

**PROPOSAL FOR EMISSION CONTROLS
ON PETROL TWO-STROKE ENGINE
DRIVEN TWO AND THREE WHEELERS
AND OTHER ISSUE**

October, 1999

**Environment Pollution (Prevention & Control) Authority
for the National Capital Region**

PROPOSALS FOR EMISSION CONTROLS ON PETROL TWO-STROKE ENGINE DRIVEN TWO- AND THREE- WHEELERS AND OTHER ISSUE

1.0 INTRODUCTION

- 1.1 The Supreme Court in its order of 4.10.1999 called for suggestions regarding emissions control from two-wheelers and three-wheelers.
- 1.2 The EPCA, in its earlier report of August, 1999, had made a brief recommendation that on scooters, which are high emitters of particulate, suggesting that the norms be tightened further, and the next set of standards be announced early. In view of the Supreme Court's order, the Authority has now studied this issue at greater depth, and has the following discussion and recommendations to place before the Supreme Court.
- 1.3 It is requested to the Court that this note may be taken into consideration along with the suggestions made in the Fourth and the Fifth Report of the EPCA, in the hearing of 24th and 25th November, 1999. For that purpose, it is requested that it may be circulated to the parties interested in the case, along with the other papers and reports, that they may also take these recommendations into account before preparing their submissions to the Supreme Court. This request is made because there was a factual error in the earlier recommendations regarding scooters, concerning EURO norms for two- wheelers, which needs to be set right; also because the subject is dealt with more exhaustively, and makes significant recommendations.

2.0 CONTRIBUTION TO AIR POLLUTION BY TWO-STROKE ENGINE VEHICLES

- 2.1 The Supreme Court has rightly drawn attention to the issue of two and three wheeler vehicles in the NCR, almost entirely driven by two-stroke engines. These have been identified as an increasing source of air pollution in the region. Figures show that the total vehicle population in Delhi rose between 1991 and 1996 by 50%, and continues to increase at a rate higher than the country average and also of the not-insignificant rate of growth of population in Delhi. In the registered fleet, the two-wheelers (mainly petrol driven two-stroke scooters and mopeds) and the three-wheelers, now placed at approximately 25.0 lacs out of a total of an estimated 36 lakh vehicles, are dominant in terms of both number and mileage:

Table 1**Vehicular Population, Utilisation, and Fuel Economy in Delhi, 1996**

	Vehicle Population	Annual Utilisation (km/yr)	Total Annual Vehicle km (millions)	Fuel Economy
Light petrol vehicles	673985	10000	6739.9	14.2
Taxi	14427	31000	448.48	9.4
Diesel Bus	28899	65000	1878.4	3.3
Diesel Truck	138513	35000	4848.0	5.6
3-wheelers	80208	42000	3368.7	20.0
2-wheelers	1824097	5000	9120.5	40.0

Source: Study by Jian Xie, Jitendra Shah and Carter Brandon, Funded by World Bank, Based on 1996 Data from the Department of Transport, Delhi

NB : Though the data is dated, the proportions have probably not changed. Provisional figures for 2000 are at approximately 25 lakh two and three-wheelers out of an estimated total of 36 lakh.

Table 2**Preliminary Estimates of Vehicular Emissions in Delhi (in Thousand Ton/annum)**

	PM ₁₀	HC	CO	NO _x
Light petrol vehicle	1.7	10.1	64.0	12.8
Taxi	0.1	2.8	13.0	1.2
Diesel Bus	3.8	3.9	23.9	15.0
Diesel Truck	9.7	10.2	61.6	38.6
3-wheeler	1.7	25.8	41.3	0.3
2-wheeler	4.6	47.2	75.7	0.9
Total	21.5	100.0	279.4	68.8

Source: Study by Jian Xie, Jitendra Shah and Carter Brandon, Funded by World Bank, Based on 1996 Data from the Department of Transport, Delhi

NB : Though the data is dated, the proportions are not likely to have changed. The EPCA was not able to lay its hands on later data analysing the pollution load.

