ENGINES OF THE DEVIL

WHY DIESELISATION OF PRIVATE AUTOMOBILE FLEET SHOULD BE BANNED — THE CASE OF DELHI

Anil Agarwal

Prepared for CSE's Right to Clean Air Campaign

May 1999

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi-110062 India
Tel: 91-11-6981110, 6981124, 6983394, 6986399
Fax: 91-11-6985879, 6980870 E-mail: cse@cseindia.org
Website: www.cseindia.org

The Centre for Science and Environment is a public interest research and advocacy organisation, which promotes environmentally-sound and equitable development strategies. The Centre's work over the past 17 years has led it to believe and argue, both nationally and internationally, that participation, equity and community-based natural resource management systems alone will lead the nations of the world towards a durable peace and development.

As a public interest organisation, the Centre supports and organises information flow in a way that the better organised sections of the world get to hear the problems and perspectives of the less organised. Environmental issues are seen in an anthropocentric perspective that seeks to bring about changes in the behaviour of human societies through appropriate governance systems, human-nature interactions, and the use of science and technology.

Though the public awareness programmes of the Centre have been its key strength and focus of work, it has endeavoured to move into associated areas of work like policy research and advocacy in the past years. Learning from the people and from the innovations of the committed has helped the Centre to spread the message regarding environment without its normal association with doom and gloom. Rather, the effort of the Centre is to constantly search for people-based solutions and create a climate of hope.

The Centre has always been, and will continue to be, editorially independent of interest groups, governments, political parties, international agencies and funding sources. CSE never accepts funding to push a donor's viewpoint. All its outputs are available for public dissemination.

Engines of the Devil

Want to buy a diesel car to keep your oil bill low? Think again. You may end up trading your life for cheap and toxic diesel.

As companies go for a hard sell of diesel cars, dieselmania grips you too. What was supposed to be cheap fuel for the poor farmers is now driving the cars of the rich.

Do not choose to ignore the fact that diesel fumes trigger cancer and pose serious threat to public health. Delhi is already reeling under high concentration of diesel-related pollutants — small particulate matter, oxides of nitrogen and ozone. Studies also show that neither improving diesel quality nor upgrading engine technology can help to avert the threat posed by toxic particulate emissions. The cleaner the diesel, the tinier the particulate matter, and higher the cancer-causing potential.

More private diesel cars on road simply negate the spirit of the Supreme Court orders steering a large part of public transport fleet away from use of diesel to a cleaner fuel like CNG to control air pollution in Delhi. The only option therefore is to ban private diesel cars.

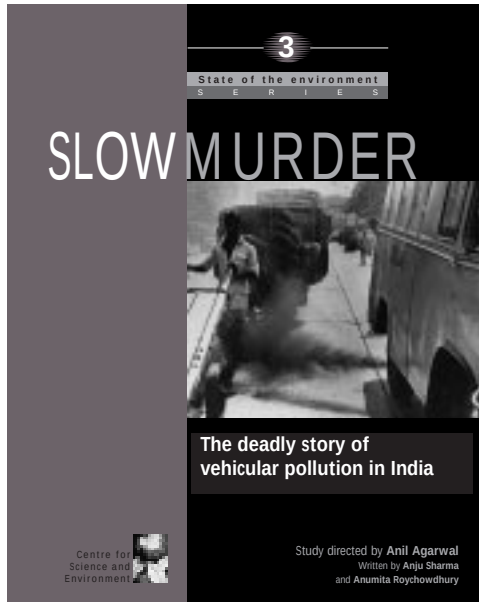
Cover cartoon: Rustam Vania

Material from this publication can be used, but only with proper acknowledgement.

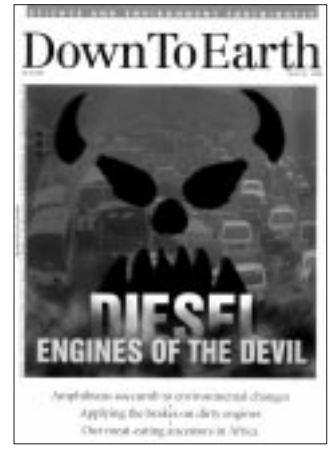
Published by
CENTRE FOR SCIENCE AND ENVIRONMENT
41, Tughlakabad Institutional Area,
New Delhi 110 062
Phones: 91-11-6981110, 6983394, 6986399
Fax: 91-11-6985879
E-mail: cse@cseindia.org Website: www.cseindia.org

Printed at Excellent Printing House, New Delhi

CONTENTS



Published in 1996,
Slow Murder gives you the complete story of vehicular pollution in India



Down To Earth
keeps you informed every fortnight. Prepare yourself to change the future

Counsel for the Government of India: *"We need some breathing time."*
Chief Justice A S Anand: *"You need breathing time when there are already people suffering from breathing problems because of your actions."*
— In the Court of the Chief Justice, Supreme Court of India on May 13, 1999.

SUMMARY AND INTRODUCTION

Why is it necessary to ban private diesel vehicles and reduce the use of diesel as much as possible ?

To understand the problem posed by diesel, it is necessary to understand the new information that has emerged over the last decade about its ill-effects. For a long time diesel was considered a 'green fuel' because it is 15-20 per cent more fuel-efficient than petrol. This means that one litre of diesel gives 15-20 per cent more mileage than one litre of petrol. But the 1990s have seen diesel take a severe beating and is now being increasingly recognised as a devilish fuel.

The first big finding came with air pollution experts discovering that diesel exhaust consists of 10-100 times (that is, one to two orders of magnitude) more particles than petrol. More than that, experts soon began to realise that it is not the total quantity of particles that matters so much for public health as the size of the particles in vehicular exhaust. The smaller the particles, the worse they are because they go deep into the lungs and stay there for a longer time.

As a result, air pollution monitoring systems in the West stopped measuring the total concentration of particles in the air. Instead, they started measuring only the concentration of those particles which had a diameter of 10 microns or less, called PM10 or respirable particulate matter. By the mid-1990s, US environmental scientists were arguing that it is not even PM10 that matter. It is PM2.5, that is, particles of 2.5 microns or less that are important. Unfortunately, monitoring systems based on PM2.5 have been difficult to implement because the equipment is still very expensive and the process is cumbersome.

Meanwhile, experiments in the UK have shown that 90 per cent of the particles in diesel exhaust are extremely tiny, of a size of one micron or less. In other words, diesel exhaust not only has a very high quantity of particles but it also mostly contains very tiny particles.

The second set of damaging studies have come from epidemiologists who have found that, of all the air pollutants, particles kill the most people — some 460,000 every year. WHO has tried to set air quality guidelines for particulate pollution in the air — a guideline is a level of pollution below which the air is safe and above which it is unhealthy — but it has failed to do so. Because epidemiological studies carried out in the late 1990s have shown that people die and/or fall ill even at levels of particulate pollution that are considered quite low. WHO has, therefore, not been able to find any threshold level, that is, any level for particulate pollution that can be considered safe.

As if this was not enough, toxicological studies have also been showing up diesel particles to be highly carcinogenic. In 1997, a Japanese scientist even reported the discovery of the most potent carcinogen found as of date in diesel exhaust. Given all this disturbing information, the California Air Resources Board formally declared in August 1998 — less than a year ago — that diesel particles are Toxic Air Contaminants, which means automobile companies will now have to drastically reduce particles in diesel exhaust, and this is not going to be an easy task.

Recognising the importance of tiny particles, scientists have also turned their attention to the size of particles in the exhaust of improved diesel engines and of engines using improved diesel fuel. As emission standards still measure the quantity of particles in exhaust, uptil now most studies have focussed on what happens to this quantity when the diesel engines or diesel fuel is improved. And improvements in diesel engines and diesel fuel do result in reductions in the total quantity of particles. But when scientists began to look at what happens to the size of particles, they found extremely damaging results.

A study in the US which compared a 1991 diesel engine with a 1988 diesel engine found that the improved engine had 15 to 35 times more particles than the earlier engine which meant that the improved engine was producing much smaller particles. A study conducted in the UK, as recently as January 1999, which tried to assess the impact of using high quality 'city diesel' also found the same results. Thus, both studies reveal that both improving engines and fuel quality result in even smaller particles, making the resulting diesel exhaust even worse from a public health point of view.

This information about diesel is extremely disturbing especially because the Central Pollution Control Board data shows that both total particulate levels and respirable particulate levels (PM10 levels) are extremely high in Delhi. Not only are they above the standard every day, there are days when they go five to six times above the standards. There is, thus, a pollution crisis in Delhi from particulates.

In such a situation, India would do well to restrict the use of diesel to the extent possible — by banning diesel cars and by converting diesel buses to CNG. Even then diesel will continue to be used in trucks and small gensets causing immense pollution. Diesel cars should be allowed only when diesel technology has matured and its health implications are adequately dealt with.

It is important to understand that the Western economic model, built on highly energy and material-intensive technologies, has proved to be an extremely **'toxic model'**. The post-war economic boom immediately landed cities from Tokyo to Los

Angeles into devastating air pollution problems even as all aquatic systems began to be poisoned to death. Having learnt from their mistakes, Western societies have conducted themselves with much greater discipline with respect to the environment and have also invested substantially in relatively environment-friendly technologies. Even then, the battle is far from won. Huge amounts of toxins still enter the global ecosystem as a result of economic processes. And the disruption of the global carbon and nitrogen cycles still continues to throw a pall over humanity's future.

Very few people understand the speed with which Western-style economic growth brings pollution. Studies carried out by the World Bank now tell us that when the economy measured in Gross Domestic Product (GDP) of Thailand doubled during the 1980s, its total load of pollutants increased an amazing ten-fold. A study conducted by the Centre for Science and Environment for India shows that when the Indian economy doubled over the period 1975-1995, its industrial pollution load went up by 3.5 times and the vehicular pollution load by 7.5 times.

The situation looks frightening. The processes of wealth generation will clearly put increasing pressure on natural ecosystems and generate huge amounts of pollution. It is absolutely vital that we recognise this problem and learn to deal with it. It was in the post-World War II period that the world began to see what was then an unprecedented economic boom in Europe, Japan and North America. By the 1950s itself, cities from Tokyo and London to Los Angeles were choking under pollution. The Western society responded to this problem with increasing investment in pollution control. It is estimated that in the early 1970s, Japan spent over 25 per cent of all industrial investment in pollution control measures. Will countries like India be able to make the necessary investment to clean up our environment? Or should we, therefore, learn from the mistakes of the Western society and restore the balance between economic growth and environmental conservation and public health.

It is part of this 'challenge of the balance' that has led us to launch our "Right to Clean Air Campaign".

The objective of the Right To Clean Air Campaign:

- **improve decision making processes related to air quality planning;**
- **build up pressure on the government for more transparent policy mechanisms; and,**
- **raise public awareness levels about poor urban air quality and risks to public health.**

According to our calculations, one person dies every hour in Delhi due to air pollution-related diseases. This could well be an underestimate. Air pollution in the city has reached alarming proportions and requires urgent policy attention. And many other cities are similarly placed.

In 1996, we published, ***Slow Murder: The deadly story of vehicular pollution in India.*** The study revealed that vehicles contribute maximum to the pollution load in Indian metros — a shocking 64 per cent in Delhi, 52 per cent in Mumbai and 32 per cent in Calcutta.

The study concluded that the problem of vehicular pollution would need a comprehensive policy framework. In 1996, we said that the government, and in particular the Delhi government, should stop focussing on "pollution under control" certificates to check tail pipe emissions. We called it "tailpipery" as not only were

pollution under control certificates available for a price but that they were also ineffective in controlling the growing pollution in the city. We suggested that the government should, instead, focus on the following issues for effective control of pollution:

- Strict monitoring of air pollutants and set stringent air quality standards for the city;
- Set stringent emission standards for vehicles and progressively tighten them to weed out outdated vehicle technology;
- Set tighter standards to improve fuel quality;
- Improve transport planning and in particular, make substantial investment in mass public transport systems;
- Improve maintenance of in-use vehicles

Our efforts

Over these past years, we have worked to build an informed public opinion about air pollution in the city. We have worked with citizens' groups, school children, teachers, doctors, technocrats and industry representatives to spread awareness about issues. Along with our volunteers we jammed the telephone lines of the former chief minister, Sahib Singh Verma to pressurise him to take action in the interest of clean air. We mobilised the prominent citizens of Delhi to condemn the misleading statements made by the Lt Governor of Delhi, Vijai Kapoor, underplaying the gravity of the air pollution in Delhi. We also protested when the former health minister of Delhi, Harsh Vardhan, denied link between air pollution and respiratory disorders in a press statement. He had to retract his statement. During the assembly elections in Delhi in November 1998, we worked with citizens of Delhi to pay for half page advertisements in *Times of India* and *Navbharat Times* to tell politicians, "If you want our votes give us clean air". We have repeatedly gone to the public through public meetings, press conferences and workshops to inform citizens about the dangers of breathing poison.

