chongqing government initiated the "Announcement for Prevention and Control of Pollution from Vehicles in Chongqing" and in due course began roadside tests. Meanwhile, the office for Vehicle Pollution Prevention and Control had been established.

When the roadside tests were initiated, there were eight test sites in the urban area. To reduce the number of institutions involved, the Vehicle Emissions Control Office was repealed and therefore road test sites were reduced to four.

The Environment Supervisory Center (commissioned by the EPB) and traffic police conduct random tests on passing vehicles for HC and CO only. If a vehicle fails the test its certificate is detained and the vehicle must be repaired and tested again. The certificate is not returned until standards are satisfied.

3. TEST SYSTEM FOR COMMERCIAL VEHICLES

The Transport Administration Bureau commissions capable enterprises to set up test stations. These stations conduct capacity tests (emissions is the key term) for all commercial vehicles in the city. If a vehicle fails, the vehicle's certificate is detained until such time as it is repaired and passes the test, upon which the certificate is returned. There are twenty-three such test stations in the city, and seven stations in the urban area. The test method and standard are the same as those for the annual test. Buses must be tested biannually, but other commercial vehicles only annually.

C. Vehicle Tests and Pass Rates

1. ANNUAL TEST SITUATION

As the annual test is seasonal, owners can prepare for it by undertaking vehicle maintenance just prior to testing (and they can enhance performance temporarily by adding high quality fuel, etc.) so the pass rate is normally high, over 90%. Due to various factors, not all vehicles have been tested annually. Table 5.4 gives the number of vehicles tested at several stations in 2000. According to statistics**,** 10-15% of vehicles were not tested in 2000.

Table 5.4

Quantity of Vehicles Tested at Different Stations in 2000

Test site	Ba shan	Qi gongli	Ren he	Tian xingqiao
Vehicle amount	26000	21000	20000	19000

Source: Chongqing Public Security Bureau Vehicle Management Institute

2. ROADSIDE TEST SITUATION

According to the EPB, 15,000-20,000 vehicles underwent a roadside test in 2000. The pass rate declined over the three year period 1998-2000 as shown in Table 5.5 below, an indication that roadside tests can be effective. However, testing is still insufficient and not integrated, and thus its impact remains limited.

Table 5.5
Chongqing Roadside Test Results (1998–2000)

Year	Vehicles Tested	Pass Rate	
		Vehicles	Percentage
1998	12269	7298	58.1
1999	10027	6072	60.6
2000	10767	6791	63.1

Source: Environmental Protection Bureau

3. ANALYSIS OF VEHICLE FAILURE TO PASS EMISSION TESTS

The following are reasons why vehicles have failed to pass tests:

- Some vehicles have not participated in normal maintenance and periodic testing therefore their technical condition remains poor and they continue to release emissions above the allowable limits.
- Most of Chongqing's vehicles have carburetor gasoline engines or diesel engines without turbochargers, technologies that are relatively low with poor combustion and thus emissions remain high.
- Poor quality parts for fuel and ignition system repairs result in poor engine condition after repairs, and lead to heavy emissions.
- The environmental awareness of some drivers is poor; they do not attach importance to meeting emissions standards and undertake unskilled vehicle repairs themselves.
- The repair industry lags behind the requirements of vehicle control developments, as indicated by the following:
  - Technical engineers to work on vehicle emissions are in short supply. There is a lack of emissions test equipment and as a result many vehicles fail to meet standards even after repair and maintenance.
  - The environmental awareness of some repair enterprises is poor, so that relative statutes on vehicle emissions are not implemented conscientiously.
  - The influence of fuel quality on emissions cannot be ignored. Although leaded gasoline is no longer produced, some poor quality fuel remains on the market and has serious implications for vehicle emissions.
  - Management of the I/M system is still inadequate, so some substandard vehicles remain in circulation.

D. Test Station Equipment and Human Capacity

1. ANNUAL TEST STATION

The majority of Chongqing's test equipment is made in China. Both CO and HC use NDIR analyzers, and smoke-testers use filter paper. There are two or three equipment test lines at each station, using models FGA4000, MEXA-324F(CO and HC), and FD-1, FBY-1(for smoke) etc. The total cost of a test station is about three to six million Yuan and each workshop costs about one million Yuan to build. The cost of equipment is 20,000-50,000 Yuan per unit. At present, none of annual test stations reach their capacity.

Each station employs about twenty to thirty people, but few engineers. Each surveyor is responsible for all test terms on one vehicle, and there is no person specifically assigned to emission tests only. For example, at Ba Shan test station the total cost of building the workshop was 800,000 Yuan (1990 price) and the equipment 280,000 USD. The station employs twenty-eight people, with only two engineers. The test capacity is 150 vehicles per day, but in 2000 the actual number tested was only 100 per day.

2. COMMERCIAL VEHICLE TEST STATIONS

The cost of building and equipping commercial vehicle test stations is the same as that for annual test stations. The personnel employed are relatively few, approximately ten to twenty on average for each station.

The total number of commercial vehicles in Chongqing is about 130,000. Commercial vehicles that have not passed the commercial test are not permitted to proceed to the annual test, so basically all affected vehicles should have completed the commercial test. Some commercial vehicles that have operated outside the city for long periods may not have completed the test in Chongqing, but they must still complete it elsewhere.

As commercial tests are influenced by the season and the number of vehicles tested at different stations is unequal, saturation degrees are also very different. While the maximum test capacity of workshops is basically the same, 150 per day, each year there are test lines which sit idle for long periods.

3. ROADSIDE TESTS

These test sites are normally set up at main roads. At each site there are two to three equipment sets and three or four personnel. One of these is a traffic policeman responsible for traffic command, while the others are technical personnel from the environment inspection center who are responsible for conducting emission tests.

E. Maintenance and Repair Management System

1. A BRIEF INTRODUCTION TO THE MAINTENANCE AND REPAIR INDUSTRY

The maintenance and repair industry includes Class I, Class II and other Non-class enterprises. The Transportation Management Bureau is responsible for censoring, authorizing and supervising all the enterprises. Workshops found to be in violation of their license are shut down for a period or their licenses are suspended, depending on the specific circumstances.

When vehicles are maintained or repaired at a maintenance workshop, the national standards on vehicle maintenance, tests and technical standards must be adhered to. Vehicle maintenance has been divided into the following three categories:

I. Daily maintenance: should be done by drivers and emphasizes cleaning, fuel filling and checking for vehicle safety.
II. Class I maintenance: emphasizes cleaning, lubrication and tightening, check-ups for safety components such as brakes, control and operation systems, etc. and emission performance. Class I maintenance should be done by a professional workshop. There are seventeen items for Class I maintenance, eight of them correlated with emissions.
III. Class II maintenance: emphasizes checks and adjustments for some fallible or critical safety components, tire dismantling for testing and changing, and engine work status and emission control fitting. This must be done by a professional workshop.