- 2.2 The share of two-stroke engine vehicles to vehicular emissions of PM10, HC and CO is calculated at 29%, 73% and 42% respectively. The health effects have been calculated (1994) at 1400 premature deaths, 12 million restricted activity days, and 38 million respiratory symptoms each year. Two stroke engines pollute intensively in terms of per vehicle and per kilometre driven. The three-wheeler is a worse offender. A typical three-wheeler is driven 100 to 120 km per day for 360 days of the year. It is calculated that the three-wheeler alone (3% of vehicle population) contributes 8% of total PM10, 26% of HC and 15% of CO (Data taken from study by Jian Xie, J.Shah and C. Carter Brandon, Funded by World Bank).

3.0 EXISTING EMISSION NORMS FOR TWO-STROKE ENGINES

- 3.1 Why two-stroke engines are so highly emission intensive is due to three causes:
- i) the engine emits high quantities of hydrocarbons including Benzene and other pollutants;
 - ii) it works on a mixture of oil and fuel rather than fuel alone, as with four-stroke engine; and
 - iii) a large quantity of the fuel is vented out unburnt.
- 3.2 Emission norms for two and three wheelers were first laid down in 1991, and then again in 1996. Pre-1996 two-stroke vehicles have very high emissions. A fresh, considerably more stringent set of norms is laid down for 2000. They do not, however, provide standards to control particulate emissions. Nor do they distinguish between a four-stroke two or three wheeler and a two-stroke one. But they do distinguish between a two-wheeler and a three-wheeler providing a relaxation in CO emissions to a three wheeler.

Table 3
Indian Standards for 2-wheelers and 3-wheelers

	CO (gm/km)		HC+NOx (gm/km)	
	2-wheeler	3-wheeler	2-wheeler	3-wheeler
1996 Type Approval	4.5	6.75	3.6	5.4
Conformity of Production	5.4	8.10	4.5	6.5
2000 Type Approval	2.0	4.0	2.0	2.0
Conformity of Production	2.4	4.8	2.4	2.4

4.0 COMPARISION WITH OTHER COUNTRY STANDARDS

4.1 Before one compares the Indian Standards with those set in other countries, it is to be understood that nowhere else is there such a high population of two- and three- wheelers because nowhere else it is used as a regular mode of personal transportation. Its use being limited in most countries to an occasional or sports vehicles. The problem of emissions from two-stroke engines is not anywhere else as significant.

4.2 EURO Standards

EURO standards for two and three-wheelers are therefore of little relevance to an exercise to control emissions from two-stroke engines in the NCR. Their proposed 1999 standards are higher than India 2000 standards for CO and lower in HC + NO_x, for all types of two-stroke vehicles except mopeds, which are lower on both counts. All others, except Taiwan, have standards more lax than those proposed for 2000 in India.

4.3 Taiwanese Standards

In Taiwan, the two-wheeler emissions standards are being tightened in four stages so far announced. The third stage norms, made applicable in 1998, are tighter on HC than the India 2000 norms. There, the 1998 norm for the Type Approval to Prototype is 3.25 gm/km for CO, and 1.75 for HC+NO_x, applicable since the year 1998; the COP standards are 3.50 for CO and 2.0 for HC+NO_x. Thus, the CO is higher, and the HC+NO_x is lower than the proposed Indian standards for a two-wheeler. For the future Taiwan is emphasising the introduction and popularisation of the electric motor cycle and has fixed a target of three million electric motor cycles by 2010, to make up one third of its total motor cycle population. Taiwan is also contemplating further tightening of emission norms from December 2003. It is proposing emission standards as low as 1gm/km for HC + NO_x for a 2-stroke engine and 2gm/km for a 4-stroke engine for a cold engine (a cold engine has emission approximately 2.5 times a warm engine). This is extremely important because the engine remains cold for at least 10 kms. before it warms up. It is expected that this will eliminate engines as they will have trouble in adjusting to the fourth stage standards.