We have continued with policy research to be able to advocate solutions. This has been our strength. Our research has helped us to identify appropriate policy options and influence public policy to push for action. People working in India know, bringing change is a question of persistence that needs constant pressure and vigil.

The impact of our Right to Clean Air Campaign:

November 1, 1996: CSE released *Slow Murder*: *The deadly story of vehicular pollution in India* and organised the first public meeting "Public Trial" on November 5.

On November 18, 1996: The Supreme Court issued *suo moto* notice to the Delhi Government, to submit an action plan to control city's air pollution following the media reports on the CSE study.

In December 1996: In response to the Supreme Court directive, the Delhi government presented an action plan to the Supreme Court to combat air pollution in Delhi. This was the first time that such a comprehensive plan was presented by the government.

November 1, 1997: CSE organised its second public meeting "Slow Murder and Since..."

In this meeting CSE released the results of its study that the death count due to air pollution in Indian cities was up by almost 28 per cent between 1991-92 and 1995.

CSE held government inaction responsible and pointed out that the Supreme Court's decisions were lacking in comprehensiveness and effectiveness in dealing with the matter.

On November 4 1997: Saifuddin Soz, the then Union environment minister, announced his plans to issue a white paper on pollution in Delhi**.**

On December 2 1997: The Union environment minister issued a white paper on pollution in Delhi.

On January 7, 1998: Supreme Court directed the government to set up a special agency, Environment Pollution (Prevention and Control) Authority for the National Capital Region under the section 3 of the Environment Protection Act 1986, to control pollution in Delhi. CSE's director Anil Agarwal was appointed as the member of this committee.

In 1998, we also further elaborated an action agenda for immediate impact on air quality.

- Stop dieselisation of private vehicle fleet.
- Immediate improvement in fuel quality — both diesel and petrol. If Indian refineries are not capable of producing clean fuel the government should import best quality fuel.
- Tax to improve diesel technology
- Introduce a comprehensive inspection and maintenance programme along with emission warranty system to make the industry accountable for the lifelong emission efficiency of all vehicles they produce.
- Industry must make the actual emission levels of the vehicles they produce public.
- Begin monitoring of all harmful gases and introduce smog alerts in cities.

Why this paper?

CSE has watched with great concern that the Indian automobile industry has chosen to ignore the frightening scientific evidences on toxic diesel fume to lure people to diesel cars and cash in on the wide gap in diesel and petrol prices. While the industry has failed to look beyond its immediate business interests to address the larger issue of public health, CSE has stepped in to campaign against the dieselisation of the private automobile fleet.

CSE has realised that there is very little appreciation of the problem at all levels: government, industry and even public. As we learn more about the health effects from diesel exhaust, we must reconsider the widespread use of diesel engines. So far the government and the automobile industry have accepted the diesel engine as a norm and have only tried to reduce pollution coming from these engines through emission regulations. But in view of the proven toxic effects of diesel fumes this is not enough. We need to seriously think about restricting diesel vehicles to reduce serious health risks by going for cleaner alternatives.

In this paper CSE presents the evidence to convince you why the "Engines of the Devil" should go.

If you agree with us, then remember to give us your support. We are fighting **Big Business** which will use all its clout to confuse the public and suppress information.

ENGINES OF THE DEVIL

Why dieselisation of private automobile fleet should be banned?

A. Fatal attraction: the dangers of diesel

A study conducted by the Centre for Science and Environment, comparing the rates of economic growth and the rates of growth in vehicular and industrial pollution, shows that during 1975-1995 the Indian economy grew by 2.63 times, but the industrial pollution load grew by 3.47 times and the vehicle pollution load by 7.50 times (See Graph 1).

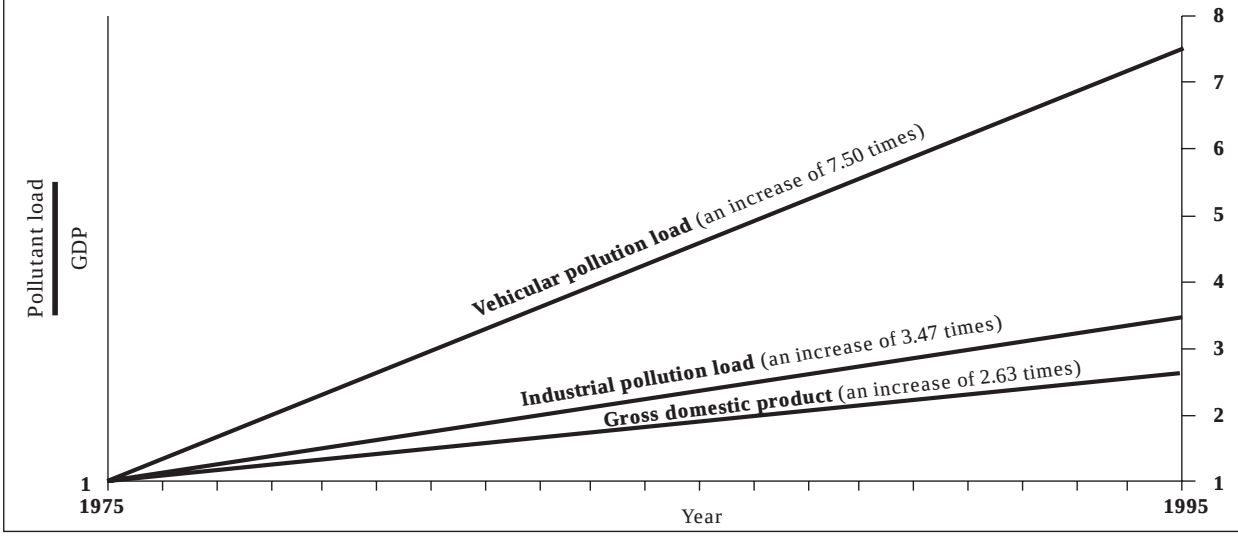
It is, therefore, not surprising that almost all Indian cities are today reeling under severe air pollution and the speed with which this pollution has grown has been quite dramatic. This is not unique to India. Within 10-15 years of the post World War II economic boom all industrialised countries — from Japan to Europe and USA — were suffering from severe air pollution problems. Only measures taken from 1970s onwards helped control air pollution to some extent. During the 1970s as much as 20-25 per cent of industrial investment in Japan was directed towards pollution control, a level of investment which India will not be able to afford in the immediate future. Therefore, pollution prevention has to be the key policy component in India.

The current trend towards the dieselisation of the private vehicular fleet is extremely worrying for a variety of reasons that are cited below, including the fact that it negates the very spirit of the Supreme Court order delivered on July 28, 1998:

- Delhi uses more diesel as compared to petrol than possibly anywhere else in the Western world.

- Diesel-related pollutants are either already very high or rapidly increasing in Delhi's air.

Graph 1: Growth in vehicular and industrial pollution has outstripped economic growth



Source: GDP from *Indian Economic Survey*, 1997-98 and Priti Kumar and Sujata Bhattacharya 1999, When Wealth is not Health in *Down To Earth*, Society for Environmental Communications, New Delhi, Vol 7, No 17, p33.

- The health impacts of diesel pollutants are deadly.
- Diesel quality in India is extremely poor. And recent scientific evidence shows that even using clean diesel fuel or moving towards clean diesel engines can have an adverse impact on public health.
- Both existing and proposed emission standards for diesel vehicles are extremely poor. Currently there are limits to diesel technology across the world in dealing with these toxic emissions.

Diesel constitutes two-third of total fuel consumption in the transport sector in the capital. In other words, diesel use is more than twice the use of petrol. In most Western cities, diesel consumption is about one-half of petrol consumption and almost never exceeds it. Not only is the diesel-petrol consumption ratio high in Delhi, diesel consumption is also galloping at a faster pace than petrol consumption.

Between 1980-81 and 1990-91, the rate of growth of petrol consumption was higher than that of diesel but this trend was reversed in the period 1990-91 to 1996-97 during which diesel consumption grew at a much higher rate than diesel (see Table 1 and Graph 2).

- In sum, Delhi not only uses a lot of diesel, but also very poor quality diesel and which is then used in very poor quality vehicles. It is no wonder that the problem of air pollution is worsening in the city.

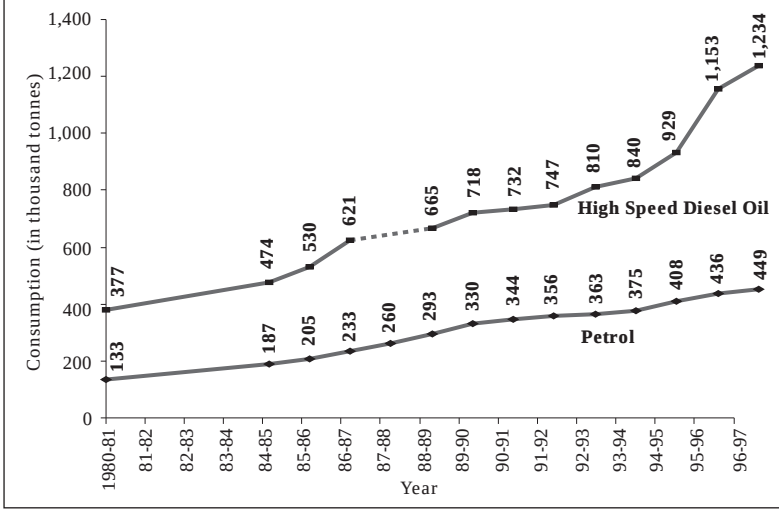
According to the Central Pollution Control Board (CPCB), diesel is responsible for 100 per cent of the particulate matters, 95 per cent of nitrogen oxides and 96 per cent of sulphur emissions produced by vehicles. The CPCB does not measure ozone, a harmful gas that is produced as a result of nitrogen oxides (see Table 2).

Table 1: Growth in diesel consumption versus petrol consumption in Delhi

Growth in consumption of	1980-81 to 1990-91 (10 year period)	1990-91 to 1996-97 (6 year period)
Petrol	158.65%	30.52%
Diesel	83.03%	68.58%

Graph 2: Growth in Petrol versus Diesel consumption in Delhi ('000 tonnes)

Diesel use has grown rapidly in recent years.



Sources:

1) Data for 1980-81 to 1989-90: Delhi Administration 1991, Delhi Statistical Handbook 1990, Delhi.
2) Data for 1989-90: Delhi Administration 1996, Delhi Statistical Handbook 1996, Delhi.
3) Data for 1990-91 to 1995-96: Delhi Administration 1997, Delhi Statistical Handbook 1997, Delhi.
4) Data for 1996-97: Delhi Administration 1998, *Personal Communication.*

Table 2: Percentage contribution of vehicular pollution load: Petrol vehicles versus diesel vehicles in Delhi

Category of vehicle	Contribution to nitrogen dioxide pollution	Contribution to sulphur dioxide pollution	Contribution to suspended particulate matter
Petrol- based vehicles	5%	4%	—
Diesel- based vehicles	95%	96%	100%

Source: Central Pollution Control Board 1998, Dieselisation of private vehicles, Note submitted to the Environment Pollution (Prevention and Control) Authority, New Delhi, *mimeo.*

B. Dieselisation of private vehicle fleet

Almost all major automobile companies have got into a race to introduce diesel versions of their vehicles to give their customers the benefit of cheap running costs (see Table 3).

- TELCO has ventured into the private vehicle segment with the diesel-based Indica Mint. It has launched four Indica models — diesel standard, diesel deluxe, diesel A/C and Indica petrol.

The overwhelming response to TELCO's diesel Indica is very worrying from the standpoint of Delhi's air quality. In the first round of its booking, 60,000 orders have been booked. Of these 15,000 are in Delhi alone. The total number of orders — about 1.15 lakh — were far more than the company could even accomodate. About 95 per cent of the orders are for the diesel version — about 75 per cent for the diesel standard and 20 per cent for diesel A/C (Data obtained from Tata Concord, automobile dealer in Connaught Place, Delhi).

- Maruti has already rushed in with diesel Zen and has also announced more diesel versions of their existing car models like Esteem in future.
- Premier Automobiles Ltd (PAL) has launched diesel-based Fiat Uno 1700cc.
- Mercedes-Benz India Ltd has added in their E-class series a diesel variant of E250.
- Mahindra Ford has flagged off diesel Escort.
- General Motors India is about to launch Astra Diesel.
- Hindustan Motors and Mitsubishi joint venture is ready with diesel Lancer.

Equally dangerous is the trend in diesel-powered three wheelers:

- Greaves Ltd rolled out their diesel three wheeler, Garuda, in 1996.
- Bajaj Auto Limited, too, afraid of losing its market share, has developed a diesel model of three-wheelers.

This trend will negate the spirit of the Supreme Court orders, which are trying to move a large part of the commercial vehicle fleet in Delhi out of the use of diesel. The increase in the private vehicular fleet running on diesel will negate the beneficial impact of the above orders.

Table 3: The Dieselisation of the Indian Automobile Fleet

The price difference between petrol and diesel is pushing almost every company towards diesel.

