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LEGISLATIVE COUNCIL
PANELS ON ENVIRONMENTAL AFFAIRS AND TRANSPORT

Progress of Vehicle Emission Control Technology and Measures

INTRODUCTION

This paper sets out the latest advancement in vehicle emission control technology and the progress of various emission control measures being implemented in Hong Kong.

NEW VEHICLE EMISSION TECHNOLOGY

Diesel Engine Technology

2. Since the early 90s, emissions from diesel engines have become a major concern worldwide. Great efforts have been made to develop cleaner diesel engines. In 1993, the European Union (EU) made the Euro I emission standards mandatory for all new vehicles. Progressively the mandatory emission standards were tightened. Euro II standards were introduced in 1996 and Euro III standards beginning this year. In general, vehicles meeting Euro III emission standards emit 87% and 44% less particulates and nitrogen oxides (NOx) than pre-Euro models.

3. Compared with a pre-Euro diesel engine, a Euro III diesel engine is characterized by a quantum leap in engine technology such as the use of much higher fuel injection pressure, common rail direct injection system, exhaust gas recirculation (EGR) and extensive use of electronic controls. The full efficiency of a typical Euro III large diesel engine is either comparable to or better than its predecessor. New engine technology allows engines to emit fewer emissions without loss in performance or increase in fuel consumption.

4. The development of diesel engines and emission control technologies will continue. Euro IV emission standard is planned for implementation in EU in 2006. This will force the development of engine technology as well as wide scale application of high efficiency particulate trap technology that is more matured nowadays. It is expected that Euro IV engines will emit over 80% less particulates than a Euro III engine. Implementation of Euro V emission standards is planned for 2009 when it is expected that, with the application of advanced de-NOx trap technology, a reduction of NOx by 78% could be achieved. Annex A compares the emission performance of different generations of engines according to Euro standards.

5. Hong Kong has been following closely the EU and tightening its emission requirements for newly registered vehicles. We implemented Euro I and Euro II standards in 1995 and 1997 respectively. More recently, Hong Kong has introduced Euro III standards for small diesel vehicles on 1 January 2001 and will implement the Euro III standards for large diesel vehicles from 1 October 2001, same pace as EU. It is our intention to adopt future EU standards such as the Euro IV and V emission standards at the same pace as EU members. Currently, Hong Kong has the most stringent emission standards in Asia.

Application of clean diesels

6. Advanced diesel engine technology requires the use of matching diesel fuel. Limit of sulphur content in automobile diesel was lowered, from 0.5%, to 0.2% and 0.05% in 1995 and 1997 respectively to match the implementation of Euro I and II standards. The sulphur content limit was further lowered to 0.035% on 1 January 2001 by legislation matching the implementation schedule of Euro III emission standards.

7. Ultra low sulphur diesel (ULSD), with a maximum sulphur content of 0.005%, will further reduce the particulate and the NOx emissions as compared to the regular motor diesel of 0.035% maximum sulphur content. ULSD will also enhance the performance of exhaust after-treatment and retrofit devices including diesel catalyst and high efficiency traps such as continuous regeneration traps (CRT). The quest for yet cleaner diesel continues worldwide. We are keeping in view the

latest EU proposal of using the ultra low or zero sulphur diesels, and the proposal in US to introduce 0.0015% maximum sulphur content requirement in the next 5-7 years.

Liquefied Petroleum Gas (LPG) Vehicle Technology

8. Recent development of LPG engine technology leads to the application of single or multi-port injection, computerized fuel management, and electronic close loop feedback control system. This engine control technology enables the achievement of extremely low exhaust emission levels. Together with the inherent clean burning characteristics, a modern LPG vehicle emits virtually no particulate emissions and much lower nitrogen oxides emissions to an extent that its advanced technology diesel counterparts cannot yet match. A simple comparison is given in Annex B.

9. A new Euro III light diesel vehicle emits much more particulates and twice the nitrogen oxides when compared with an LPG vehicle. A Euro IV diesel vehicle (expected to be available around 2006) will still emit about 26% more nitrogen oxides than an existing LPG model. It is expected that the emission control technology for LPG vehicle will further improve by 2006. Even though diesel engine technology is expected to improve, it is still considered worthwhile from an environmental perspective to continue to look for cleaner alternatives.