4.4 Indian Standards beyond 2000

The Government may undertake an exercise to tighten norms for the near future, and to set the standard, for 2003 and 2005. The Supreme Court could consider directing the Ministry to do so or to set it a time-limit for setting the standard.

Table 4
Two-Wheeler Emission Standard Across Countries

Country	Year	Status	Vehicle type	CO (g/km)	HC + NOx (g/km)	Durability (kms)	Test
India	1996	Active	All types	4.5	3.6	None	IDC (Warm)
	1998	Proposed	All types	4.5	3.6	None	IDC (Cold)
	2000	Proposed	all types	2.0	2.0	None	IDC (Cold)
Taiwan	1991	Active	All types	3.75	2.4	6000	CNS 11386
	1998	Passed	All types	3.25	1.75	15000	D3165
European Union	1997	Passed	Moped	6.0	3.0	None	ECE R47
			4-stroke M/Cycle	13.0	3.3	None	ECE R40
			2-Stroke M/Cycle	8.0	4.1	None	ECE R40
	1999	Passed	Moped	1.0	1.2	None	ECE R47
		Proposed	All Types	3.0	1.3	None	ECE R40

Source From Study on Vehicle Emissions Control in India in the next Decade by Dr. B. P. Pundir, Professor, Department of Mechanical Engineering, IIT, Kanpur

- 4.5 Setting tougher standards would work to make the future cleaner, but it is unlikely that it would make a difference into the emission load from on-road two and three wheeler for a long time. To have such an impact, it is considered that stricter measures against the existing population of vehicles as, if not more, important.

8.1 Suggestive Measures

The problem of two-stroke two- and three- wheelers may therefore be desegregated into the two categories of new and on-road or existing vehicles, and measures proposed for each kind that may be implemented by industry, state governments and enforcement agencies.

5.0 NEW AND FUTURE VEHICLES

- 5.1 Since we are already on the subject of future standards, this category may be taken up first for discussion.
- 5.2 Since the emission norms of 2000 or later make no distinction between two-stroke and four-stroke engines, automobile manufacturers are taking two routes to reach the emission standards - while some are moving on to four-stroke engines on two-wheelers, others are fitting a catalytic converter on the two-stroke engine to achieve the same norm.
- 5.3 Of the emissions control technologies available for two-stroke engines, such as direct fuel injection to reduce scavenging losses; exhaust port throttling by an auto ignition process for light road or part load combustion; exhaust after treatment by oxidation catalytic converters, with or without secondary air, the most popular with manufacturers is the after-exhaust treatment by oxidation catalysts, for being the least expensive option. The greatest problem with it is its durability. India 2000 norms do not specify the durability of the catalytic converter, and it is thus not tested at either prototype or COP stage. Different manufacturers are proposing different durability, ranging from 15000 kms to 30000 kms.
- 5.4 Experience with catalytic converters on cars has shown that when the vehicle is sold, the consumer is not educated or impressed with the need for replacement of the catalytic converter after its life came to an end. As a result, a majority of the vehicles sold after 1.4.1996 with a mileage more than the estimated durability of 80000 kms are in all probability now running with uncontrolled CO and HC emissions because the life of their catalytic converter has expired, and no arrangements to make a replacement or repair are put in place. Experience of other countries also shows that the majority of owners do not voluntarily incur the not inconsiderable expenditure involved in the replacement, even if the procedure is available. In India, there is no Inspection and Maintenance Certification of a non-commercial vehicle, and therefore no system to detect or order replacement of an expired catalytic converter.

6.0 DURABILITY OF THE CATALYTIC CONVERTER

- 6.1 The life of a two-wheeler catalytic converter is considerably shorter than that of a car. The two-stroke engines fitted with a catalytic converter will meet the COP norms, as claimed by the manufacturers for only about 15000 to 30000 km or less, before the converter expires, and the engine emissions rise to levels well beyond the standard. In all likelihood, the two-wheeler will thereafter be driven on the roads with emissions as high as the ones now being manufactured. The chances that the owner will incur the expenditure to change the catalytic converter every 15000- 30000 km cannot be rated high, especially when one remembers that the USP of a scooter in this country is its price. Those who buy scooters are not likely to be the ones willing to incur recurring expenditure on replacement of the catalytic converter.