Table 5.6
Items Tested Prior to Second Level Maintenance

Number	Test Items
1	Engine power, cylinder pressure
2	Emission pollutants, the effect of catalyst
3	Electronic control for fuel injection system
4	Fuel injection advance, interval and fuel pressure of injection pump for diesel vehicle

Based on these test results, troubleshooting is undertaken to confirm the additional items to eliminate faults. The purpose of basic and additional maintenance items is to maintain and renew vehicles in normal condition. The final test is done after maintenance to check that the second level maintenance has achieved its purpose.

2. ALLOCATION OF EQUIPMENT AND TECHNICAL SKILLS IN REPAIR WORKSHOPS

There are some maintenance and repair enterprises which have integral emissions test equipment and the ability to repair vehicles to reach standards on power, fuel economy and emissions etc., but the allocation of equipment and technical skills in most is inadequate. This situation will be improved as soon as possible. While some technicians are skilled at using emissions test equipment correctly, they need improved knowledge about pollution causes and affects, and about technology and information for reducing vehicle emissions.

3. TECHNICAL STANDARDS AND INFORMATION

Many enterprises can undertake emission repairs but lack the skill and technical references for maintenance. This must be improved.

F. Present Capital Sources for the I/M System

The government commissions some enterprises with relevant capacity for annual and commercial vehicle tests. Such enterprises build the workshops and purchase equipment themselves. Maintenance enterprises include state-owned, collective-owned, stock, and private companies etc., so the sources of capital are different but still prepared by the enterprises themselves. The capital for road side tests is funded by the EPB.

G. Public Awareness for the I/M System

The increase in mobile emission sources in recent years has led to vehicles and the environment receiving increasing government attention as described below:

- In 1996, the Chongqing government promulgated an announcement to control vehicle emissions, and standardized a variety of management and penalty systems related to vehicle pollution.
- After the 1996 law on prevention and mitigation of air pollution was promulgated, the Chongqing EPB produced awareness leaflets to disseminate public information about vehicle emission laws and standards.

- Each year the EPB has arranged meetings on new vehicle emissions control and proclaimed relevant policies and new emissions standards over time.
- After carburetor car sales were prohibited in cities on September 1, 2001, the SEPA and the EPB carried out stringent inspections on many different product lines.
- Given the in-use vehicle pollution problem in the urban area, in recent years the EPB has arranged numerous discussion meetings and made great efforts to cooperate with other relevant departments on improving the I/M system. During this period, the EPB encouraged many scientific research institutes and universities to take part in relevant research. There have been significant achievements made as a result.
- Various forms of media have publicized the urban area's air pollution situation, which has helped focus more public attention on the environment. The media has also given coverage to the emission pass rates of various vehicle makes. Chongqing's I/M system is in its initial stage and public propaganda work has been limited, as a result people have given inadequate attention to the issue and more work is required.

H. Current Data Management

The test data collected at each test station is submitted regularly to the relevant government department. Data accumulated over several years indicate that although the emissions situation is continuously improving, it remains a severe problem. This reveals the need for all relevant government departments to institute counter measures, including the following:

- Strengthen emissions tests and improve equipment precision and the technical skills of personnel. In annual and commercial vehicle test stations, the emission test has been a key item, and vehicles must reach the standard otherwise they will not pass the test.
- Institute severe restrictions on heavy emission vehicles. This should include banning some heavy emission vehicles from the urban area during certain periods, and adopting a clampdown on heavily polluting middle buses in the urban area.
- Introduce reliable catalysts for reducing emissions.

Due to a lack or inability of personnel to do periodic statistical work, test results have not been analyzed and cannot be adequately used. This kind of analysis should be undertaken and reinforced in the I/M system.

CHAPTER 6

Forecast of Vehicle Emissions Growth in Chongqing

With Chongqing's rapid economic development, both the motor vehicle fleet and vehicle emissions will continue to increase in future.

A. Vehicle Fleet Growth

To evaluate the future impact of motor vehicle emissions on the environment, the vehicle growth trend over the next twenty years in Chongqing's urban area has been projected as shown in Table 6.1. The following assumptions have been made in calculating the projection:

I. Growth rates: motor vehicle growth from 2001 to 2020 is assumed to be linear, based on the regression of vehicle growth in recent years.
II. Average annual vehicle growth rate: the growth rate of each vehicle category remains the same for each five year period. The average annual growth rates of vehicles are shown in Table 6.2.

Tables 6.1 and 6.2 show that vehicle numbers will increase quickly before the year 2010, and that the vehicle fleet will double between 2000 in 2006.

Table 6.1
Vehicle Growth 2000-2020

Vehicle Type	2000	2005	2010	2015	2020
LDGV	80,933	141,742	203,206	264,702	326,096
LDGT	22,990	38,184	53,256	68,326	83,409
HDGV	22,202	36,759	52,064	67,371	82,680
LDDT	30,404	44,529	58,253	71,970	85,685
HDDV	36,615	52,663	68,536	84,432	100,327
MC	54,179	104,546	156,190	207,837	259,498
Total	247,323	418,424	591,504	764,638	937,695

LDGV = light-duty gasoline vehicle; LDGT= light-duty gasoline truck; HDGV= heavy-duty gasoline vehicle; LDDT= light-duty diesel truck; HDDV = heavy-duty diesel vehicle; MC= motorcycle

Figure 6.1
Motor Vehicle Growth Trend

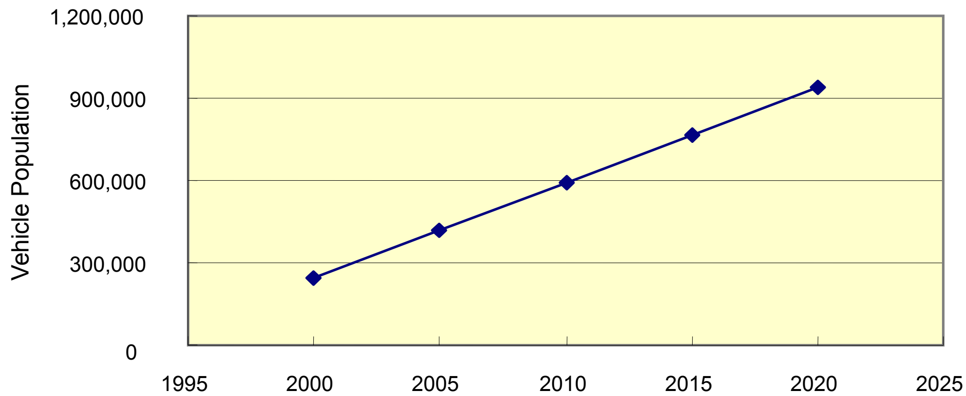


Table 6.2
Average Annual Growth Rates of Vehicles

Vehicle Type	2000-2005	2005-2010	2010-2015	2015-2020
LDGV	11.86%	7.47%	5.43%	4.26%
LDGT	10.68%	6.88%	5.11%	4.07%
HDGV	10.61%	7.21%	5.29%	4.18%
LDDT	7.93%	5.52%	4.32%	3.55%
HDDV	7.54%	5.41%	4.26%	3.51%
MC	14.05%	8.36%	5.88%	4.54%