Electric Vehicles

10. Zero tail-pipe emission has been the driving force behind electric vehicle (EV) development. Worldwide EV development, however, has slowed down due to the lack of break-through in battery technology that can enable an EV to match the driving range and performance of its diesel or petrol counterpart. Therefore, the viability of EVs is heavily limited to uses that can operate within the operational driving range limit and a viable charging schedule. Also, much higher vehicle price and operating costs are the other constraints. We have been supporting the introduction of EVs through the waiving of First Registration Tax.

Fuel additive

11. Diesel fuel sold at refueling stations today already contains fuel additives needed for engine protection. Different vehicles respond differently to aftermarket fuel additives due to different engine conditions and maintenance level. Most fuel additives have short-term benefits in reducing emissions from engines that needed maintenance and/or repair. The additives function as detergents to clean up the engines, fuel systems and combustion chambers carbon deposit. However, for an engine that is well maintained, tuned and operated at its designed optimal state, reduction in emissions will be insignificant. If an engine is not properly repaired or tuned up and relies solely on additives to reduce emissions, the cleaning effect will be short-lived. Hence, our emphasis on maintaining lowest possible emissions has been on good vehicle maintenance and driving habit.

Aftermarket Retrofit Devices

Mainstream Technology

12. There are well-recognized aftermarket technologies that can be retrofitted on an in-use diesel vehicle to reduce emissions. Diesel oxidization catalysts are well established means of lowering not only particulate matters but also carbon monoxide and hydrocarbons. Particulate filters or traps are also being introduced in various parts of the world. But many of these systems require the use of ultra low sulphur or zero sulphur fuel in order to achieve optimal effect and/or avoid damage to the devices.

13. Other technologies such as biodiesel, de-NOx traps and water mixed diesel are also being tried through EPD cooperation with local bus and truck companies.

Non-Mainstream Technology

14. There are other advanced emission control technologies which have yet to be accepted by the scientific community at large. The

operation principles of some of these technologies are also un-conventional. Almost all suppliers of these technologies would claim benefits of their technology including fuel saving and reduction of air pollutant emission. Our practice is to facilitate these suppliers to meet with the local trades to conduct trials. Through field trials, users will be able to tell whether the technology is useful. So far, the efficiency of such devices has yet to be confirmed. Since 2000, 65 dealers have approached us and 9 cases are still active in some form of trials sponsored by the transport trade and the suppliers.

PROGRESS OF EMISSION CONTROL MEASURES IN HONG KONG

Ultra Low Sulphur Diesel

15. ULSD became the only motor diesel available at petrol filling stations around end August 2000, one month or so after the introduction of a duty concession for this cleaner fuel. All franchised buses have switched to use ULSD as from February 2001. Hong Kong is the only city in Asia and among the very few worldwide where ULSD is widely used by motor vehicles.

16. Given the steady supply of ULSD since its introduction and that it is effectively the only motor diesel available in the Hong Kong market, the Administration proposes to make ULSD the statutory standard for motor diesel and will put the necessary legislative amendments to the Legislative Council for consideration at the beginning of next legislative session.

LPG Taxis

17. To encourage early replacement of existing diesel taxis with LPG ones, we have been providing a one-off grant of $40,000 for each diesel taxi replaced by one that runs on LPG since August 2000. Currently, over 10,000 of the 18,000 taxis run on LPG and about 1,000 taxis are being replaced monthly. Replacing all diesel taxis with LPG ones can reduce particulate and NOx emissions from vehicles by 25% and 6%

respectively.

18. To encourage early replacement, particularly of the older diesel taxis which are more polluting, the deadline for application of the LPG taxi grant by owners of diesel taxis of 7 years old or above has been set at 31 December 2001. We have undertaken to review in mid-2001 if there is a case for extending the deadline. As at mid-June 2001, around 7,300 of the 9,800 diesel taxis which would have reached the age of 7 or above by end-2001 have already been replaced by LPG taxis. As the provision of LPG filling facilities have been improved, and as Annex C shows, the total LPG filling capacity will be able to match the growth in the number of LPG taxis even at a replacement rate of 1,000 per month, we generally do not see a case for extending the deadline. To extend it would counter the objective of the incentive scheme, which is to encourage early replacement, particularly of the older and more polluting diesel taxis.