Company	Diesel Model	When introduced or to be introduced
Peugeot and Premier Automobile Ltd (PAL)	309 GLD	1997
Premier Automobile Ltd	138 NE Premier Padmini Fiat Uno	Already existing Already existing 1998
Tata Engineering and Locomotive Company Ltd (TELCO)	Indica Tata Estate Tata Sierra Tata Sumo Tatamobile	1998 Already existing Already existing Already existing Already existing
Mahindra & Mahindra Ltd with Ford Motor Company	Ford Escort	1997
Maruti Udyog Limited	Zen Diesel (Esteem and Gypsy are likely to follow)	1998
General Motors India Ltd	Astra	1998
Mereceds-Benz India Limited	Mercedes E250 Diesel	1998
Eicher Motors Ltd	Chatenet Stella	Not yet launched in India
Greaves Ltd	Garuda, 3-wheeler (6 seater)	Already existing
Bajaj Auto Ltd	3-wheeler	1998
Bajaj Tempo Ltd	4-wheeler tempos	Already existing
Scooters India, Lucknow	Vikram, 3-wheeler	Already existing
Sunku Auto, Hyderabad	Sunku Auto	Already existing
Kerala Auto, Thiruvananthapuram	6 seater Auto	Already existing
Atul Auto, Jamnagar	Khushbu	Already existing
Royal Enfield Motors	2-wheeler	Already existing

Source: Data collected from automobile dealers in 1998.

This trend is being encouraged by the enormous difference in petrol and diesel prices — a result of the government's flawed fuel pricing policy. Diesel prices are no longer subsidised and they are allowed to fluctuate according to international prices. But diesel is not taxed while petrol is heavily taxed to cross-subsidise kerosene. Also, diesel prices are the lowest in Delhi as compared to all other metros of India (see Table 4). The myth attached to government policy is that diesel prices should be kept cheap to help the agricultural sector and to support public transport. But the biggest benefactors of cheap diesel and subsidised kerosene are urban consumers. While the transport sector uses 70 per cent of the diesel produced in the country, the urban population use 70 per cent of the kerosene meant for the rural poor. And now even luxury cars are being manufactured to run on diesel. But the most worrying is the dieselisation of the small car segment which dominates the private automobile market.

Table 4: Diesel prices in different Indian metros

Diesel prices are the lowest in Delhi. On January 8, 1999, diesel prices were reduced by about 10 per cent. This was the third downward revision since the decision to link domestic diesel prices with import parity prices taken about a year ago.

City	Existing Rates as of 7.1.97 (Rs./litre)	New Rates as of 8.1.97 (Rs./litre)
Delhi	9.87	8.89
Calcutta	10.16	9.11
Chennai	10.89	9.79
Mumbai	11.19	10.04

Source: Anon 1999, Good news rides on reforms wave, *The Indian Express*, New Delhi, January 9.

AMIT SHANKER / CSE

Car mania hits Delhi. Car population is increasing at a faster pace than that of two wheelers. Industry is luring consumers with diesel models to cash in on cheap diesel prices. Even if half of the new cars are to run on toxic diesel it is enough to choke Delhi

Table 5: Growth in the number of cars in Delhi 1985-2010

Year		Total number of registrations of Car/Jeep/ Station wagon (as on March 31 of each year)
1984-85	(A)	1,57,743
1985-86	(A)	1,79,671
1986-87	(A)	2,11,774
1987-88	(A)	2,48,993
1988-89	(A)	2,92,853
1989-90	(A)	3,45,157
1990-91	(A)	3,98,479
1991-92	(A)	4,40,166
1992-93	(A)	4,77,783
1993-94	(A)	5,22,264
1994-95	(A)	5,75,762
1995-96	(A)	6,33,802
1996-97	(A)	7,05,923
1997-98	(A)	7,65,470
1998-99	(P)	8,41,757
1999-2000	(P)	9,25,647
2000-01	(P)	10,17,897
2001-02	(P)	11,19,340
2002-03	(P)	12,30,893
2003-04	(P)	13,53,564
2004-05	(P)	14,88,460
2005-06	(P)	16,36,800
2006-07	(P)	17,99,923
2007-08	(P)	19,79,304
2008-09	(P)	21,76,561
2009-10	(P)	23,93,477

Note: (A): Actual number (P): Projection
Source: Projections calculated on the basis of the 'Statement showing the registered population of vehicles in Delhi 1985-1999,' provided by the Office of the State Transport Authority, Delhi.

The annual rate of increase of cars in Delhi has outpaced two-and three-wheelers since 1987. This is in contrast to the national trend. *The average annual rate of increase for cars during the three-year period, 1995-96 to 1997-98 was about 10 per cent as opposed to about 7 per cent in the case of two-wheelers.* As the city becomes richer, it is only to be expected that people will turn more to cars than two-wheelers. Using these average annual growth rates to project the future car population, we get a total car population of 23.93 lakh by 2009-10. This is over three times the car registrations on March 31, 1998 (see Table 5).

We should expect a large proportion of this car population to be diesel-fueled if current fuel pricing policies continue. Assuming that 25-50 per cent of the increase in this category of vehicles is going to be diesel-driven — these figures may turn out to be low given the response to diesel Indica indicated above — by March 31, 2010, Delhi could see a diesel car population equal to its entire population of cars registered today (see Table 6). *In other words, above 8 lakh new diesel vehicles could be on the roads of this city by 2010.* If the economic growth rate of the city is higher than that of the period 1995-1996 to 1997-1998, then the car population as a whole, and the diesel driven car population as its subset, could rise even further than estimated above. These calculations, even though rough and tentative, provide a cause for considerable concern.

Table 6: Projected diesel car population in Delhi

Date	Projected car/jeep/station wagon population	Additions over 31.3.1998	Diesel car population	
			Assuming that 25% of additions are diesel driven	Assuming that 50% of additions are diesel driven
31.3.1998 (A)	7,65,470	—	—	—
31.3.2003 (P)	12,30,893	4,65,423	1,16,356	2,32,712
31.3.2008 (P)	19,79,304	12,13,834	3,03,459	6,06,917
31.3.2010 (P)	23,93,477	16,28,007	4,07,002	8,14,004

A: Actual P: Projection
Source: Projections calculated on the basis of the 'Statement showing the registered population of vehicles in Delhi 1985-1999,' provided by the Office of the State Transport Authority, Delhi.

C. Supreme Court actions on vehicular pollution

The Supreme Court order dated July 28, 1998, on control of vehicular pollution in national capital region including Delhi, calls for the following steps to be taken with respect to automotive fuels:

i) Elimination of leaded petrol from NCT Delhi as proposed by the Environment Pollution (Prevention and Control) Authority and agreed to by the Ministry of Petroleum and Natural Gas (*Deadline: September 1, 1998*);

ii) Supply of only pre-mix petrol in all petrol filling stations to two stroke engine vehicles (*Deadline: December 31, 1998*);

iii) Replacement of all pre-1990 autos and taxis with new vehicles on clean fuel (*Deadline: March 31, 2000*);

iv) Financial incentives for replacement of all post-1990 autos and taxis with new vehicles on clean fuels (*Deadline: March 31, 2000*);

v) No 8-year old buses to ply except on CNG or other clean fuels, (*Deadline: April 1, 2000*); and

vi) Entire city fleet (DTC and private) to be steadily converted to single fuel mode on CNG (*Deadline: March 31, 2001*).

The Supreme Court-appointed Environment Pollution (Prevention and Control) Authority for the National Capital Region has also asked the Delhi government not to register any diesel taxi in Delhi;

Several of these above directions relate to substitution of diesel by cleaner fuels. These orders will force a large part of the commercial vehicular fleet to move from diesel to cleaner fuels.

However, diesel will continue to be an important source of air pollution in Delhi because:

i) Diesel use will continue to grow because of the large number of diesel vehicles, especially trucks, which will continue to enter and/or ply in Delhi;

ii) Diesel use will inevitably increase because of the predictable exponential growth of vehicles in the public goods and private vehicles fleet;

iii) On March 31, 1998, Delhi had over 30 lakh vehicles registered and they were growing at a rate of about 2 lakh a year. By 2011, that is, in about a decade from now, Delhi will have an estimated total of 60 lakh vehicles (Virendra Sharma and N. Nagarajan 1998, Recommended Actions to Reduce Vehicular Pollution in Delhi by 50 per cent by 2005: Technological Improvements in Road Engineering, Paper presented at the Workshop on Integrated Approach to Vehicular Pollution Control in Delhi, Sub-Group 1, April 16-18, 1998, New Delhi, *mimeo*);

iv) Diesel consumption is also growing because of non-vehicular factors, which don't appear to be easily controllable in the near future. Because of regular power blackouts, there has been an enormous increase in diesel generator sets — in Delhi and across India. India today is the world's biggest market for these sets. Many of these sets are produced in the informal market with discarded engines and have a very poor quality and high emissions. This problem will get

controlled only when the Delhi government improves the power supply and distribution situation. And nobody knows when this will happen; and,

v) Standards have been set for generator sets in India. These standards are such that they will force the industry to phase-out gensets based on the highly polluting two-stroke engines and those based on kerosene. Thus, when these standards get applied, the market will mainly consist of diesel gensets.

D. High levels of diesel-related pollutants in Delhi's air

Diesel vehicles are primarily responsible for harmful emissions of:

i) Sulphur dioxide;

ii) Extremely tiny small particles which are not only respirable and go deep into the lungs but are also extremely toxic;

iii) Nitrogen dioxide; and,

iv) Ozone.

We present below an analysis of the levels of diesel-related air pollutants in Delhi carried out by the Centre for Science and Environment. Data published by the Central Pollution Control Board (CPCB) is restricted only to three pollutants — sulphur dioxide, nitrogen dioxide and total suspended particulate matter — and is available only for the years 1987 to 1995. This data shows the following situation:

D.1. Suspended particulate matter

a) The consistently high levels of total suspended particulate matter (SPM) in Delhi's ambience is extremely worrying. The annual average SPM level has remained consistently high and much above the national standards (see Graph 3). The data on annual maximum and annual average air quality provided by the Central Pollution Control Board clearly show that a pollutant like Total Suspended Particulate Matter is constantly above the standard at all the stations on any day (see Graph 3).

b) The annual average levels have fluctuated over the years but they have consistently remained well above the permissible limits — from 3.85 times the limits in 1987 to 2.15 times in 1988. In other words, the total suspended particulate matter levels are above the permissible limit almost every day of the year.

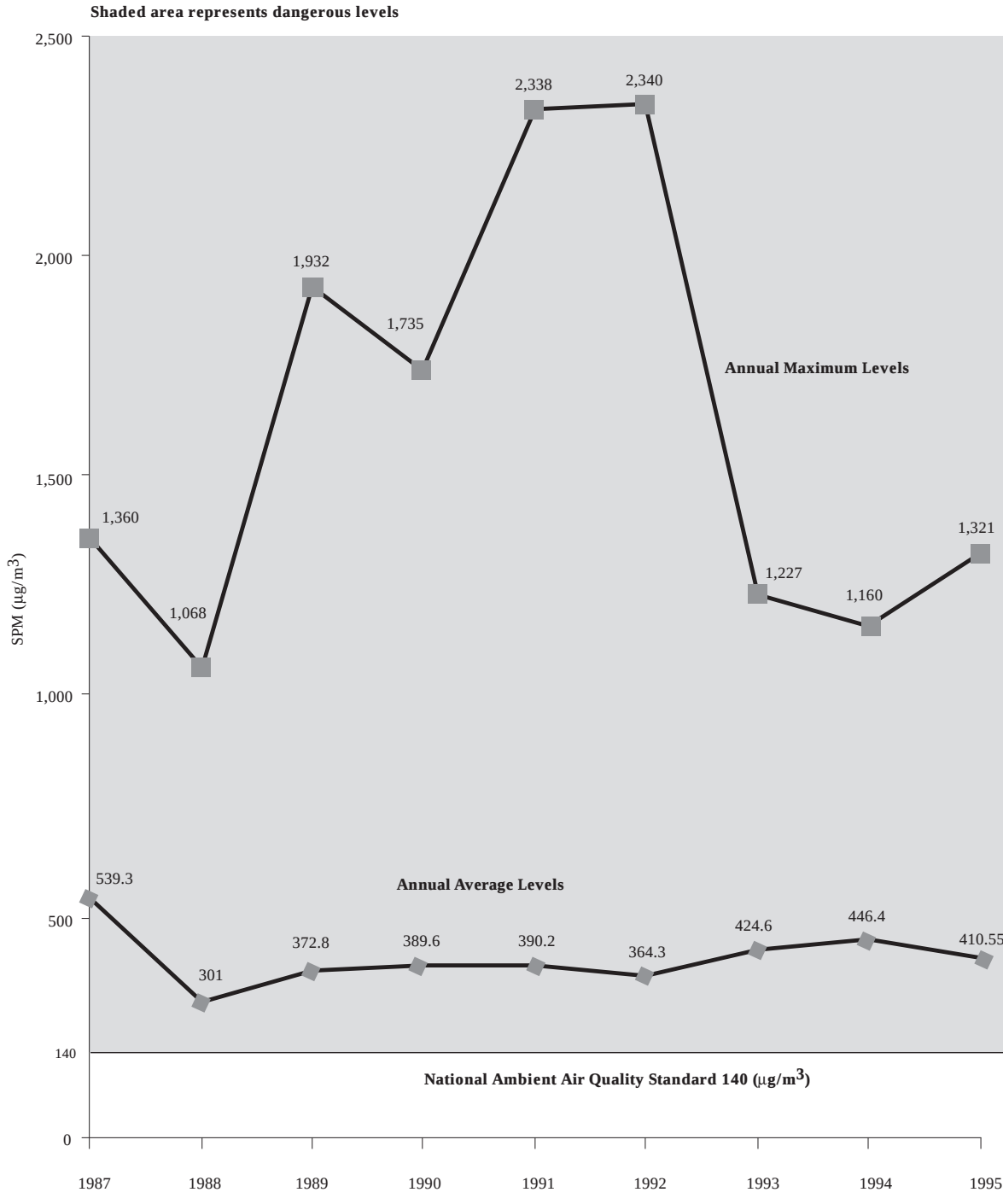
AMIT SHANKER / CSE

c) The annual maximum levels have reached even more frightening levels — ranging from a low of 7.6 times the permissible limit in 1988 to a high of 16.7 times the limit in 1992.