LDGV = light-duty gasoline vehicle; LDGT = light-duty gasoline truck; HDGV = heavy-duty gasoline vehicle; LDDT = light-duty diesel truck; HDDV = heavy-duty diesel vehicle; MC = motorcycle

B. Motor Vehicle Emissions Growth

PRC began to implement new emissions standards for some categories of vehicles (light-duty vehicles and heavy diesel vehicles) in the year 2000. However due to rapid vehicle growth, the lack of stringent controls over some vehicle categories, and the fact that many existing highly polluting vehicles will be running for several more years, vehicle pollution will remain a strong challenge.

1. DIFFERENT LEVELS OF VEHICLE EMISSION CONTROLS

In accordance with PRC's situation, emission controls are being implemented in a series of increasingly stringent levels, as follows:

a) Uncontrolled until 1991;
In 1990, China started to implement ECE 1503 and crankcase emissions control; in 1993 a fuel evaporation standard (trap method) was issued and implemented from 1994;

b) Engine Controls until 2000;
c) Euro 1 until 2004;
d) Euro 2 until 2009; and
e) Euro 3 thereafter.

2. AVERAGE ANNUAL MILEAGE FOR VEHICLE CATEGORIES

Average annual mileage accumulation for various vehicle categories is shown in Table 6.3.

Table 6.3
Average Annual Mileage

Vehicle Type	Annual Mileage (km)	Remarks
LDGV	35000	Includes: private cars, taxis
LDGT	50000	
LDDV	50000	
LDDT	50000	
HDGV	50000	Includes: portion of public buses and trucks
HDDV	50000	Includes: portion of public buses, trucks and construction vehicles
MC	8000	

LDGV = light-duty gasoline vehicle; LDGT = light-duty gasoline truck; DGV = heavy-duty gasoline vehicle; LDDT = light-duty diesel truck; HDDV = heavy-duty diesel vehicle; MC = motorcycle

3. FORECAST OF TOTAL EMISSIONS

Based on vehicle growth forecasts and the existing and anticipated programs for vehicle and fuels clean up, the following emissions forecast has been calculated. The total emissions from Chongqing's motor vehicles in the next twenty years are shown in Table 6.4 and Figure 6.2.

Table 6.4
Forecast of Total Emissions (Tons)

Item	2000	2005	2010	2015	2020
THC	44,210	49,287	44,021	34,523	31,170
CO	307,548	376,662	387,296	364,624	379,705
NO_x	44,251	56,739	56,784	48,747	39,695
PM	4,428	5,358	5,219	4,009	2,667

Figure 6.2
Forecast of Total Emissions

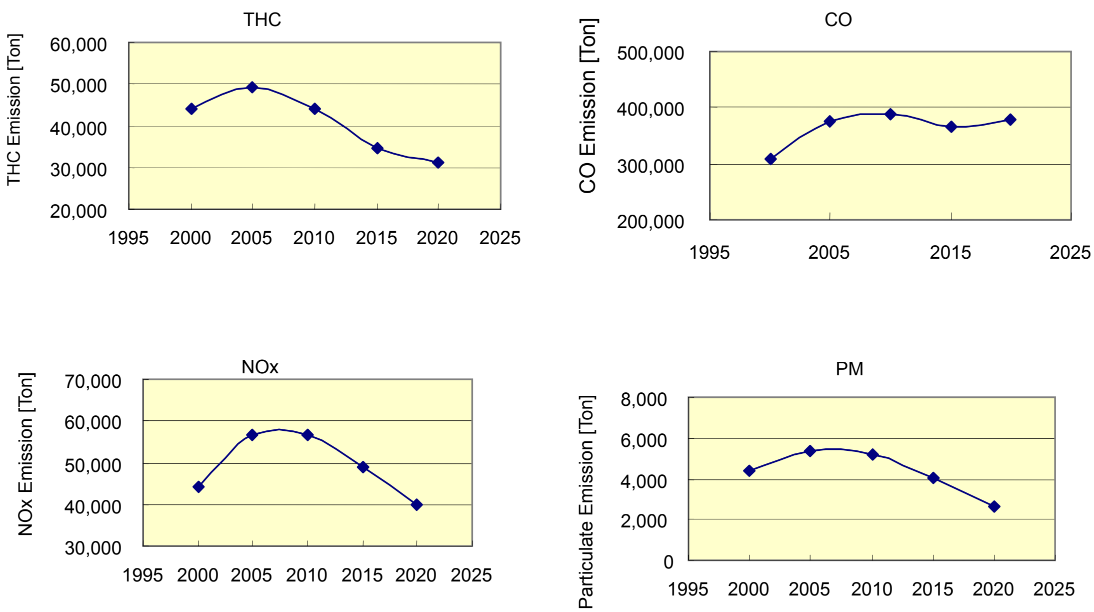


Table 6.4 and Figure 6.2 show that:

a) Emissions are expected to increase rapidly before 2005. Although newly-produced vehicles added to the fleet will meet stringent standards, existing old vehicles will still play a key transport role and contribute heavily to emissions. The vehicle growth rate is expected to be higher during this period, and some vehicle categories such as heavy-duty gasoline vehicles and motorcycles will not have implemented the proposed stringent standards by 2002.

b) Between 2005 and 2010, the rate of emissions increase will slow down because most old vehicles will be retired while new vehicles will have improved technology and lower emissions.

c) As more stringent emissions standards are adopted and the ratio of low emission vehicles increases during the period of 2010-2015, the total emissions will start to decline.

d) The assumption here is only up to Euro 3 after 2009, but the vehicle fleet will grow continually so that emissions will increase again after 2015.

CHAPTER 7

Action Plan to Strengthen I/M

A. Emissions Standards for In-use Vehicles

1. TESTING OPTIONS

Vehicles of different ages and technical levels have existed simultaneously since Euro I was implemented in 2000, so there has been more variation in standards due to differences in vehicle ages and technical specifications. Currently, there are many testing options for the I/M program.

(a) No-Load short tests

The term denotes all tests during which no external load is exerted and the car operates with the transmission in neutral position.