19. However, we consider that there is a case for extending the deadline for the Lantau taxis which would become 7 years old or above by end-2001. The first LPG filling point on Lantau became available only on 31 March 2001. Hitherto, the closest filling point for Lantau LPG taxis was at Tsing Yi. LPG taxis had to pay toll for crossing the Lantau Link to get to Tsing Yi for refilling. As Tsing Yi is also outside of their permitted operating area, they had to travel without passengers between Lantau and Tsing Yi. That could reduce their in-service time and affect their business. This could have a discouraging effect on owners of Lantau diesel taxis to replace their vehicles with LPG ones before 31 March 2001.

20. Of the 50 Lantau taxis, 25 would turn 7 years old or above by end-2001. 10 of these 25 diesel taxis have been replaced by LPG ones as at mid-June 2001. In view of the situation described in paragraph 19 above, we consider that there appears to be a case to give owners of the remaining Lantau diesel taxis that would age 7 or above a longer time to apply for the grant. We plan to extend the deadline of 31 December 2001 by six months until 30 June 2002 for these Lantau taxis.

Retrofitting of Particulate Traps and Diesel Catalysts

21. We have been providing one-off grant to assist owners of pre-Euro light diesel vehicles to retrofit their vehicles with suitable particulate traps or catalysts since September 2000. About 14,200 particulate traps and catalysts have been installed on such vehicles so far. Retrofitting all 40,000 such vehicles can reduce particulate emissions by vehicles by 6%. The retrofit program will end in October 2001. We have sent out two reminders to the eligible vehicle owners in the past and will send out a third reminder telling them again our plan to make the installation a mandatory requirement. We plan to introduce legislation at the beginning of the next legislative session for this purpose.

22. The franchised bus companies have retrofitted about 2,000 pre-Euro and Euro I buses with catalytic converters by end-June 2001. A catalytic converter can reduce particulate emissions from a pre-Euro bus by 30%. More advanced technology such as the CRT referenced above are being tried by bus companies as well as on government Euro I and II vehicles.

23. A diesel oxidation catalysts can reduce particulates from a pre-Euro large diesel vehicle by up to 30%. We intend to require pre-Euro large diesel vehicles to be retrofitted with catalysts in order to reduce their emissions. To identify suitable catalysts, EPD is running a trial of catalysts together with the transport trades. The target is to draw up the specifications and the requirements for the catalysts required within 2001. We intend to apply for funding from the Finance Committee for the provision of the one-off grant to assist owners in retrofitting their pre-Euro large diesel vehicles with suitable catalysts as soon as possible and to make it a mandatory requirement for such vehicles to be retrofitted with such catalysts.

Action to Reduce Smoky Vehicles

24. In addition to various actions to reduce motor vehicle emissions, we have also increased the fixed penalty on smoky vehicles from $450 to $1,000 from 1 December 2000. The Administration has undertaken to review the effectiveness of the new fixed penalty level and the case for

imposing heavier penalty on repeated offences before the end of the current legislative session. We have undertaken such a review.

25. As Annex D shows, the number of smoky vehicles spotted by EPD has been decreasing since the middle of 2000 and sees a sharper drop since the beginning of this year after the new fixed penalty level became effective. We could also see from Annex E that the trend of the number of smoky vehicles issued with more than one Emission Testing Notices within 6 months in the preceding 12 months has also been decreasing since the latter part of last year for all vehicles and sees a sharper drop since December 2000 when the new fixed penalty level became effective. The enhanced effectiveness of the fixed penalty can also be seen in the number of fixed penalty tickets issued to repeated offenders (vehicles issued with more than one fixed penalty tickets within 6 months in the preceding 12 months) has more than halved since January 2001 (see Annex F). These analyses clearly show that the situation regarding smoky vehicles has greatly improved in respect of first time as well as repeated offenders. We consider that there is no need for imposing heavier penalties on repeated offenders for the time being. We should continue to monitor the situation closely and consider the need for enhancing the deterrent effect when required.