A haze of toxic dust shrouds Delhi. The level of killer dust always remains several times higher than the permissible limit. Small particles are not even monitored separately on a routine basis in Delhi

Graph 3: Annual Average and Maximum of Total Suspended Particulate Matter (SPM) in Delhi from 1987-1995

Total SPM levels are not only always above the standard, but there are days when they have reached nearly 17 times the standard



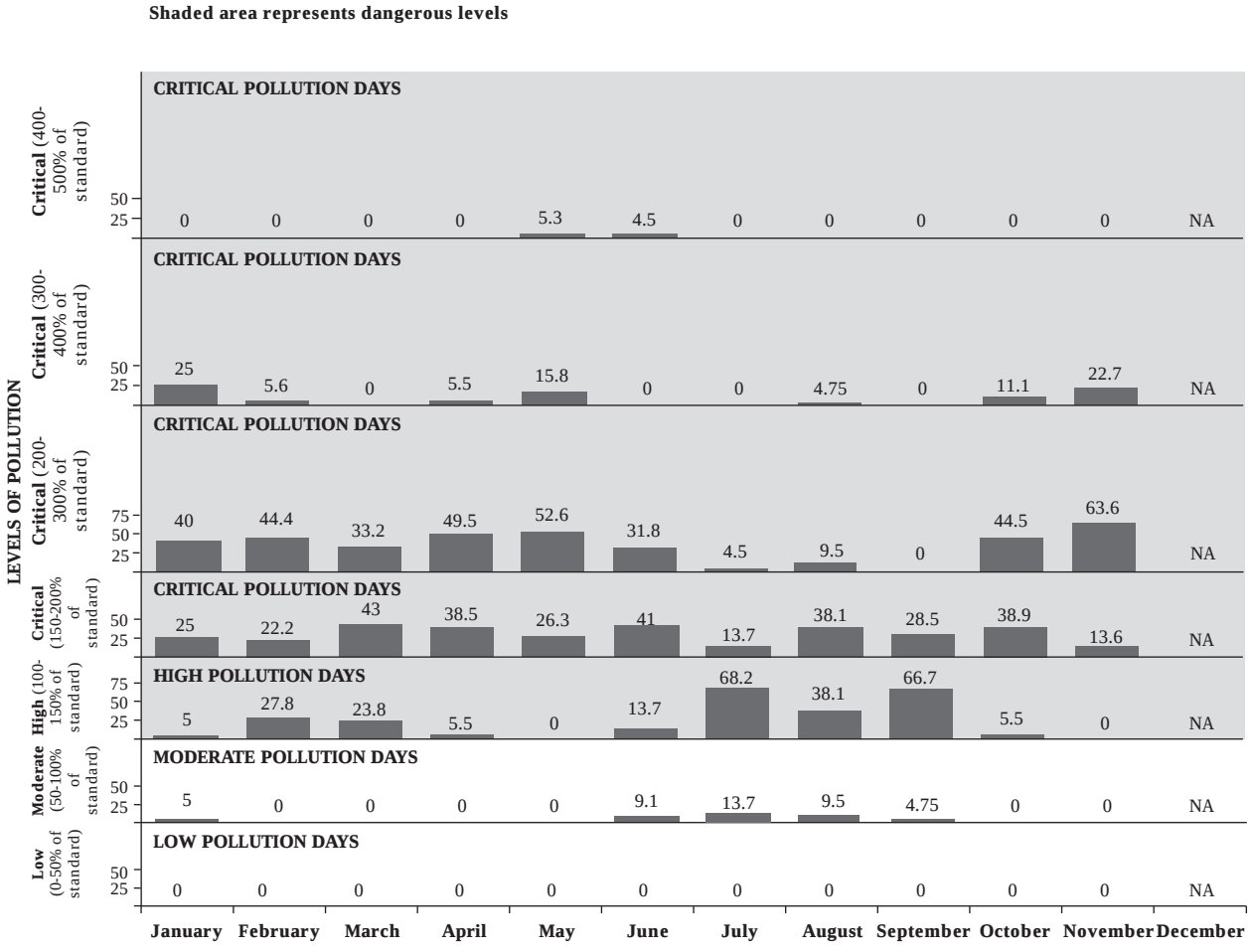
Source: Calculated on the basis of data provided by Central Pollution Control Board.

Graph 4: 1998 Total Particulate Pollution Levels at ITO Crossing

Percentage of measured days when Total Suspended Particulate Matter was above the standard

National Standard (Residential) — 200 µg/m^3 (24 hours average)

Total particles reached 4-5 times above the standard in 1998



Source: Calculated on the basis of data provided by Central Pollution Control Board.

NA = not available

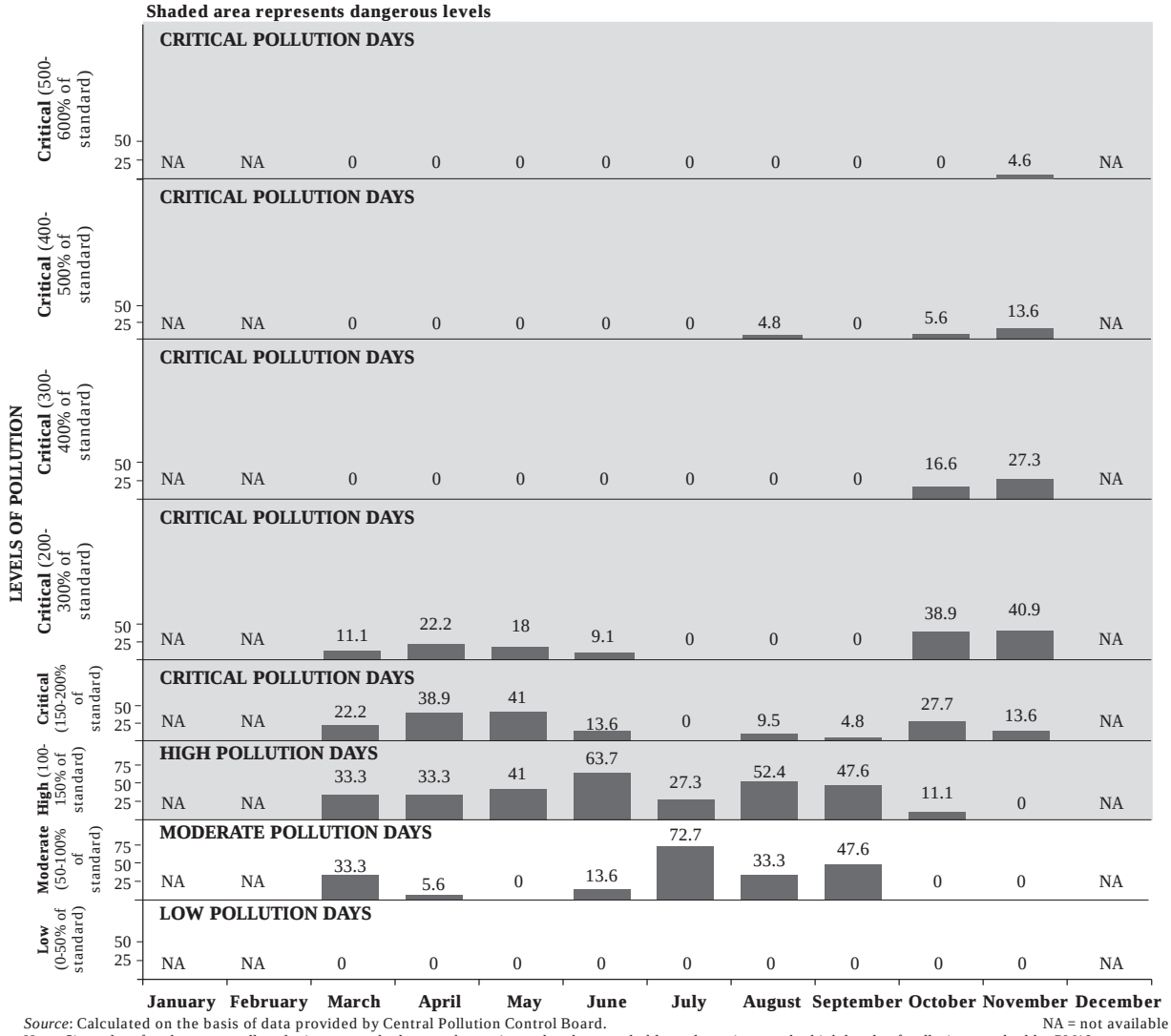
d) But it is not enough to look at annual and monthly averages and maxima to understand the severity of the air pollution. For human beings what matters most is what is the air quality today? Should I venture out of my house or not? To make such a judgement, it is important to have the latest information day-by-day and monitoring station by station. The CPCB does not publish daily data of its various monitoring stations in Delhi. But the CPCB was kind enough to provide the Centre for Science and Environment (CSE) daily air quality data for 1997 and 1998 (excluding December) of the Income Tax Office (ITO) monitoring station and our analysis revealed a horrifying daily pollution picture. This data presented in Graph 4 shows that at the ITO Crossing there were days in 1998 when total suspended particulate matter went 4 times above the standard.

Graph 5: 1998 Respirable Particulate Pollution Levels at ITO Crossing

Percentage of measured days when Respirable Suspended Particulate Matter (PM10) was above the standard

National Standard (Residential) — 100 μg/m^3 (24 hours average)

The first survey of respirable particles shows that they reached extremely dangerous levels — as much as 5-6 times above the standard — in 1998



Source: Calculated on the basis of data provided by Central Pollution Control Board. NA = not available

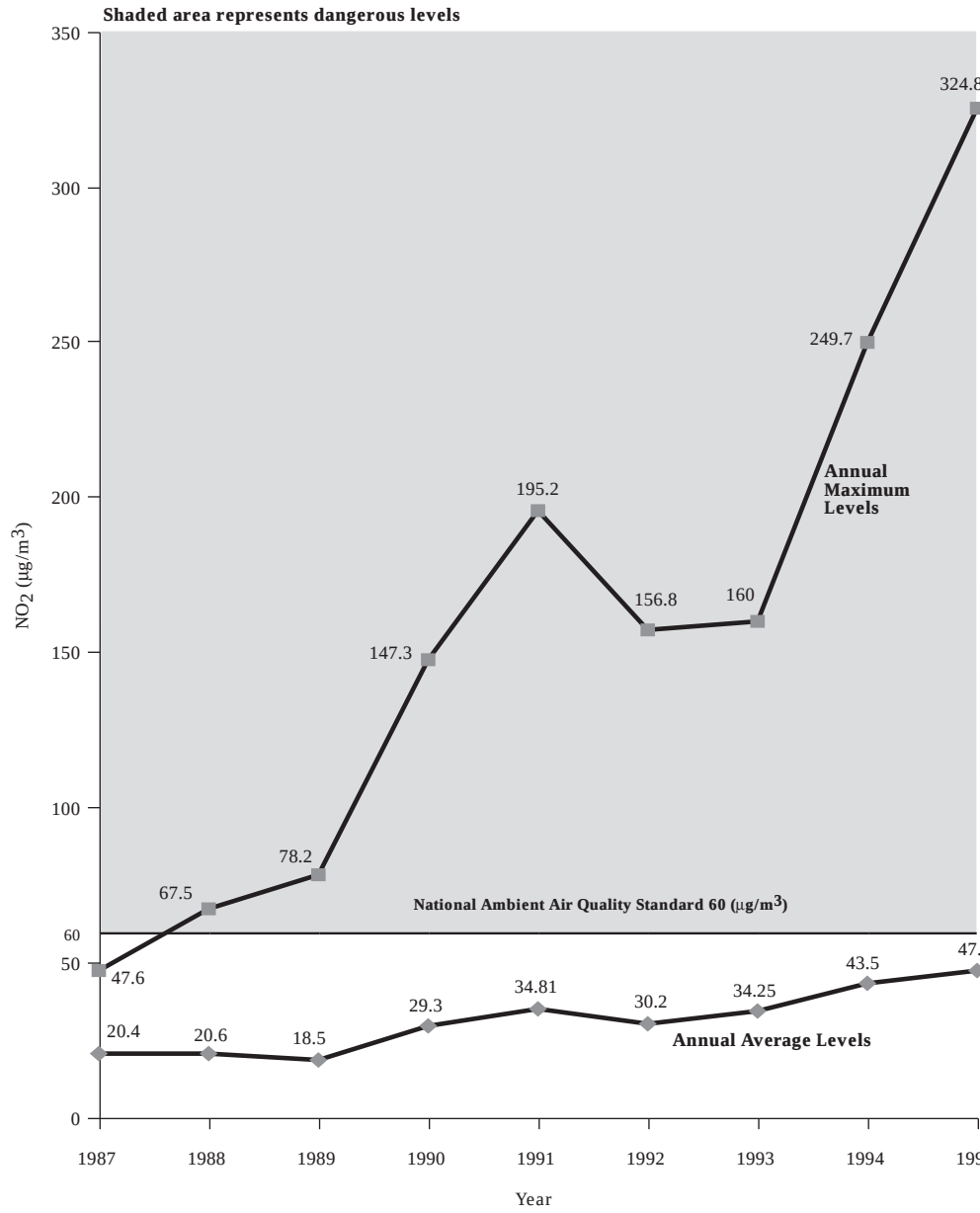
Note: Since data for the more polluted winter months has not been given, the chart probably underestimates the high levels of pollution reached by PM10