(i) Idle / fast idle test

The test involves concentration measurements of carbon monoxide (CO), hydrocarbons (HC) and eventually carbon dioxide (CO_2) in the raw exhaust gas at idle speed and/or at higher engine speed (2000-3000 rpm). The test lasts from less than one minute (in the case of a one-speed idle test without pre-conditioning) to about 10 minutes (in the case of a two-speed test with "second chance" test including pre-conditioning). A garage-type non-dispersive infrared (NDIR) analyzer capable of measuring CO, HC and CO_2 concentrations is sufficient.

(ii) Idle / fast idle tests with lambda (λ) test

For catalyst equipped cars a lambda test may be coupled with an idle/fast idle test in order to check the performance of the mixture preparation system. Three types of tests can be performed:

- The air/fuel ratio is indirectly determined through measurements of CO_2, CO, O_2 and HC concentrations at fast idle (2000 - 3000 rpm) in the raw exhaust.
- The air/fuel ratio is artificially modified by adding oxygen, propane or re-circulated exhaust gas to the intake air, or by tampering and then checking the response of the lambda control system. Long response times imply that the oxygen sensor is degraded, while no response means that the lambda control system is out of operation.
- One or more of the electronic lambda control circuit characteristics are measured and compared with auto manufacturers' specifications.

(b) Steady-state loaded tests (ASM)

NO_x emissions at no-load conditions are negligible and therefore a loaded test is necessary to measure them. This is a critical issue for urban air pollution. The simplest loaded tests are the steady-state loaded tests, which involve a dynamometer with steady-state power absorption. A simulation of the car's inertia weight is not required because there is no transient phase in the emission test. The car is driven at constant speed and load, and pollutant concentrations (CO, HC, NOx and CO_2) are measured during the load phase.

During the seventies, several loaded tests were developed in the United States such as the Federal 3-Mode Test, the Clayton Key-Mode Test and the CalVIP. However, their implementation was limited due to the high cost of the dynamometer and NO_x analyzer.

More recently, and due to the introduction of 3-way catalyst equipped cars, the Acceleration Simulation Mode (ASM) Tests were developed and evaluated. According to the ASM principle, the car is driven on a chassis dynamometer at constant speed and steady-state power absorption equal to the actual road load of the car during acceleration. One can thus achieve a realistic simulation of the car's load at a specific driving mode, without the need of flywheels for inertia simulation. However, at high speed and high acceleration combinations the required power absorption is too high to be achieved without engine overheating problems. Pollutant concentrations (CO, HC, NO_x) are, in principle, measured in the raw exhaust. Each steady-state test mode would require about ten minutes for preparation, pre-conditioning, actual testing and documentation.

(c) Transient Loaded Tests (IM 195 or IG 195)

In transient tests, cars are driven on the dynamometer according to a specific driving schedule; the main difference from a type approval test is the duration of the driving cycle and the hot start. Since exhaust gas emissions are expressed in mass units, a CVS system and laboratory-quality analyzers are required in order to detect low pollutant concentrations in the diluted exhaust sample. A multiple-curve dynamometer with flywheels is also required in order to simulate the instantaneous road load and the power necessary to accelerate the car's inertia masses. A number of transient loaded short tests were developed in the 1970's in the United States, and were examined as to their correlation with FTP 75.

(d) Remote Sensing System

Today's Remote Sensing systems can measure CO, CO_2, HC and NO_x in vehicle exhaust. The most advanced systems under investigation may also measure particulate opacity.

An optical remote sensor is conventionally set up to transmit a beam of radiation across a parcel of air to be investigated. This involves the siting of a transmitter (normally a radiation source) at one location and a receiver at another; the path between these two points defines the optical path.

Optical remote sensors may be conveniently grouped into two distinct classes, monochromatic and spectrally broadband. The former group contains laser long-path absorption and differential absorption lidar and the latter group contains the more familiar Fourier transform infra-red (FTIR) spectrometer, ultra-violet spectrometer and correlation radiometers. The broadband detectors may be further subdivided into dispersive and non-dispersive. The dispersive systems (e.g. FTIR) are essentially open path spectrometers, while the non-dispersive sensors (e.g. correlation radiometers) involve the comparison of the radiation beam after it has passed through two alternating filters.

2. BASIC I/M PROGRAM

The basic requirement for every vehicle is regular inspection and roadside inspection, using national standards which every vehicle must meet. This is in keeping with the Air Law which regulates that "A vehicle should not be driven on the road if it fails to meet the emissions standard". The detailed requirement is in Table 7.1.

3. STRENGTHENING PROGRAM FOR HIGHLY POLLUTING VEHICLES

A highly polluting vehicle will emit five to ten times more pollutants than a normal vehicle. The most important measure and purpose of the I/M program is to identify dirty vehicles and reduce their emissions; this will reduce vehicle emissions by 20-50%.

For highly polluting vehicles (those which exceed emissions standards) or old vehicles (at or close to the retire time limit), a strengthening program shall be conducted. Loaded tests shall be used, and stringent emissions standards will encourage vehicle owners to do maintenance. Scrappage of old dirty vehicles will also be promoted. A strengthening program will be applied to rid the vehicle fleet of highly polluting vehicles, (as detailed in Table 7.1) including those which:

- Exceed emissions standards as identified by roadside tests;
- Are highly polluting vehicles as identified by remote sensing;
- Are close to or at their service life limit;
- Are high smoke vehicles reported by the public.

4. DIFFERENTIATION IN STANDARDS BETWEEN VEHICLES OF DIFFERENT AGE AND TECHNICAL SPECIFICATIONS

(a) Gasoline vehicles (including gas vehicles)

- Basic I/M program:
  - Idle test to check CO and HC emissions for pre-Euro 1 vehicles;
  - Two stage idle test for new catalytic type (Euro 1 and after) vehicles; check λ to ensure the O_2 sensor and ECU system work properly.
- Strengthening I/M program:
  - Loaded chassis dynamometer tests shall be used. At present, SEPA is drafting an IM 195 (or Vmass) test standard, which will be issued in the near future. This new national standard is suggested to strengthen the inspection program, in which different limits will be used for different vehicle types.

(b) Diesel vehicles

- Basic I/M program:
  - Free acceleration smoke test - 93 national standard (filter type);
  - For Euro 1 vehicles and later, the new free acceleration smoke test standard and opacity smoke test will be used;
- Strengthening I/M program
  - The loaded chassis dynamometer smoke (lug-down) test is suggested which has been used successfully in Hong Kong, China and some European countries, and is to be developed in PRC.