IMPROVEMENTS IN AIR QUALITY

26. With the implementation of the various emission control measures including those above, noticeable improvement in both the long-term and short-term air quality was observed in 2000.

Long-term Air Quality

27. The improvement was reflected by the decreasing levels of pollutants and increasing number of air quality monitoring stations complying with the annual Air Quality Objectives (AQO) for the pollutants -

(a) Compared with 1999, the overall annual concentrations of respirable suspended particulate (RSP) and NOx in the air reduced by 8% and 6% respectively in 2000. The decreasing

trend was more apparent from August 2000 onwards when a number of key measures including the provision of grant for replacement of diesel taxis, particulate trap installation programme and introduction of ULSD were put in place. Between August and December 2000, the RSP and NOx levels dropped by 13% and 10% respectively compared with the same period in 1999.

(b) The number of air quality monitoring stations complying with the annual AQO for both RSP and NOx increased from 8 stations in 1999 to 10 stations in 2000.

Short-term Air Quality

28. The number of hourly API readings with very high pollution level recorded at the air quality monitoring stations reduced in 2000:

(a) In 2000, the hourly API readings recorded at the 11 general stations exceeding 100 reduced by about 45%, as compared with 1999 (309 readings in 2000 as compared with 558 readings in 1999). The hourly API readings recorded at the three roadside stations exceeding 100 reduced by about 66%, as compared with 1999 (441 readings in 2000 as compared with 1,288 readings in 1999).

(b) Between August and December 2000, two hourly API readings recorded at the general stations exceeded 100, compared with 286 such readings in the same period in 1999. As for roadside stations, 112 API readings exceeded 100 between August and December 2000, compared with 339 in the same period in 1999.

29. The above improvements reflect clearly that the measures being implemented are taking effect. We expect to see continued improving trend in our air quality in the coming few years upon full implementation of the control measures.

Environmental Protection Department
Environment and Food Bureau
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Annex A

Diesel Vehicle Exhaust Emission Standards Summary --- Comparative Emission Reductions (Using pre-Euro Standards as Baseline)

Implementation date / Vehicle type	**1 January 92**	**1 April 95**	**1 April 97**	**1 October 2001**	**1 October 2006 Under current plan of EU**	**1 October 2009 Under current plan of EU**
Large Diesel Vehicles (over 3.5 tonnes)	*Pre-Euro*	*Euro I*	*Euro II*	*Euro III*	*Euro IV*	*Euro V*
Particulate	Baseline	47%	80%	87%	97%	97%
NOx	Baseline	11%	20%	44%	61%	78%

Annex B

Current Alternative-Fuelled Vehicle Emissions

	Euro III + ULSD	**LPG**	**Euro IV**
Particulate	Baseline	Negligible	78% lower
NOx	Baseline	About 50% lower	26% lower