e) Small particulates which go straight into the lungs (that is, particles with a size of less than 10 microns or PM10) are not monitored separately on a routine basis in Delhi. The Central Pollution Control Board only monitors total suspended particulate matter, in other words, the quantity of all particles in the air. But short term monitoring of PM10 levels by CPCB shows that on an average nearly 40 per cent of the total SPM in Delhi is PM10. It is these particles which are the most dangerous.

f) In 1998, CPCB monitored small particles (PM10) regularly at the ITO crossing. This data shows that respirable particles were also well above the standards. The situation is worse than that of total particles. In November they were as high as five times above the standard (see Graph 5). In fact, Graph 4 shows that

Graph 6: Annual Average and Maximum of Nitrogen Dioxide (NO_2) in Delhi from 1987-1995

Nitrogen dioxide is an extremely harmful gas. Both its annual average levels and annual maximum levels are growing rapidly in Delhi.



Source: Calculated on the basis of data provided by Central Pollution Control Board.

total suspended particulate matter levels at ITO never went five times above the standard in 1998. In other words, the concentrations of respirable particles in 1998 reached higher levels than all tiny particles combined at ITO Crossing. A large portion of these particles come from diesel vehicles.

D.2. NITROGEN DIOXIDE

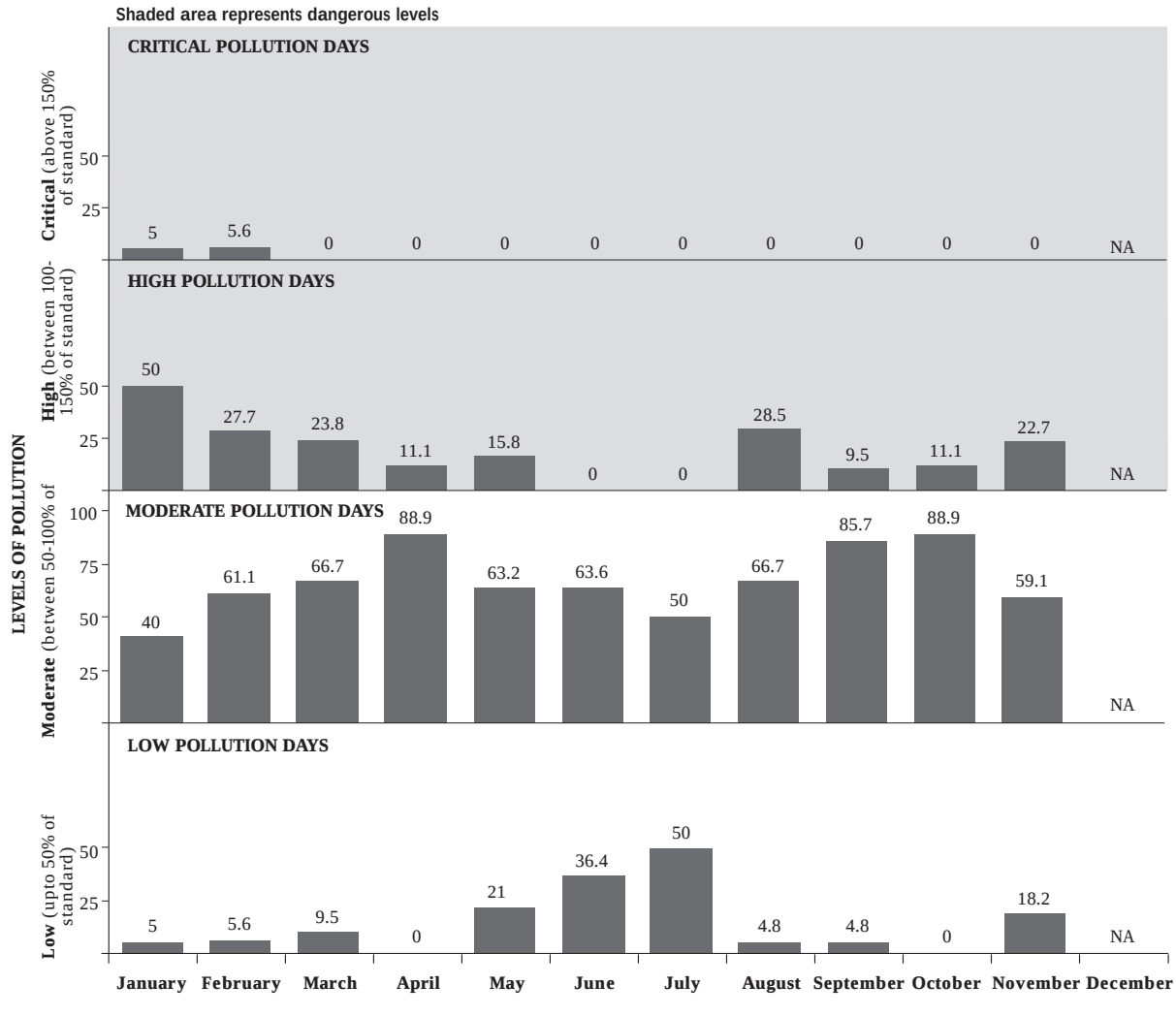
The peak levels of nitrogen dioxide recorded in Delhi have been rising rapidly and

Graph 7: 1998 Nitrogen Dioxide Pollution Levels at ITO Crossing

Percentage of measured days when nitrogen dioxide was above the standard

National Standard (Residential) — 80 µg/m^3 (24 hours average)

Except for the monsoon months, there are several days in the year when nitrogen dioxide reaches high and critical levels.



Source: Calculated on the basis of data provided by Central Pollution Control Board.

NA = not available

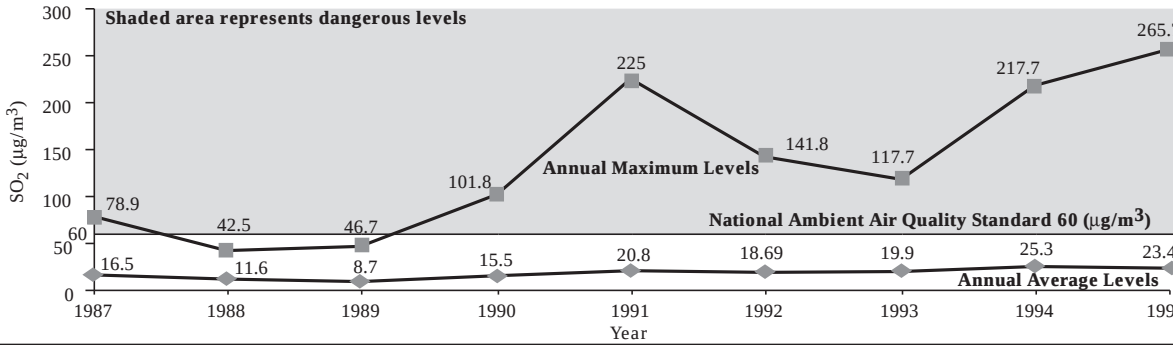
so has the annual average level (see Graph 6). Nitrogen dioxide is a highly toxic gas which attacks the lungs.

a) The annual average level of nitrogen dioxide has remained below the permissible limit but it has been increasing rapidly — in the nine years from 1987 to 1995, it increased by 2.3 times and, in 1995, it had reached 79 per cent of the permissible limit as compared to 34 per cent in 1987. If the annual average level were to equal the standard, it would mean that the pollutant was going upto permissible limits all round the year.

b) Graph 7 shows that there are several days — one out of every five days, in fact — at the ITO Crossing, when this pollutant goes well above the standards.

Graph 8: Annual Average and Maximum levels of Sulphur Dioxide (SO_2) in Delhi from 1987-1995

Though the annual average levels of sulphur dioxide remain below the standards, peak levels are reaching as much as 4 times the standards. Sulphur dioxide generally remains low because it gets converted into highly dangerous acidic particles in the air.

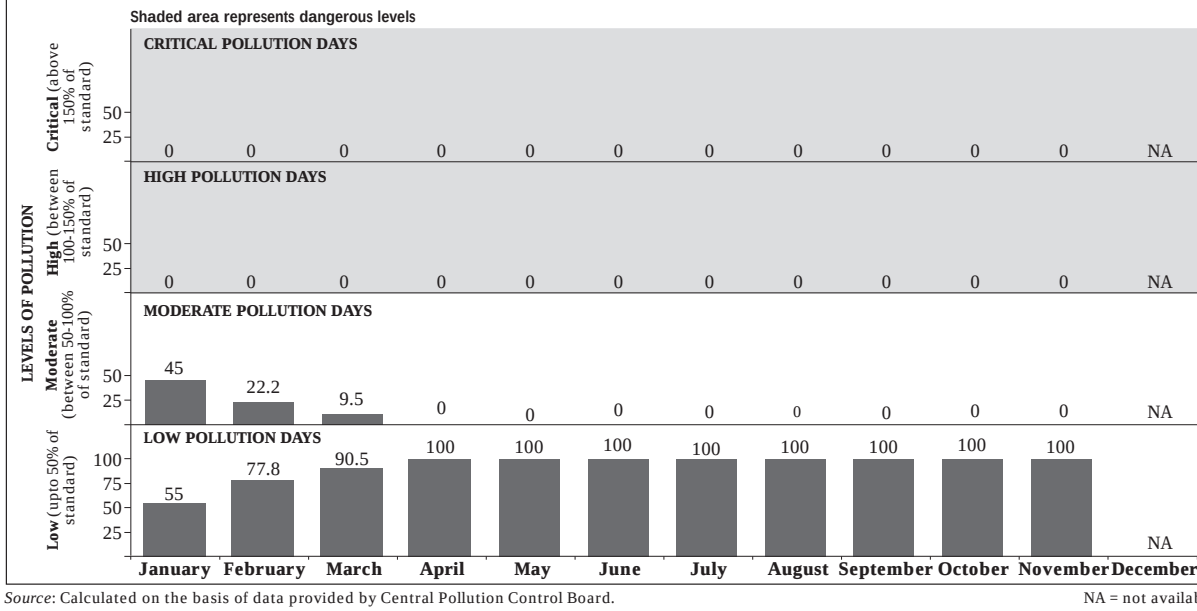


Source: Calculated on the basis of data provided by Central Pollution Control Board.

Graph 9: 1998 Sulphur Dioxide (SO_2) Pollution Levels at ITO Crossing
Percentage of measured days when sulphur dioxide was above the standard

National Standard (Residential) — 80 µg/m^3 (24 hours average)

During the winter months, sulphur dioxide levels tend to increase.



Source: Calculated on the basis of data provided by Central Pollution Control Board. NA = not available

D.3. SULPHUR DIOXIDE

The annual average level of sulphur dioxide for the entire city has generally remained below the permissible air quality standard but it has been showing a slow rise. On the other hand, the maximum levels reached in a year have been showing a rapidly rising trend reaching 4.4 times the permissible limit in 1995 (see Graphs 8 and 9).

Levels of sulphur dioxide gas are apparently low because it can get attached to particles in the atmosphere and also form highly acidic, and therefore highly dangerous particles, in the atmosphere.