(c) Motorcycles

- Basic I/M program:
  - Idle test to check CO and HC emissions - 93 national standard;
- A new national motorcycle emissions standard is being devised for new model motorcycles (Euro 1 and later) to be issued and implemented in the near future. This will start from Euro 1 and the corresponding stringent idle emissions standard will be made effective.

Table 7.1
I/M Standards for Vehicles of Different Ages and Technologies

I/M Program	Fuel	Category		Standards
Basic I/M Program	Gasoline	Pre-Euro 1	LDGV	’93 National Std.:Idle or dual idle tests—check CO,HC
			HDGV	’93 National Std.:Idle or dual idle tests—check CO,HC
			MC	’93 National Std.:Idle test—check CO,HC
		Euro 1 and after	LDGV	*New national std.:Idle or dual idle test—check CO,HC,λ*
			HDGV	*New national std.:Idle or dual idle test—check CO,HC,λ*
			MC	*New national std.:Idle test—check CO,HC*
	Diesel	Pre Euro 1	LDDV	’93 National Std.:Free acceleration smoke test
			HDDV	’93 National Std.:Free acceleration smoke test
		Euro 1 and after	LDDV	New National Std.:Free acceleration smoke test (opacity, stringent limits)
			HDDV	New National Std.:Free acceleration smoke test (opacity, stringent limits)
Strengthening I/M Program	Gasoline	Pre Euro 1	LDGV	Loaded chassis dynamometer test: IM or IG 195(National std.)
			HDGV	***Loaded chassis dynamometer test***
		Euro 1 and after	LDGV	Loaded chassis dynamometer test: IM or IG 195(National std.)
			HDGV	***Loaded chassis dynamometer test***
	Diesel	Pre Euro 1	LDDV	***Lug-down chassis dynamometer smoke test***
			HDDV	***Lug-down chassis dynamometer smoke test***
		Euro 1 and after	LDDV	***Lug-down chassis dynamometer smoke test***
			HDDV	***Lug-down chassis dynamometer smoke test***

Notes:
1 Standard character: effective standards.
2 *Italics: Standards being drafted or revised by SEPA, to be issued and implemented soon.*
3 *Bold and italics: Standards to be developed.*
4 Application of Basic I/M Program: for regular inspection (annual inspection), and random inspection (roadside test).
5 Application of Strengthening I/M Program: for high polluted vehicles, e.g. Excess of emissions standards identified by roadside tests; High polluted vehicles identified by remote sensing system; Vehicles close or reach the retire time limit; High smoke vehicles reported by public.

B. Future I/M Program

1. INSPECTION

(a) Regular Inspection

The goal of regular inspection is the final pass and stickers will only be issued to vehicles that pass the emissions inspection.

a) Initial Inspection
   - For different levels of vehicle, different procedures are used:
   - For pre-Euro 1 vehicles, do tests one by one as the conditions are not stable;
   - For Euro 1 light duty gasoline vehicles, a visual inspection shall be done to check if the emission control system is installed properly.
   - For Euro 1 diesel vehicle, a visual inspection and Free Acceleration Smoke test shall be needed;
   - For Euro 2 vehicles, initial inspection will not be needed.

b) Annual Inspection
   - The annual inspection has been conducted for many years in Chongqing. For pre-Euro 1 vehicles, an annual test shall be done as usual. For Euro 1 vehicles and later, the frequency of inspection may be reduced gradually, i.e. vehicles that meet Euro 2 or higher, start with a lower inspection frequency when vehicles are new, advance to testing once every two years, and after four years of running, test annually.

c) Increased Regular Inspection Frequency – Biannual or Quarterly Inspection (Strengthening I/M Program)
   - Old vehicles: Have unstable emissions and worsen easily. The frequency of inspection for these vehicles must be increased to encourage owners to maintain such vehicles in good condition. The loaded test should be used for these vehicles if necessary.
   - Commercial vehicles: These vehicles (e.g. taxis, buses, trucks, etc.) work long daily hours, and the frequency of inspection for these vehicles must be increased.

d) Scrappage Inspection
   - For old vehicles (at or near service limit), use the Strengthening I/M Program.

(b) Random Inspection

Random inspection is an important measure to control in-use vehicle emissions. It has been enforced for many years in Chongqing and has produced good results.

- **Roadside Inspection**
  This measure has been in force for many years and plays an important role in controlling in-use vehicle emissions, and shall be continued and strengthened.
- **Remote Sensing System**
  To identify dirty vehicles, remote sensing will be more efficient and less costly than roadside inspections. This will be a very effective approach to strengthen inspection of in-use vehicles. After adopting the remote sensing system, roadside spot tests shall be reduced.
- **Door to Door Inspection**
  For concentrated vehicle companies or parking areas (i.e. bus, taxi and transportation companies, etc.), random door to door inspections could be conducted.

(c) Retest after Enforced Maintenance

If a vehicle fails the random test above, it must be repaired or maintained until it passes the retest.

2. MAINTENANCE

Maintenance includes regular maintenance, enforced repairs (for failed vehicles) and trouble shooting. The item of check-up and maintenance of emission control systems shall be added to every level of regular maintenance or relevant repair (i.e. combustion and fuel systems, etc). Repair workshop mechanics shall be trained and pass qualifying tests, and repair workshops shall be equipped with the necessary emissions test instruments. The following points apply:

- **Regular Maintenance:** Maintenance items for emission control systems should be added into every level of regular maintenance and repairs.
- **Enforced Repairs:** This item is for vehicles which do not pass the random test. An owner must repair, maintain or adjust a vehicle until it meets the emissions standard, or it should be scrapped.
- **Trouble Shooting:** Emission tests should be conducted after completion of all repair work for trouble related to combustion or emission control systems.
- **Technical criteria:** Criteria for vehicle emissions control should be formulated by the repair industry administrative department.
- **Training:** Training and qualifications for technicians shall be required.
- **Facilities:** Emissions test equipment should be available in the repair workshop.

C. Roles and Responsibilities in the I/M Program

1. GOVERNMENTAL AGENCIES

(a) Municipal Environmental Protection Bureau

- Is the chief governmental department of the I/M program, and unifies supervision and management for in-use vehicle emissions control;
- Sets environmental goals and vehicle emissions reduction targets;
- Makes local I/M enforcement regulations;
- Implements national emissions standards and makes local emissions standards more stringent if necessary;
- Approves qualifications, administration and audits of vehicle emissions inspection stations;
- Issues emission certificates for vehicles which pass emissions tests;
- Licenses repair workshops to undertake enforced emissions maintenance under the coordination of the Department of Transportation;
- Collects and manages emissions test data;
- Organizes training and licensing of local inspectors;
- Evaluates impact of the I/M program;
- Releases vehicle emissions status reports to the public.