- 6.2 The contention of the automobile manufacturers is that the emission norms do not make a distinction between one two-stroke and four-stroke engines, and that so long as they meet the specified COP standards the technological choice of the route to conformity has to be allowed to them. Such an argument may be legally valid, but is of no practical use. It allows the manufacturers to get away with meeting the emission standards for a few years after manufacture, passing on thereafter the onus of meeting the emission norms on the owner of the vehicle, who is not in a position to honour it, even if conditions were to be put in place to by the manufacturers to enable him to replace or repair emission control devices.
- 6.3 In other countries where a catalytic converter is accepted as the emissions-control technology, the durability is being specified (Taiwan) and emissions warranty or On-board Diagnostics (computers to monitor emission for the driver) are being made compulsory (USA and Western Europe). The European Commission has put forward proposals to introduce 'Control of Conformity of Vehicles in Service'.
- 6.4 In our view, the two-stroke engine with a catalytic converter should not be acceptable as the technology that meets the emission norms of 2000 for the reasons given above. In case the Supreme Court desires to allow two-stroke engines with catalytic converters for use in NCR, then they must come with a manufacturer's Emission Warranty. But to implement this regulation new systems like recall of defective vehicles, control over fuel adulteration, good inspection and maintenance systems, will have to be initiated which may take a lot of time. Therefore, keeping all this in mind, **we recommend that only four-stroke two wheelers should be allowed to be sold in the NCR w.e.f. 1.4.2000.**

7.0 AVAILABILITY OF FOUR-STROKE ENGINES IN DELHI

- 7.1 The manufacturer's association has supplied figures that show a production capacity of over 7 lakh four-stroke two wheeler in 1999-2000, increasing to approximately 14.5 lakh in 2000-2001 for four-stroke two wheelers. The annual 2-wheeler registration is approximately 12 lakhs (21997-98) in Delhi. The production figures are, therefore, sufficient to meet the demand of the city and the NCR. Such a decision is clearly implementable with effect from April 1,2000.

Table 5
Planned Production Capacity of manufacturers

	1999-2000		2000-2001		2001-2002	
	4-stroke	2-stroke	4-stroke	2-stroke	4-stroke	2-stroke
Scooters	305000	1660000	655000	1615000	980000	1430000
Motor-cycles	440000	835000	729000	725000	1319000	520000
Mopeds	-	635000	75000	575000	170000	570000
Total	745000	3130000	1459000	2915000	2469000	2520000

Source : AIAM data of January 1999 submitted to the EPCA

8.0 EMISSIONS TAX

- 8.1 There is a clear possibility of improving the technology of the two wheelers and three-wheelers further which is important because of their high number which are introduced every year. For this purpose, we would recommend that the Ministry of Finance undertake a study to introduce in emissions-based tax which gives incentive to manufacturers to continuously upgrade their technology and introduce it in the market without losing their market share. This will encourage manufacturers to move towards scooters with gaseous fuels like LPG or CNG and even towards battery scooters.

9.0 NEW THREE-2WHEELED VEHICLES

- 9.1 The Supreme Court, vide its order of 16.12.97, had restrained the State Government from granting fresh permits in respect of auto-rickshaws in Delhi except in replacement of old ones being phased out. This order was passed specifically to restrict the heavy pollution caused by three-wheelers on two stroke engines, which are one of the worst emitters on the road. Despite the order, there has been a net increase in the auto-rickshaw fleet in the city since then and none of these seem to be on cleaner fuel like CNG. Apart from the State Government now being answerable for a contempt of the Court, this has meant an increase in the pollution load from three wheelers which the Court had tried to stem.
- 9.2 Given this situation, it is recommended that the sooner the whole fleet is converted to CNG the better. **New autos could be allowed registration, to unblock the pent up demand that encourages such lapses in enforcement, but only if they are on dedicated CNG engines.**