D.4. DAYS WITH CRITICAL POLLUTION

One way of understanding pollution levels in Delhi would be to ask ourselves how many days were there in a month when a particular pollutant reached critical levels. The CPCB has classified the levels of pollution as follows:

Table 7: Levels of pollution

Level of pollution	Concentration of pollutant
Low	Less than 50 per cent of the standard
Moderate	50-99 per cent of the standard
High	100-149 per cent of the standard
Critical	150 per cent or more above the standard

Using this classification, when CSE analysed the Central Pollution Control Board data the pollution picture at ITO during 1998 looked as follows:

Table 8: Percentage of measured days when a particular pollutant reached high and critical levels at ITO Crossing

Month	Sulphur dioxide levels 1998		Nitrogen dioxide levels 1998		Total suspended particles levels 1998		Respirable particles levels 1998	
	High	Critical	High	Critical	High	Critical	High	Critical
Jan	0	0	50	5	5	90	NA	NA
Feb	0	0	27.7	5.6	27.8	72.2	NA	NA
Mar	0	0	23.8	0	23.8	76.2	33.3	33.3
Apr	0	0	11.1	0	5.5	93.5	33.3	61.1
May	0	0	15.8	0	0	100	41	59
June	0	0	0	0	13.7	77.3	63.7	22.7
July	0	0	0	0	68.2	18.2	27.3	0
Aug	0	0	28.5	0	38.1	38.1	52.4	14.3
Sept	0	0	9.5	0	66.7	28.5	47.6	4.8
Oct	0	0	11.1	0	5.5	94.5	11.1	88.9
Nov	0	0	22.7	0	0	100	0	100
Dec	NA	NA	NA	NA	NA	NA	NA	NA
Total	0	0	19	2	23.9	72	34.3	42

NA: Not Available

Note: It is to be noted that December is one of the worst months for which unfortunately data was not available to us for 1998. As a result the above table probably understates the air pollution problem.

Source: Calulation based on the air quality data for 1998 from Central Pollution Control Board.

The above table shows clearly that the two pollutants mostly caused by diesel — nitrogen dioxide and suspended particles, including respirable particles — were reaching high pollution levels and critical pollution levels, respectively.

Delhiites gasp on a deadly cocktail of poison. There are days when the levels of all pollutants reach dangerous levels posing serious health risk

RUSTAM VANIA / CSE

D.5. DEADLY COCKTAIL OF POLLUTANTS FROM DIESEL EXHAUST

Extremely worrying is the high concentrations that several on pollutants that these gases reach on certain days.

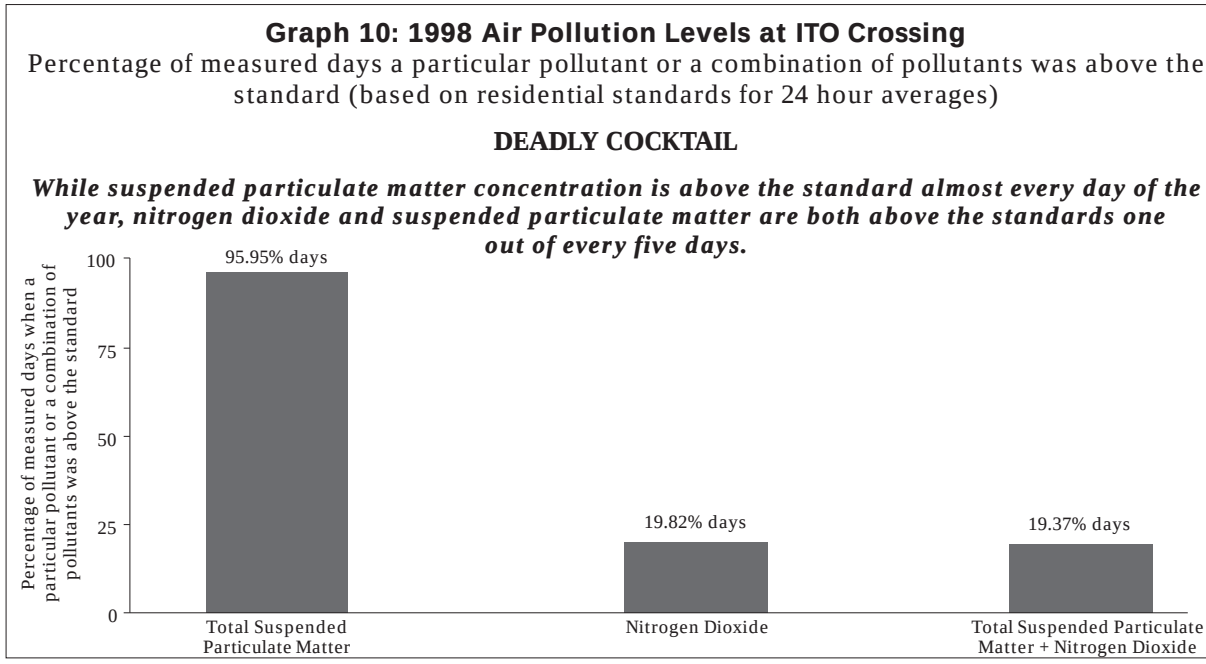
Suspended particulate matter levels crossed four times the standard in 1998. Respirable particles crossed 5 times the standard. Nitrogen dioxide levels crossed 1.5 times the standard.

It is clear from the above data that at the ITO Crossing, air pollution is high or critical almost every day of the year from the point of view of suspended particulate matter. One out of every five days it becomes high or critical also from the point of view of nitrogen oxides.

The ITO Crossing data also shows that it is not just one gas that crosses the standard on a particular day. In 1997 and 1998, almost every single day suspended particulate matter was above the standard. One out of every five days, nitrogen dioxide levels went above the standard, and on almost all those days, both the pollutants — suspended particulate matter and nitrogen dioxide — went above the standard. It is hard to think of a more deadly cocktail of air (see Graph 10).

Graph 10: 1998 Air Pollution Levels at ITO Crossing

Percentage of measured days a particular pollutant or a combination of pollutants was above the standard (based on residential standards for 24 hour averages)



Note: These figures may understate the problem as pollution levels were not available for December, when high pollution levels are expected.
Source: Calculated on the basis of data provided by Central Pollution Control Board.

D.6. SEASONAL VARIATIONS

The various pollutants also show seasonal variations.

i) Total Suspended Particulates show a marked rise initially in the summer months of May and June with a sharp decline in the rainy months of July, August and September and then a sharp rise again in October. The winter levels from October to February are generally high but not as high as in the summer months of May and June. But even in the cleanest months, the particle levels stay well above the permissible limits (see Graph 4).

ii) Respirable particles also show a similar trend (see Graph 5).

iii) Nitrogen dioxide levels are also at their lowest during the monsoon months and show a rise in the winter months of January and February (see Graph 7).

It is obvious that the winter months are the worst in Delhi when all pollutants tend to reach high levels, presumably because of the temperature inversion that takes place.

D.7. LEVELS OF POLLUTANTS THAT CPCB DOES NOT MEASURE

The above is an analysis of the pollution in Delhi based on the levels of pollutants monitored by the CPCB. But what CPCB does not monitor could be even deadlier. This is because the air pollution monitoring exercise in Delhi is extremely inadequate. All over the world, monitoring agencies measure all those pollutants that are called criteria pollutants, which include respirable particles less than 10 micron in size (PM10), non-methane hydrocarbons and ozone. None of these are regularly measured in India. Diesel is an important source of hydrocarbons and respirable particles and also contributes to ozone production.

The few studies that are available on ozone levels in Delhi's air show frightening levels. Ozone is an extremely powerful irritant to the lungs. Studies done by the Central Road Research Institute (CRRI) and School of Environmental Sciences of Jawaharlal Nehru University (JNU) show very high ozone concentrations in Delhi. In many cases, the maximum concentration of ozone has exceeded the upper limit of WHO guideline by two times (see Graph 11).

Ozone is considered a secondary pollutant because it is produced as a result of the interaction of other air pollutants, particularly nitrogen oxides, which are largely produced by diesel vehicles, and hydrocarbons, which are produced both by petrol and diesel vehicles. Because of two-stroke engines, Delhi's air has high levels of hydrocarbons. Sunlight accelerates the chemical reactions in the atmosphere.

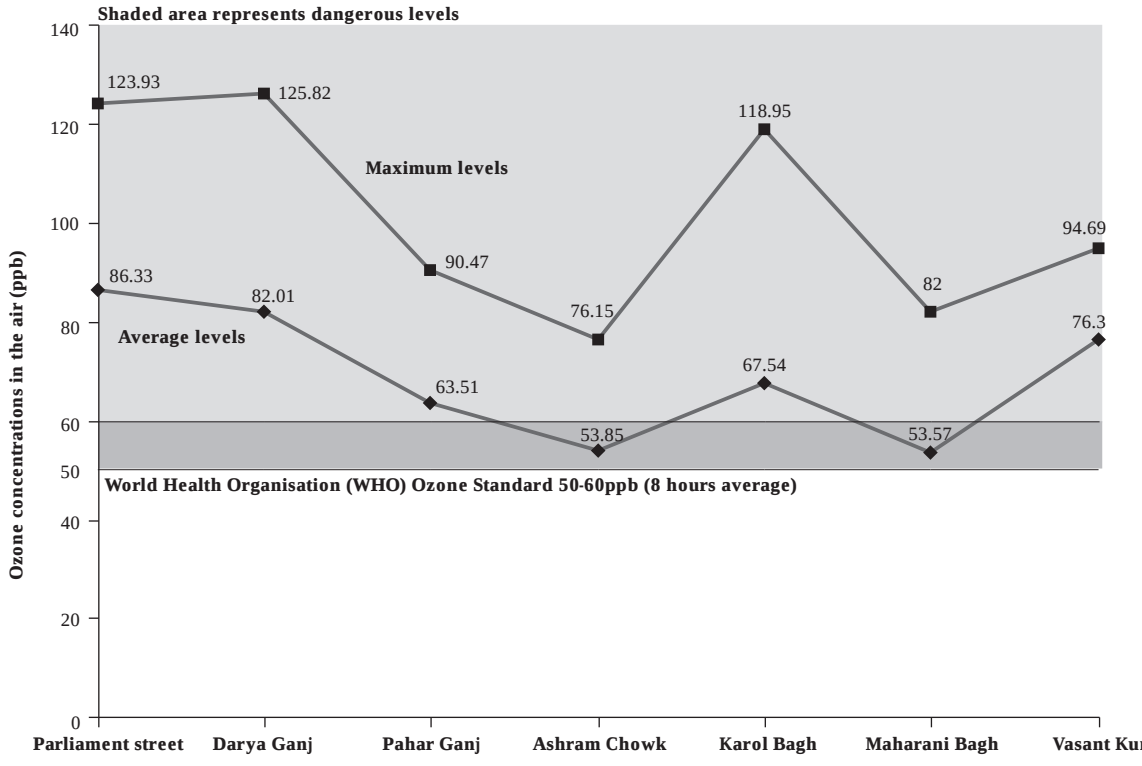
Let us present the information available on ozone. Studies carried out by the JNU during 1989-90 showed that ozone levels were high during the summer months (June-August), especially around noon, and were low during the winter months (November-January), which is in keeping with trends noted worldwide. The maximum concentration was observed during August 1990. On many occasions, the ozone levels approached or exceeded the air quality standards for ozone set by WHO (C K Varshney 1998, VOC and Ozone Pollution: Health Implication, *mimeo*).

Subsequent studies conducted by the CRRI and the JNU have revealed some unusual results about ozone levels in Delhi. The CRRI study carried out in 1991 showed high ozone levels even during winter, when "ground-based temperature inversion" is common. It appears that the pollutants which lead to the formation of ozone get trapped in the inversion conditions which lead to high ozone levels even during the early hours of the day though traffic levels are low. As the day progresses, the pollutants get dispersed leading to reduced levels of ozone, which begin to build up again in the evening because of the inversion effect.

The JNU-CRRI study also found high levels of ozone even in a suburban area like Vasant Kunj, where the levels did not tend to go down even at noon. Once ozone gets produced in the city centre and gets dispersed to the suburban areas, it tends to have a long lifetime in these areas because of the absence of other pollutants to destroy it (A Singh *et al* 1997, Ozone distribution in the urban environment of Delhi during winter months, *Atmospheric Environment*, Vol. 31, No. 20, p.3421-3427).

Graph 11: Ozone levels in Delhi in 1993 (Winter)
WHO Ozone standard 50-60 ppb (8 hours average)

Ozone has a severe impact on the lungs. It is normally expected to be high in summer. But even in winter it reaches dangerous levels in Delhi



Source: A Singh, *et al.* 1997, Ozone distribution in the urban environment of Delhi during winter months, *Atmospheric Environment, Vol. 31, No. 20, p.3421-3427.*

Ozone also plays an important role in creating the extremely foggy conditions and the poor visibility of winters. The hydroxyl radical (OH), ozone and oxides of nitrogen react to form Peroxy Acetyl Nitrate (PAN) which has a tremendous ability to absorb moisture and create fog-like conditions. PAN hangs around for a long time without dispersing and allows very little light to pass through. Ozone also gets trapped in the fog and poses a serious threat to human health (Arun Kumar Attri 1999, School of Environmental Sciences, JNU, *personal communication*, Kazimuddin Ahmed).