(b) Municipal Public Security Bureau

- Legislation enforcement agency for vehicle traffic administration;
- Oversees new vehicle registration, annual vehicle safety inspections and licenses vehicle safety inspection stations;
- Enforces regular environmental inspection and vehicle roadside testing coordinated with the EPB;
- Undertakes legislative activity on road traffic for vehicles without emissions certificates or highly polluting vehicles.

(c) Municipal Transportation Management Bureau

- Administrative agency for the vehicle repair industry;
- Licenses repair workshops, manages quality control and assurance of repair industry;
- Licenses commercial vehicles.

(d) Municipal Quality & Technical Supervision Bureau

- Oversees metrological certification and calibration of test instruments.

(e) Municipal Finance and Price Departments

- Reviews and approves inspection prices.

(f) Inspection Agency

Independent companies or agencies equipped with qualified facilities that meet vehicle emissions standards may apply to the municipal EPB to be licensed as a vehicle emissions inspection station. While such agencies are certified and commissioned by the EPB, they may conduct emissions inspections in accordance with national or local emissions standards. The inspection agencies shall:

- Be equipped with the facilities to meet national or local emissions standards;
- Conduct personnel training and qualification examinations for mechanics who do inspections on standards and criteria;
- Maintain and calibrate test equipment regularly to ensure test quality;
- Analyze and report the test data at the request of the EPB;
- Ensure that there is no cheating during inspection services.

2. AIR QUALITY MONITORING AGENCIES (MUNICIPAL, DISTRICT AND COUNTY ENVIRONMENTAL MONITORING STATIONS)

- Monitor atmospheric environment air quality;
- Monitor road traffic and roadside air quality;
- Provide regular monitoring analysis reports and advanced warning for serious pollution to the EPB.

3. UNIVERSITIES, RESEARCH INSTITUTES, ACADEMIC ORGANIZATIONS

- Conduct vehicle emissions factor measurements and studies;
- Undertake studies on vehicle emissions control strategies;
- Research and develop vehicle emissions control;
- Provide the above study results and policy proposals to municipal government.

4. COMMERCIAL VEHICLE COMPANIES (PUBLIC BUS, TAXI, AND TRANSPORTATION COMPANIES)

- Manage regular vehicle maintenance;
- Maintain vehicles regularly, checks emissions while doing maintenance to keep vehicles running in good condition;
- Conduct awareness education for company employees to help them gain environmental knowledge, maintain their vehicles voluntarily, and discourage them from driving dirty vehicles.

5. VEHICLE MANUFACTURERS AND REPAIR INDUSTRY

- Vehicle manufacturers should give the service companies sound training on how to maintain emissions control systems;
- Repair workshops should maintain or repair sub-standard vehicles and keep them in good condition to meet the emissions standards;
- Repair workshops should prepare vehicle specification information to correctly repair vehicles;
- They should educate mechanics on environmental regulations, standards and emissions control technology.

6. FINANCE AGENCY

- Invests and participates in running inspection stations and repair workshops.

7. CITIZENS AND PRESS

- Report highly polluting vehicles to legislative enforcement agencies;
- Educate public on pollution control;
- Supervise the media, and expose highly polluting vehicles via the media system.

D. Specifications of I/M Test Equipment

The details of the five categories of I/M test equipment are shown in Table 7.2, and are:

1. NDIR for CO and HC: used for basic I/M for pre-Euro 1 gasoline vehicles and all motorcycles;
2. Smoke meter (Rb filter type or opacity): used for basic I/M programs for all diesel vehicles;
3. 5 component analyzer (CO,HC,O_2,CO_2,NO_x): used for basic I/M programs for gasoline vehicles of model year 2000 and later;
4. Chassis dynamometer, CVS (or V-mass) and 5 component analyzer: used for strengthening I/M programs for all gasoline vehicles;
5. Chassis dynamometer, opacity smoke-meter: used for strengthening I/M programs for all diesel vehicles.

Table 7.2

Specifications of I/M Test Equipment

I/M Program	Fuel	Category		Standards	Instruments
Basic I/M Program	Gasoline	Pre-Euro I	LDGV	'93 National Std.:Idle or dual idle tests—check CO,HC	NDIR CO and HC analyzer
			HDGV	'93 National Std.:Idle or dual idle tests—check CO,HC	NDIR CO and HC analyzer
			MC	'93 National Std.:Idle test—check CO,HC	NDIR CO and HC analyzer
		Euro I&II	LDGV	*New national std.:Idle or dual idle test—check CO,HC'λ*	5 components analyzer (CO, HC, O_2,$CO_2$and NO_x)
			HDGV	*New national std.:Idle or dual idle test—check CO,HC,λ*	5 components analyzer (CO, HC, O_2,$CO_2$and NOx)
			MC	*New national std.:Idle test—check CO,HC*	NDIR CO and HC analyzer
	Diesel	Pre-Euro I	LDDV	'93 National Std.:Free acceleration smoke test	Smoke meter (filter type or opacity)
			HDDV	'93 National Std.:Free acceleration smoke test	Smoke meter (filter type or opacity)
		Euro I&II	LDDV	*New National Std.:Free acceleration smoke test(opacity, stringent limits)*	Opacity smoke meter
			HDDV	*New National Std.:Free acceleration smoke test(opacity, stringent limits)*	Opacity smoke meter
Strengthening I/M Program	Gasoline	Pre-Euro I	LDGV	*Loaded chassis dynamometer test: IM or IG 195(National std.)*	Chassis dynamometer, CVS (or V-mass) and 5 components analyzer
			HDGV	***Loaded chassis dynamometer test***	Chassis dynamometer, CVS (or V-mass) and 5 components analyzer
		Euro I&II	LDGV	*Loaded chassis dynamometer test: IM or IG 195(National std.)*	Chassis dynamometer, CVS (or V-mass) and 5 components analyzer
			HDGV	***Loaded chassis dynamometer test***	Chassis dynamometer, CVS (or V-mass) and 5 components analyzer

Diesel	Pre-Euro I	LDDV	***Lug-down chassis dynamometer smoke test***	Chassis dynamometer, opacity smoke-meter
		HDDV	***Lug-down chassis dynamometer smoke test***	Chassis dynamometer, opacity smoke-meter
	Euro I& II	LDDV	***Lug-down chassis dynamometer smoke test***	Chassis dynamometer, opacity smoke-meter
		HDDV	***Lug-down chassis dynamometer smoke test***	Chassis dynamometer, opacity smoke-meter

E. I/M System Quality Improvements

1. INSPECTION QUALITY CONTROL MEASURES

- Regulation and technical criteria should be formulated for emissions inspection from in-use vehicles;
- Enforcement and supervision must be strict;
- Centralized inspection requires that inspection stations must be independent of repair workshops;
- There must be a public supervision system.