10.0 EXISTING THREE WHEELERS

10.1 Now that a network of CNG outlets is shortly going to be provided in the city, a directive such as passed by the Supreme Court in respect of buses would be well in order in respect of three-wheelers. The recommendation is that the entire existing fleet of three-wheelers should be converted to CNG by 1.4.2000. From 1.4 2000, the State Government could ensure that autos that come for annual fitness certification are denied certification if they are not converted to CNG and seized. After 1.4.2001, all autos on the road should be on CNG, and the enforcement agencies should be fixed with the responsibility to prevent any that continues unconverted by seizure and scrapping. Considering the price differential in favour of CNG, the owners should not have any intrinsic objection except that of the affordability of the conversion kit in the initial instant. Here, the State Government should be open to provide loans to spread the initial cost, recovering it along with tax if no other system suggests itself.

11.0 GOODS CARRIAGE BY THREE-WHEELERS

11.1 The figures given above of the share of vehicular emissions by three-wheelers is calculated taking into account passenger carrying autos. The situation is far grimmer with goods carriage. It is the practice in the city, when the body of an auto has deteriorated beyond economic repair, to convert the vehicle to a goods carriage, by fitting a new cage-like body to it, and using it for short hauls within the city. This practice grossly overloads the engine. Quite often, the body itself is equal to or beyond the gross vehicle weight; with goods, the engine chugs out heavy emissions and moves at a rate on the road that slows the entire traffic movement, contributing further to pollution.

11.2 **It is recommended that the registration or re-registration of three-wheeled two-stroke engines for goods carriage should be restrained immediately and existing vehicles more than ten years old phased out by April 1, 2000 and the remaining being converted to CNG by April 1, 2001.**

12.0 EXISTING TWO-WHEELERS

12.1 No practical solution suggests itself. Retrofitment of catalytic converters is not found practical; nor can the scooter be easily converted to CNG or other clean fuels. At the same time, waiting for the old ones to die out and be replaced slowly by new vehicles with controlled emissions is unacceptably long. **The old two-stroke two wheelers can only be dealt with by phasing them out.** But this move will be extremely unpopular, and undoubtedly lead to some hardship and much heart-burning, especially where a good public transport system is not in place.

12.2 A Buy Back scheme

Realising the difficulties involved, and the Government's track record in handling replacements, the Authority would like to suggest to the manufacturers that they propose a buy-back plan, supported by incentives from the manufacturers and the Government including reduction of taxes on vehicles bought in replacement, so as to make the replacement attractive to the owner. The increased sale of new vehicles should be incentive enough for the manufacturer to propose a viable buy-back option which should be applicable to all vehicles that are pre-1991 to begin with. The second-hand vehicles can be sold outside NCR which would make the scheme more attractive but mechanism would be needed to ensure that they do not go to other polluted towns and cities of the country. The government would have the incentive of being able to enforce its replacement scheme; replacing an old with a new and better controlled-emissions vehicle; as well as the savings on health costs, pointed out by the above-quoted World Bank study as in para 2.2. Under direction of the Supreme Court, the government and the manufacturers should be able to work out an attractive scheme. The owner should co-operate if this carrot is used by the Government and emissions tax as suggested above to persuade him to buy more environment -friendly vehicles, and the buy back scheme and incentives to attract him for replacing old vehicles.

13.0 RELATED MEASURES - QUALITY OF FUEL AT THE RETAIL END

13.1 The necessity of supplying clean fuel to technologically improved vehicles has been emphasised earlier as well. The improvement in fuel is not only necessary to clean the air, but, often, is essential if the improved engine is to function at all. Improvement in the quality of petrol, to our mind, needs now to focus on,

- i. further reduction of benzene levels to bring them down to less than one percent v/v;
- ii. improvement in the quality of fuel at the retail end.