Annex C

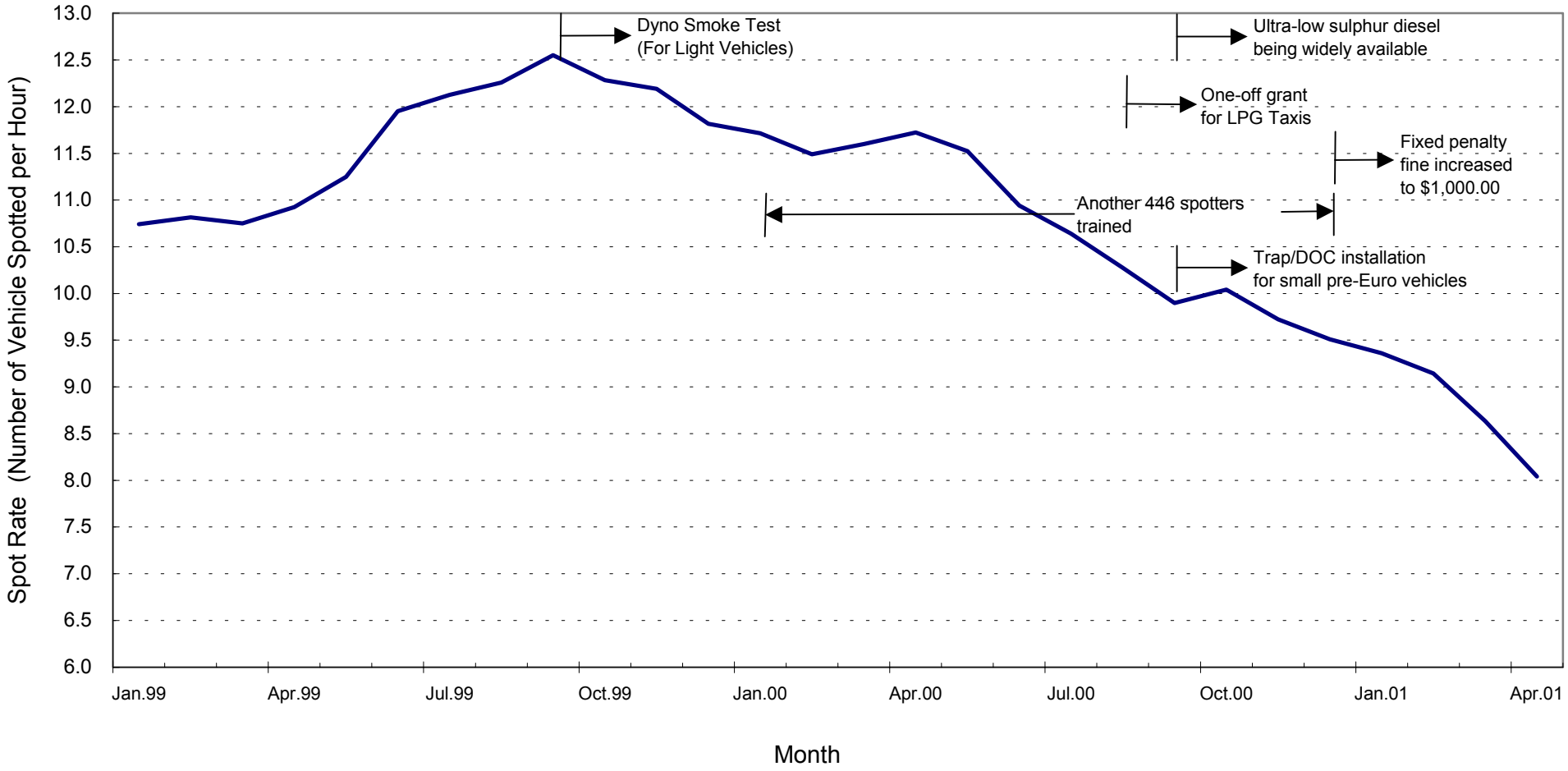
LPG Filling Facilities

	Cumulative no. of stations	**Cumulative no. of nozzles**	**Cumulative filling capacity (no. of taxis)**
As at 1 June 2001	13	136	8160
By end-June 2001	17	154	9240
By end-July 2001	22	172	10320
By end-Aug 2001	24	178	10680
By end-Sept 2001	28	206	12360
By end-Oct 2001	30	218	13080
By end-Nov 2001	31	224	13440
By end-Dec 2001	37	280	16800

Note: Government is discussing with two oil companies on retrofitting 5 existing petrol filling stations with 28 LPG nozzles to provide additional LPG filling capacity for 1680 taxis.