2. REPAIR AND MAINTENANCE QUALITY CONTROL MEASURES

- Regulation and technical criteria for vehicle emission control maintenance must be formulated;
- The vehicle inspection agency committed by the EPB has the responsibility to supervise repair quality;
- Random inspections of repair workshops should be conducted, to check personnel qualifications, emission test facilities and quality control systems;
- The repair industry management department should establish a vehicle repair information center, and repair workshops should set up a repair database connected with the information center;
- There must be technician training and a qualification system.

F. I/M Data Management Improvements

The Chongqing EPB shall establish an Inspection and Maintenance Data Management Center to collect and manage the I/M data. This I/M Data Management Center shall establish network management for inspection data and maintenance data.

1. ESTABLISHING NETWORK MANAGEMENT FOR INSPECTION DATA

The Inspection and Maintenance Data Management Center shall:

- connect with inspection stations to collect test data, conduct statistical analysis and share information resources, etc.;
- analyze the data collected and give reports to EPB regularly;
- find problems based on the data collected and propose countermeasures to the relevant departments;
- share data such as (i) information on vehicle registration and (ii) test records of vehicle regular inspections and random tests.

2. ESTABLISHING NETWORK MANAGEMENT FOR REPAIR DATA

The Inspection and Maintenance Data Management Center shall:

- Connect with the emissions repair workshops to:
  - collect repair and maintenance data of vehicles inspected,
  - conduct statistical analysis on repair management;
  - exchange information and get feedback;
  - train personnel on network management.

- Establish repair record databases in emissions repair workshops, and connect with the I/M Data Management Center.

- Share data with emissions repair workshops, including:
  - information on vehicle registration;
  - specifications of various vehicle models (i.e. emissions standard enforced, emission control system, etc.);
  - vehicle history and regular maintenance records;
  - mechanics training and qualification records.

CHAPTER 8

I/M Capacity Building

A. Annual Inspection (Regular Inspection)

Based on the annual inspection capacity in 2000 and assuming that annual inspection will implement only basic I/M testing, the annual inspection capacity needed over the next 15 years is projected in Table 8.1 as follows:

a) Per test line: 150 vehicles/day for 5days/week, 43 weeks/year (no test in January and February), for a total of 32250 vehicles/year.
b) There are now six lines in the Chongqing urban area, four are for cars and two are for motorcycles.

Table 8.1
Annual Inspection Equipment Requirements

Year	2000	2005	2010	2015	Remarks
Vehicle fleet	247,323	418,424	591,504	764,638	
Gasoline cars	126,125	216,685	308,526	400,399	
Diesel cars	67,019	97,192	126,789	156,402	
Motorcycle fleet	54,179	104,546	156,190	207,837	
Test lines	6 (4+2)	10	15	19	40,000/line/year
Idle analyzer	18	30	45	57	(3/line)
Smoke meter	8	20	30	38	(2/line)
Personnel	12	20	30	38	(2 persons /line)

Notes: The vehicles not inspected include:
(1) Special utility vehicles and extra large vehicles (no inspection required);
(2) Illegal vehicles; (3) Vehicles in remote areas; (4) Vehicles which lie idle.

B. Commercial Vehicle Inspection

Table 8.2
Commercial Vehicle Inspection Equipment Requirements

Year	2000	2005	2010	2015	Remarks
Commercial vehicles	80951	118451	156825	195200	
Gasoline	39299	65982	93382	120782	
Diesel	41652	52469	63443	74418	
Test line	7 lines	7 lines	7 lines	7 lines	30,000/line/year
Idle analyzer	14	14	14	14	(2/line)
Smoke meter	7	7	7	7	(1/line)
Personnel	7	7	7	7	(2/line)

Currently the commercial vehicle test stations' capacity for commercial vehicles is underutilized, and their capacity is estimated to be more than enough until the year 2015. The government is currently considering changes to the commercial vehicle inspection method so actual needs will change in the future.

This Action Plan recommends that the commercial vehicle test frequency be increased to at least two tests per year. The commercial vehicle test stations may complement the need for current inspection stations managed by the Public Security Bureau, and so the municipal EPB may commission these commercial test stations to meet the need of increased commercial vehicle tests.

C. Roadside Test Capacity

The roadside test for emissions is administered randomly, and the number of vehicles tested depends on the vehicle pollution situation as determined by the environment department. Considering the roadside test capacity forecast above, the projected vehicle fleet growth and increase in urban area, some roadside test spots will be added but will not depend on vehicle growth rates. With the implementation of strict new vehicle standards and improved vehicle technology, the focus of supervised tests will also change gradually from gasoline vehicles to diesel vehicles in order to reduce heavy smoke pollution from in-use diesel vehicles. However, if remote sensing systems are introduced, these can reduce or completely replace roadside spot tests.

Table 8.3
Roadside Test Capacity

Item	2000	2005	2010	2015
Total car fleet	247,323	418,424	591,504	764,638
Gasoline cars	126,125	216,685	308,526	400,399
Diesel cars	67,019	97,192	126,789	156,402
Motorcycle fleet	54,179	104,546	156,190	207,837
Roadside test spots	4	6	8	10
Vehicles tested	18,000/year	18,000/year	18,000/year	18,000/year
Idle analyzer	8	10	12	16
Smoke meter	2	6	10	16
Personnel	12	18	30	48

D. Other Test Systems

One remote sensing system unit will be enough given its high efficiency and mobility. The price and test capacity of the loaded test system is shown in Table 8.5. Assumptions for the loaded test system described in Table 8.4 are as follows:

1) About 70% of in-use gasoline vehicles will be catalytic vehicles by the year 2005, and at least eight sets of loaded test systems will be needed to test these vehicles. For diesel vehicles, the lug-down smoke tests will focus on the highly polluting vehicles by 2005, so two sets of systems will be adequate; one for light-duty diesel vehicles and another for heavy diesel vehicles.

2) From 2010, all gasoline vehicle inspections will use the loaded test system, but the frequency of inspection will be reduced for new vehicles and vehicles with OBD systems. For diesel vehicles, about 30-50% of dirty vehicles will need loaded testing.
3) In 2015, although the vehicle fleet will have increased, newly added vehicles will all be installed with OBD systems and the old type vehicles will be reduced. As a result, more test equipment may not be needed.