Sporadic studies have also been carried out by the Central Pollution Control Board at the ITO Crossing and Sirifort and both show high levels of ozone (see Table 9).

Table 9: Ozone levels in Delhi

	Measured Value 1996 ITO Crossing	Measured Value 1995 Sirifort	Permissible Limit
Ozone	250 µg/cum, Range: 100-400 µg/cum	100 µg/cum (January 1998)	100-120 µg/cum

Note: µg/cum: microgrammes per cubic metres *Source:* Central Pollution Control Board

With 2-stroke scooters and, therefore, levels of hydrocarbons growing in Delhi's air and rapidly increasing concentrations of nitrogen dioxide because of the growing use of diesel, the threat of ozone, an extremely harmful gas for asthmatics and all those who suffer from respiratory diseases, becomes worse with every growing day.

E. Toxic effects of diesel pollutants

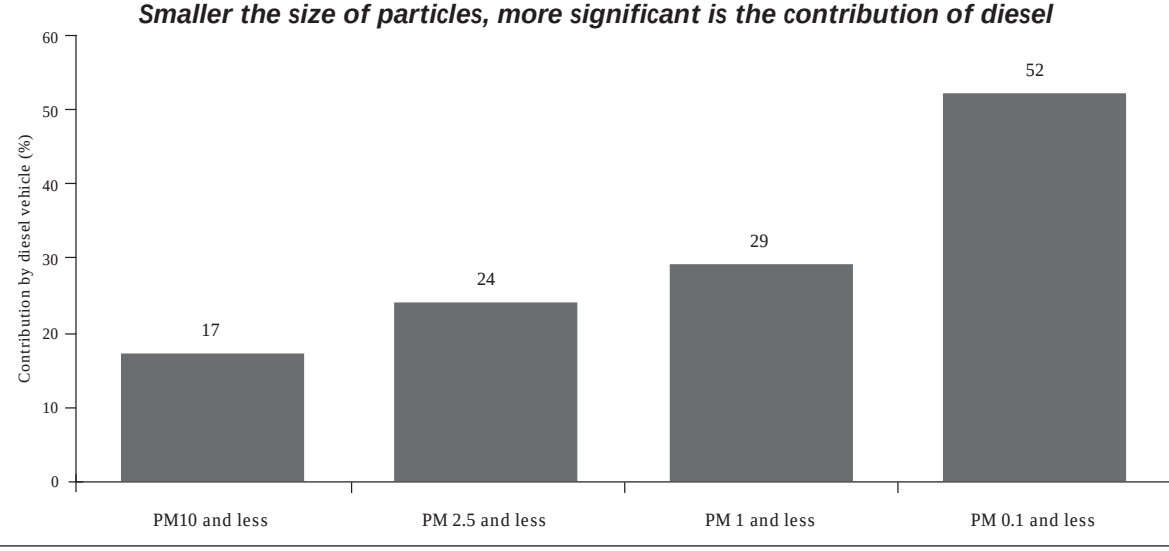
In 1994, the World Bank had published a study on the health effects of air pollution in 36 Indian cities entitled *The Costs of Inaction: Valuing the economy-wide cost of environmental degradation in India.* This study revealed that the 1991-92 levels of suspended particulate matter in Delhi alone lead to the premature death of 7,491 every year.

This study was repeated for the year 1995 by the Centre for Science and Environment and it showed that the number of deaths had increased to 9,859 in just three years, which means a death rate of one per hour due to air pollution, and this too only because of one pollutant (Priti Kumar *et al* 1997, Death is in the Air in *Down To Earth*, Society for Environment Communication, New Delhi, Vol 6, No 12, p29-43).

There is growing scientific evidence worldwide that diesel produces extremely toxic pollutants. Let us look at the health effects of air pollutants produced by diesel vehicles.

It is now well recognised that diesel vehicles are a major source of extremely tiny particles that are highly carcinogenic. Michael Walsh, editor of *Car Lines* and a former air pollution control specialist at the US Environment Protection Agency (USEPA) reports that according to a study conducted to assess which sources were contributing to airborne particulate matter in the United Kingdom in 1996, it was found that smaller the size of the particulates, the higher was the share of diesel emissions. While only 17 per cent of PM10 and less size particles came from diesel vehicles, as much as 52 per cent of PM 0.1 and lesser size particles came from diesel vehicles (see Graph 12) (Michael P Walsh, 1999, Global Trends in Diesel Particulate Control — 1999: Update, 1999 SAE International Congress and Exposition, in *Car Lines*, USA, Issue 99-2, March).

Graph 12: Size distribution of particles from diesel and other sources in the UK in 1996



Source: Anon 1999, *Source Apportionment of Airborne Particulate Matter in the United Kingdom*, Report of the Airborne Particles Expert Group, January, quoted in Michael P Walsh 1999, "Global Trends in Diesel Particulate Control — 1999: Update, 1999 SAE International Congress and Exposition", *Car Lines*, Arlington, USA, Issue 99-2, March.

PRADIP SAHA / CSE

E.1. SUSPENDED PARTICULATE MATTER

i) The World Health Organisation has concluded that, on a worldwide basis, suspended particulate matter (SPM) is the most serious air pollutant which is resulting in a total excess mortality per year of about 4,60,000 additional deaths, of which 1,35,000 are because of chronic obstructive pulmonay disease (COPD) or chronic asthma and about 90,000 due to cardiovascular diseases (CVD) (Dieter Schwela 1996, Health Effects of and Population Exposure to Air Pollutants: Global Aspects, Keynote Speech, World Congress on Air Pollution in Developing Countries, San Jose, 21-26 October 1996, *mimeo*).

ii) Scientists also point out that it is not all particles that are equally dangerous. It is particles that are respirable (that is, less than 10 microns in size or PM10) that are much more dangerous. And the most dangerous are really fine particles which are less than 2.5 microns in size. One micron is one-millionth of a metre.

Scientific evidence mounts that diesel produces extremely toxic pollutants exposing citizens to serious health risks

Table 10: Substances in diesel exhaust listed by California EPA as Toxic Air Contaminants

Acetaldehyde	Inorganic lead
Acrolein	Manganese compounds
Aniline	Methanol
Benzene	Naphthalene
Beryllium compounds	Nickel
Bis[2-ethylhexyl]phthalate	Phenol
1, 3-butadiene	Phosphorus
Cadmium	Polycyclic organic matter, including Polycyclic aromatic hydrocarbons (PAHs) and their derivatives
Chlorine	
Chlorobenzene	
Chromium compounds	Propionaldehyde
Cobalt compounds	Selenium Compounds
Creosol isomers	Styrene
Cyanide compounds	Toluene
Dibutylphthalate	Xylene isomers and mixtures
Dioxins and dibenzofurans	O-xylenes
Ethyl benzene	M-xylenes
Formaldehyde	P-xylenes

Note: Toxic air contaminant, as defined by California Health and Safety Code, Section *39655(a)*, is an air pollutant which may cause or contribute to increase in mortality or in serious illness, or which may pose a present or potential hazard to human health.

Source: Gina M Solomon *et al* 1998, *Exhausted by Diesel: How America's Dependence on Diesel Engines Threatens our Health*, California, Natural Resources Defense Council, Inc., California p6.

iii) Equally, acid particulates, especially sulphuric acid particulates, are extremely dangerous. Sulphur dioxide gas can attach to particles or moisture droplets to become acidic particulates (Richard Wilson and John D. Spengler 1996, *Particles in Our Air: Concentrations and Health Effects*, Harvard University Press, USA).

iv) Particulate matter in diesel exhaust is extremely tiny which makes them even more harmful because they penetrate deep into the respiratory tract. A recent study in the UK has found that 90 per cent of the particles emitted by diesel vehicles are particles of 1 micron size or less. In other words, almost all particles produced in diesel are so fine that they penetrate deep into the lungs (Michael Walsh, December 1997, *Personal Communication*). Another study shows that in terms of mass, more than 85% of Diesel particulate emissions are less than 1µm. This corresponds to over 99% by number (D E Hall *et al*, 1998, SAE International, San Francisco, California, October 19-22, page 37, *mimeo*).

E.1.1. CANCER-CAUSING POTENTIAL OF DIESEL PARTICULATES

Not only do diesel particles go deep into the lungs, they are coated with polycyclic aromatic hydrocarbons (PAH), which are highly carcinogenic. The California Air Resources Board formally designated diesel particulate as a Toxic Air Contaminant on August 27, 1998, which means that it has the potential to cause serious health damage and should be controlled, following the submission of a report by a scientific panel.

The decision to declare diesel particulates as carcinogenic and not diesel exhaust was a political decision and reached after protacted discussion with the automobile industry because declaring all of diesel exhaust as carcinogenic would have meant that diesel vehicles would simply have to go off the road. Now if diesel engine manufacturers can control diesel particulates in diesel exhaust then they can still sell diesel engines, though even doing this is going to be technically very difficult.

The Scientific Review Panel of the California Air Resources Board points out that a chronic exposure to 1 µg/cum of diesel exhaust will lead to 300 additional cases of lung cancer per million people (Anon, 1998, Findings of the Scientific Review Panel on the Report on Diesel Exhaust as adopted at the Panel's April 22, 1998 Meeting, California Air Resources Board, *mimeo*) (see Table 11). For a population of ten million in Delhi, this means 3000 extra cases of lung cancer for a chronic exposure to one µg/cum of diesel exhaust. If the chronic exposure is, say, to 50 µg/cum of diesel exhaust, then we can expect an additional 150,000 cases of lung cancer. Lung cancer remains even today a largely incurable cancer. Diesel exhaust has a higher potency for cancer than even benzene, a potent carcinogen produced in petrol exhaust which is implicated in blood cancers. Unfortunately, we have no data on exposure to either diesel exhaust or benzene in Delhi.

This decision in California ended a near-decade long investigation into the health effects of exposure to diesel exhaust and discussions between environmentalists, Air Resources Board and the diesel engine industry. The decision came in the wake of a unanimous report by the state's Scientific Review Panel consisting of nine scientists that diesel exhaust should be identified as a Toxic Air Contaminant. Calling it the "most important" public health issue it has dealt with since it was formed, the panel urged the California Air Resources Board to take action (Anon 1998, Diesel emissions in California called toxic, *Car Lines*, Arlington, May).

Table 11: Cancer potencies of various chemical compounds present in diesel exhaust approved by the scientific review panel of the California Air Resources Board, from 1984-98 (in order of cancer potency)

Compound	Unit Risk $(\mu g/m^3)^{-1}$	Expected Incidence of Cancer (per million population)	Range $(\mu g/m^3)^{-1}$	Range of expected Cancer Incidence (per million population)
Chromium VI	1.5×10^{-1}	150,000	1.2×10^{-2} to 1.5×10^{-1}	12,000- 150,000
Cadmium	4.2×10^{-3}	4,200	2.0×10^{-3} to 1.2×10^{-2}	2000 – 12,000
Inorganic Arsenic	3.3×10^{-3}	3,300	6.3×10^{-4} to 1.3×10^{-2}	630 –13,000
Benzo[a]pyrene	1.1×10^{-3}	1,100	1.1×10^{-3} to 3.3×10^{-3}	1,100 – 3,300
Diesel Exhaust	3×10^{-4}	300	1.3×10^{-4} to 2.4×10^{-3}	130 – 2,400
Nickel	2.6×10^{-4}	260	2.1×10^{-4} to 3.7×10^{-3}	210 – 3,700
1,3- Butadiene	1.7×10^{-4}	170	4.4×10^{-6} to 3.6×10^{-4}	4.4 – 360
Ethylene Oxide	8.8×10^{-5}	88	6.1×10^{-5} to 8.8×10^{-5}	61 – 88
Vinyl Chloride	7.8×10^{-5}	78	9.8×10^{-6} to 7.8×10^{-5}	9.8 – 78
Ethylene Dibromide	7.1×10^{-5}	71	1.3×10^{-5} to 7.1×10^{-5}	13 – 71
Carbon Tetrachloride	4.2×10^{-5}	42	1.0×10^{-5} to 4.2×10^{-5}	10 – 42
Benzene	2.9×10^{-5}	29	7.5×10^{-6} to 5.3×10^{-5}	7.5 – 53
Ethylene Dichloride	2.2×10^{-5}	22	1.3×10^{-5} to 2.2×10^{-5}	13 – 22
Inorganic Lead	1.2×10^{-5}	12	1.2×10^{-5} to 6.5×10^{-5}	12 – 65
Perchloroethylene	5.9×10^{-6}	5.9	3.0×10^{-7} to 1.1×10^{-5}	0.3 – 11
Formaldehyde	6.0×10^{-6}	6.0	2.5×10^{-7} to 3.3×10^{-5}	0.25 – 33
Chloroform	5.3×10^{-6}	5.3	6.0×10^{-7} to 2.0×10^{-5}	0.6 – 20
Acetaldehyde	2.7×10^{-6}	2.7	9.7×10^{-7} to 2.7×10^{-5}	0.97 – 27
Trichloroethylene	2.0×10^{-6}	2.0	8.0×10^{-7} to 1.0×10^{-5}	0.8 – 10
Methylene Choride	1.0×10^{-6}	1.0	3.0×10^{-7} to 3.0×10^{-6}	0.3 – 3
Asbestos	1.9×10^{-4} (per 100 fibre/m^3)	190 (per 100 fibre/m^3)	Lung: $11 – 110 \times 10^{-6}$ (per 100 fibres/m^3) Mesothelioma: $38 – 190 \times 10^{-6}$ (per 100 fibre/m^3)	Lung 11 – 110 (per 100 fibre/m^3) Mesothelioma: 38 – 190 (per 100 fibre/m^3)

Note: 1. $\mu g/m^3$: microgramme/cubic metre 2. Unit risk is defined as an increase in the risk of developing cancer by a life-time exposure of a population to a chemical at an ambient concentration of $\mu g/m^3$.
Source: Anon 1998, Findings of the Scientific Review Panel on The Report on Diesel Exhaust as adopted at the Panel's April 22, 1998, *mimeo*.