13.2 We highlighted this last measure in our earlier Vth progress report suggesting a change in the system of supply and distribution of fuel by the oil companies so that they can be held accountable for the quality of fuel supplied to their consumers. The current system, whereby they deem their responsibility ended at the oil depot, even though the transport from their to the petrol pumps is organised by them, and the petrol pumps are all their agents, only encourages collusion in adulteration and irresponsibility towards the consumer. It is common knowledge that solvents, naphtha, kerosene and other such additives are mixed with fuel once it is out of the refineries. The adulterants can change emissions characteristics of vehicles on the road and possibly even affect the durability of emission control systems of vehicles. Yet the oil companies and petrol pumps have always maintained that the adulteration of fuel is done mainly by the drivers and crew of vehicles. For adulteration that

is discovered at the retail end, the owner of the petrol pump should be held responsible. Due to the number of intervening handlers from the refinery to the retail site, and the fact that closure of a pump means loss of sales, they have seldom taken strict action against anyone.

- 13.3 It is necessary to fix the accountability of the oil companies for the quality of fuel sold at the retail end. If oil companies are made answerable for the fuel they supply up to the retail end, and not just at the refinery gate, their sale and distribution network, which under the existing system is divorced from the business of ensuring the quality of fuel, will also get involved in putting in place systems that check the adulteration of the fuel in transit from the refineries and at the retail outlets.

14.0 RELATED MEASURES - IMPROVEMENT OF THE CITY BUS SERVICE

- 14.1 The city, according to traffic projections, is required to increase its city mass transport service to 10,000 buses by 2001. Only when this is done, and done efficiently, will it be able to provide commuters with a viable option to using their own vehicles, and thereby reducing the congestion of vehicles on the road. Although we have said this before, we cannot forbear from reiterating it, so important do we think this measure to the orderly planning for traffic and air quality management of the city. With this emphasis, we may reiterate the need to put all buses in the city on CNG, as early as possible, and definitely by the date specified by the Supreme Court.

15.0 RELATED MEASURES - BYPASS

- 15.1 This has, again, been emphasised earlier. Given the number of trucks that pass through the city, on the many highways that run through it, vehicular air pollution due can be tackled efficiently only if the large volume of long haul through trucks are diverted onto a route that takes them outside the city.

16.0 CONCLUSION

In conclusion, we recommend the following:

- i. The government be directed to announce, by a definite date, tighter norms for two-wheelers and three-wheelers for 2003 and 2005.
- ii. Only four-stroke two wheelers should be allowed to be sold in the NCR w.e.f 1.4.2000.
- iii. The Ministry of Finance be directed to undertake a study to introduce an emission-based tax which provides incentives to manufacturers to continuously upgrade their technology.

- iv. New three-wheeled autos could be allowed registration, to unblock the pent up demand that encourages such lapses in enforcement, but only if they are on dedicated CNG engines.
- v. The entire existing fleet of three-wheeled autos should be converted to CNG by 1.4.2001.
- vi. Registration or re-registration of three-wheeled two-stroke engines for goods carriage should be restrained immediately and existing vehicles more than ten years old be phased out by April 1.2000 and the remaining converted to CNG by April 1, 2001.
- vii. The Government and manufacturers be directed to develop a buy-back scheme with incentives from both manufacturers and the government to help phase out the old and polluting two stroke two wheelers and replacing them with new and less polluting ones.
- viii. The Ministry of Petroleum should direct the oil companies to supply petrol with 1% Benzene v/v to the NCR.
- ix. The Ministry of Petroleum should set-up systems to hold oil companies accountable for the quality of fuel sold at the retail end in order to reduce the problem of fuel adulteration.
- x. The Delhi Government should ensure that all buses (public and private) are converted to CNG by 1.4.2001 the date already fixed by the Supreme Court.
- xi. The Delhi Government should augment the DTC bus fleet to 10000 buses running on dedicated CNG engines by April 2001, for which a direction has already been given by the Supreme Court with a fixed deadline.
- xii. The NCR government should construct a by-pass by a fixed deadline to divert the heavy inter-state truck traffic that currently passes through Delhi.