Table 8.4
Other Test Systems Required

Year	2000	2005	2010	2015	Remarks
Vehicle Fleet	247,323	418,424	591,504	764,638	
Gasoline cars	126,125	216,685	308,526	400,399	
Diesel cars	67,019	97,192	126,789	156,402	
Motorcycle fleet	54,179	104,546	156,190	207,837	
Remote sensing system	None	1 set	1 set	1 set	Avg. USD 100,000/unit
Loaded test equipment for gasoline vehicles (e.g. IM 240, IG 240, ASM etc.)	None	8 sets	20 sets	20 sets	Avg. USD 70,000/unit
Lug-down test bench for diesel vehicles.	None	2 sets	10 sets	10 sets	Avg. USD 90,000/unit
Funding for test equipment	—	US$ 0.84 mil.	US$ 1.56 mil.	—	

Table 8.5
Loaded Test System Price and Capacity

Item	IM 240	Vmass	ASM	Lug-down Smoke (LDDV)	Lug-down Smoke (HDDV)
Price [USD]	120,000	70,000	60,000	60,000	120,000
Vehicles tested/hour	12-18	12-18	15-18	4	3
Vehicles tested/year	18,000	18,000	18,000	7,000	5,500

CHAPTER 9

Strengthening I/M: The Impact on Vehicle Emissions

The emissions reduction results shown in Table 9.1 and Table 9.2 are calculated from US model Mobile 5 combined with the experience of PRC's I/M program. Two scenarios (2 stage idle and IM 240) were selected for I/M impact analysis. Table 9.4 and 9.5 show the results and Figure 9 shows the emissions impact from different scenarios.

Table 9.1
Emission Reductions by Various I/M Tests (non-catalyst vehicles)

Test type	CO	HC	NOx
Idle	-18%	-10%	0%
2 Stage Idle	-25%	-15%	0%
ASM	-30%	-25%	0%
IM240	-30%	-25%	0%

Table 9.2
Emission Reductions by Various I/M Tests (catalyst vehicles)

Test type	CO	HC	NOx
Idle	-11%	-11%	0%
2 Stage Idle	-15%	-15%	-5%
ASM	-20%	-20%	-25%
IM240	-35%	-32%	-25%

Table 9.3
Emissions Projection: Base Scenario (tons)

Item	2000	2005	2010	2015	2020
THC	44,210	49,287	44,021	34,523	31,170
CO	307,548	376,662	387,296	364,624	379,705
NO_x	44,251	56,739	56,784	48,747	39,695
PM	4,428	5,358	5,219	4,009	2,667

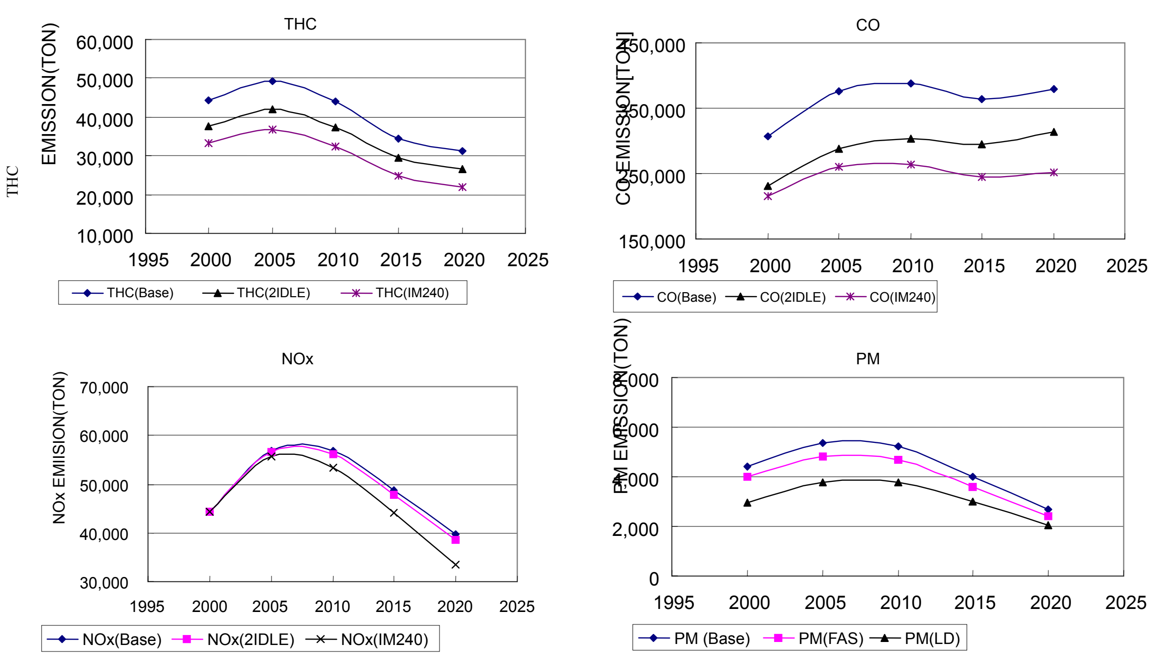
Table 9.4
Emissions Projection: 2 Stage Idle Scenario (tons)

Item	2000	2005	2010	2015	2020
THC	42,000	46,541	41,197	31,856	28,411
CO	252,189	312,312	326,750	313,982	331,691
NOx	44,251	56,739	56,784	48,747	39,695

Table 9.5
Emissions Projection: IM240 Scenario (tons)

Item	2000	2005	2010	2015	2020
THC	41,879	45,094	38,615	28,150	23,911
CO	251,910	298,398	293,482	260,065	260,356
NOx	44,234	54,504	52,957	43,186	33,954

Figure 9
Impact of Strengthening I/M on Vehicle Emissions



FAS= Free acceleration smoke test, LD= lug-down test

Figure 9 shows that:

- The unloaded test (i.e. the idle test, two stage idle test, free acceleration smoke test, etc.) will have positive results for HC, CO and PM reduction but no effect on NO_x reduction;
- The loaded test (i.e. IM 240, Vmass, ASM and Lug-down smoke test, etc.) will reduce CO, HC and PM emissions more effectively, but will also have no effect on NO_x reduction;
- To reduce NO_x emissions, two measures must be taken:
  - o Strict enforcement of new vehicle standards and scrapping of old type, pre-Euro 1 vehicles as soon as possible will be the most efficient approach to reduce NO_x emissions;
  - o Loaded tests for in-use vehicles of Euro 1 and later. The use of two-stage idle tests alone to check emissions from catalytic vehicles will not be sufficient to control NO_x emissions.

CHAPTER 10

Conclusion

According to the above analysis, prior to 2005 the focus of in-use vehicle emissions control in Chongqing shall focus on reducing emissions from old type vehicles and capacity building of loaded test equipment. This will lay a sound foundation for efficient inspection of new catalytic vehicles as they increase year by year. After 2005, catalytic vehicles will constitute the major proportion of the in-use vehicle fleet, and as far as possible loaded tests should be implemented for in-use vehicle inspection in order to control NO_x emissions efficiently.