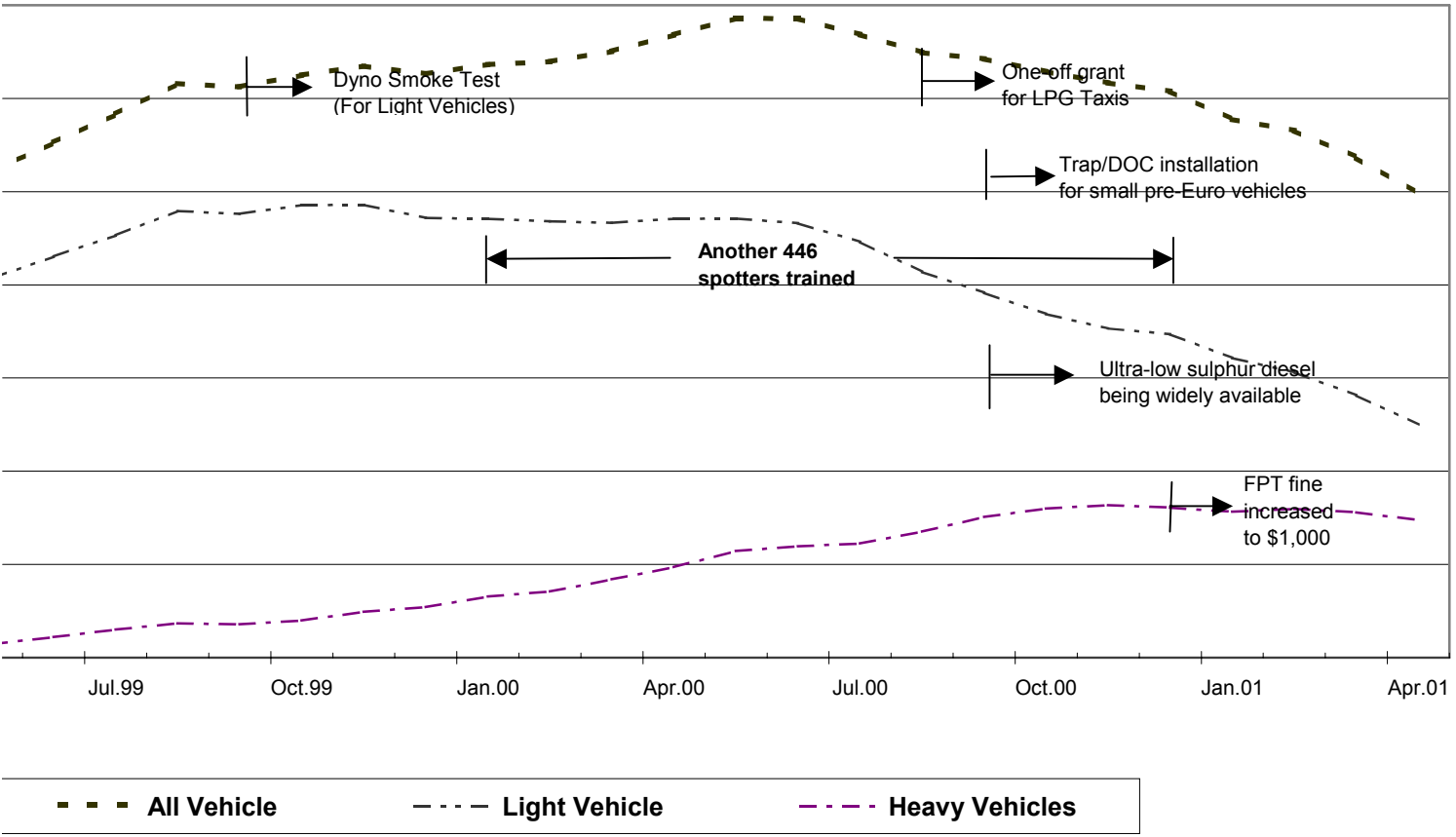
Annex D

12-Month Moving Average of Hourly Spot Rate from 1999 up to now



Annex E

Vehicles issued with more than one Emission Testing Notices
within 6 months in the preceding 12 months
e issued with a fixed penalty ticket and those reported by smoky vehicle spotters)



Annex F

Number of Fixed Penalty Tickets Issued for Smoky Vehicles

Offending Period	Number of Repeated Offenders*	Number of Fixed Penalty Tickets Issued
April 2000	35	377
May 2000	31	335
June 2000	46	712
July 2000	71	828
August 2000	69	900
September 2000	47	462
October 2000	68	625
November 2000	48	559
December 2000	62	452
January 2001	31	376
February 2001	23	159
March 2001	18	282
April 2001	12	257

* Repeated offenders: Vehicles issued with more than one fixed penalty tickets for emitting excessive smoke within 6 months in the preceding 12 months.