As a result of this formal identification of diesel particles as a Toxic Air Contaminant (TAC), California's state law requires that a review be undertaken to determine potential control strategies. An advisory group is being formed, comprised of state and local air quality officials, environmentalists, business and industry representatives. The law also requires the government to make the public aware of significant toxic exposures and measures for reducing risk (Anon 1998, CARB designates diesel PM as toxic, *Car Lines*, Arlington, October). A process to assess the health risks of and future controls for diesel engines and fuels has already started. The draft risk management guidelines are expected be ready by April 1999 and a draft needs assessment by December 1999.

The California decision is expected to have serious repercussions worldwide. According to a report in a publication called the *World*, "If past trends hold true, the decision by the ARB to classify particulate emissions from diesel exhaust as toxic

air contaminants (TAC) and the strategies it ultimately adopts to reduce those emissions could have broad implications on global pollution policy. History has shown that air quality policies launched in California tend to catch on not only in the US but also in countries outside North America" (Anon 1998, Diesel Fuel on the Defensive, *World*, October).

On the eastern coast of USA, too, a "Dump Dirty Diesel" campaign by a coalition of health, environment, transportation and public interest groups has forced the New York City to start replacing its diesel-powered buses with models running on cleaner fuels, including natural gas.

E.1.2. THERE IS NO SAFE LEVEL FOR PARTICULATE POLLUTION

Equally disturbing information is coming out of the World Health Organisation about the health effects of particulate matter. There is a growing argument that there is no safe level of particulate pollution. In other words, even if particulate levels are well below the standards, they remain dangerous to human health.

In June 1996, environmental researchers across Europe released results from the first major European study linking air pollution with health problems and early deaths. This research will help Europe to draw up new standards to monitor toxic pollutants in cities, whereas until now they were relying on US research for setting such standards. The project sponsored by the European Commission's Science and Research Directorate is known as APHEA (Air Pollution and Health — a European Approach). Eleven research groups have analysed data in 15 large cities in eastern and western Europe making the study unique because all the groups used the same statistical techniques. Results of the APHEA project indicate that increases in suspended particulate matter, sulphur dioxide or ozone can significantly increase respiratory deaths and hospital admissions for respiratory illnesses.

The APHEA project results demonstrate that ambient air pollution has an adverse health effect, even at fairly low pollution levels that are below what are usually considered safe concentrations. This information makes the high levels of particles in Delhi's air look even more deadly.

For this reason, the health community is coming up with a new concept called Air Quality Guidelines. According to Dieter Schwela of WHO, "Air Quality Guidelines (AQG) should be clearly distinguished from Air Quality Standards (AQS). AQG are derived from purely epidemiological/toxicological (that is health-related) data while AQS are AQG promulgated through legislation in a country or community, and in the process of promulgation issues of technological feasibility, costs of compliance, prevailing exposure levels, social, economic and cultural conditions are possibly taken into consideration" (Dieter Schwela 1998, Air Quality Guidelines/Standards, WHO/UEH, Geneva, *mimeo*).

The air quality standards of a nation are therefore more political numbers and may, therefore, not fully take into account the health effects of a pollutant. With respect to suspended particulate matter, Schwela says, "a threshold for this compound, including the size-dependent fractions PM10 and PM2.5 could not be established and consequently no guideline (can) be given." In other words, scientists cannot yet find any level of particulate pollution at which it is safe (see Table 12).

Several studies across the world also confirm this contention. In Cleveland, USA, average PM10 levels were only 43 $\mu g/m^3$, which is only a fraction of Delhi's level. But even at such low PM10 levels, a Cleveland study estimated that an increase of 100 $\mu g/m^3$ led to an additional 12 per cent of the population suffering from respiratory

Table 12: WHO recommended air quality guidelines for Europe

Compound	Guideline value	Averaging time
Ozone	120 µg/m^3	8 hours
Nitrogen Dioxide	200 µg/m^3	1 hours
Nitrogen Dioxide	40-50 µg/m^3	Annual
Sulfur Dioxide	500 µg/m^3	10 min
Carbon Monoxide	100 mg/m^3	15 min
Carbon Monoxide	60 mg/m^3	30 min
Carbon monoxide	30 mg/m^3	1 hour
Carbon monoxide	10 mg/m^3	8 hours
Particulate	**No threshold**	

Note: mg/m^3: milligramme/cubic metre µg/m^3: microgramme/cubic metre
Source: Michael P Walsh 1999, "Global Trends in Diesel Particulate Control – A 1999 Update SAE International Congress and Exposition", *Car Lines*, Arlington, USA, Issue 99-2, March, p26.

illness (J Schwartz *et al* 1996, Methodological issues in studies of air pollution and daily counts of deaths or hospital admissions, *Journal of Epidemiology and Community Health*, 50 (Suppl 1): S3-S11). In Delhi, PM10 levels were going above 500 µg/cum at the ITO Crossing in 1998.

Another study carried out in Lyon, France from 1985 to 1990 showed that respiratory and cardiovascular deaths increased by 4 per cent when PM13 levels increased by 50 µg/ m^3. PM13 levels in Lyon were only 38 µg/ m^3 when the above estimation was made, which is again only a fraction of Delhi's levels (D Zmirou *et al*, 1996, Short term effects of air pollution on mortality in the city of Lyon, France, 1985-1990, *Journal of Epidemiology and Community Health*, 50 (Suppl 1): S30-S35).

E.2. Polycyclic aromatic hydrocarbons (PAH)

i) The hydrocarbons in diesel exhaust are extremely toxic because they can cause cancer and affect the genetic make-up of human beings. Disturbing news has recently come from Japan. One new PAH called 3-nitrobenzathrone has been discovered in diesel exhaust by Japanese scientists and they have found it to be the strongest carcinogen analysed till date. Another powerful mutagen known to exist in the diesel exhaust is 1,8 dinitropyrene (Fred Pearce 1997, Devil in the Diesel, *New Scientist*, IPC Magazines Ltd, London, October 25, p4).

ii) These carcinogenic hydrocarbons coat the particles in diesel exhaust.

E.3. Nitrogen dioxide

i) Oxides of nitrogen are formed chiefly during combustion of fuel in motor vehicles. Of the oxides of nitrogen (NO_x) occurring in ambient air, nitrogen dioxide (NO_2) is the most toxic. Nitrogen dioxide (NO_2) is not only a toxic gas by itself but it is also a precursor to the production of ozone, which is also an extremely harmful gas.

ii) Haemoglobin has much greater affinity for absorbing NO_2 than Oxygen. About 80 to 90 per cent NO_2 inhaled is easily absorbed, which then reduces the oxygen carrying capacity of the blood. NO_2 causes lung tissues to become leathery and brittle and can cause lung cancer and emphysema (severe breathing problems). Emphysema occurs due to the breakdown of the alveolar air sacs in the lungs, which then progressively diminishes the ability of the lungs to exchange oxygen and carbon dioxide in the blood stream. NO_2, thus, causes bronchitis and bronchopneumonia (B S N Raju 1997, *Fundamentals of air pollution*, Oxford and IBH Publishing Company Private Limited, New Delhi).

E.4. Ozone

i) Nitrogen dioxide reacts with hydrocarbons in the air in the presence of sunlight to form ozone. Ozone is a powerful lung irritant. A great deal of research has been conducted on the health effects of ozone which shows that it causes

impairment of the lung function, inflammation of the deep lung, respiratory symptoms, and limitation on activity. Ozone is absorbed by mucous membranes in the lungs by a process of dissolution in water. Since ozone is a powerful oxidant, it damages the nasal cavity and throat as well as sensitive parts of the lungs that are responsible for gas exchanges between air and the blood circulation.

ii) Children and young adults show greater responses on exposure to ozone than older adults. Asthmatic children appear to be at special risk from ozone exposure. Ozone impairs lung function and induces respiratory and other effects.

iii) Field studies suggest eye, nose and throat irritation, chest discomfort, cough and headache may be associated with hourly average concentrations of 200 $\mu g/m^3$ or more. Similar and higher concentrations resulted in lung function impairment in children with a 1-4% decrease in pulmonary function for each 100 $\mu g/m^3$ of ozone (WHO 1992, *Acute Effects on Health of Smog Episodes*, WHO Regional Office for Europe, Copenhagen, 1992) and a 6-8% decline in people aged 6-24 years for each 100 $\mu g/m^3$ above 90 $\mu g/m^3$ (J Schwartz 1989, Lung function and chronic exposure to air pollution: A cross-sectional analysis of National Health and Nutrition Examination Survey (NHANES II), *Environmental Research*, 50, 309-321). Field studies also show decreased athletic performance, and increased incidence of asthma attack and respiratory symptoms in asthmatics. Nasal inflammation and other respiratory inflammatory responses in children living in Mexico City have been reported to be associated with ozone exposure.

iv) Ozone is suspected of having synergistic effects with other substances linked to the appearance of allergies, asthma and other diseases that are related to lung function. This means that when humans are exposed to ozone with other specific substances, its effects become even deadlier. Ozone pollution is also known to cause coughing, shortness of breath, breathing disorders, chest pain, eye, nose and throat irritation, nausea and related health problems. It may also worsen bronchitis, heart disease, emphysema and asthma.

It is clear from the above that the health effects of diesel exhaust are extremely serious and, therefore, the growing use of diesel in Delhi poses a serious threat to public health.

F. Diesel fuel quality

Not only does Delhi use a lot of diesel but also very poor quality diesel. Variables which determine the levels of various harmful constituents in diesel fumes are sulphur content, the fraction of aromatic hydrocarbons in the fuel, fuel additives and the volatility of the diesel fuel. Moreover, studies are throwing up disturbing evidence that even using clean diesel fuel may not help to solve the problem of toxic particulate emissions. It appears that the total quantity of particles goes down only slightly while the size of particles gets reduced significantly making them even more dangerous.

F.1. Sulphur content

The level of sulphur in the diesel has a direct and linear relationship with particulate emissions in diesel exhaust. Therefore, it is very important to eliminate or reduce sulphur to the maximum possible level. Though the diesel available in Delhi is the best in the country in terms of its sulphur content, it is still extremely poor compared to international standards. Compared to the best diesel available in the world, that is, Swedish diesel which has 0.001 per cent sulphur, the diesel with 0.25 per cent sulphur now available in Delhi, has 250 times more sulphur and 5 times

Delhi takes pride in pumping out the country's best quality diesel which is 250 times dirtier and deadlier than the world's best

AMIT SHANKER / CSE

more than the 0.05 per cent sulphur diesel currently used in Europe. Very soon, Europe as a whole will be moving towards even lower sulphur diesel.

We can ask ourselves the question: why do Western countries which use much less diesel compared to petrol have such high standards for diesel fuel quality? Rationality would argue that since we use so much diesel, our standards should be the strictest.

Yet, fuel standards in India are extremely lax (see Table 13).

Table 13: Comparison of Swedish and Indian diesel standards

Diesel Parameters	Swedish Diesel Standards		Indian Diesel Standards proposed for 2000
	ECI	EC2	
Sulphur content (maximum)	0.001%	0.005%	0.25% (that is, 250 times worse than Environmental Class I diesel)
Aromatics (volume content)	5%	20%	No limit specified
PAH (volume content)	0.02%	0.1%	No limit specified

Source: Svensk Standard SS 15 54 35, December 1993: Diesel fuel oil of environmental class 1 and 2 for high speed diesel engines, SIS Stockholm.

F.2. AROMATICS AND PAH CONTENT

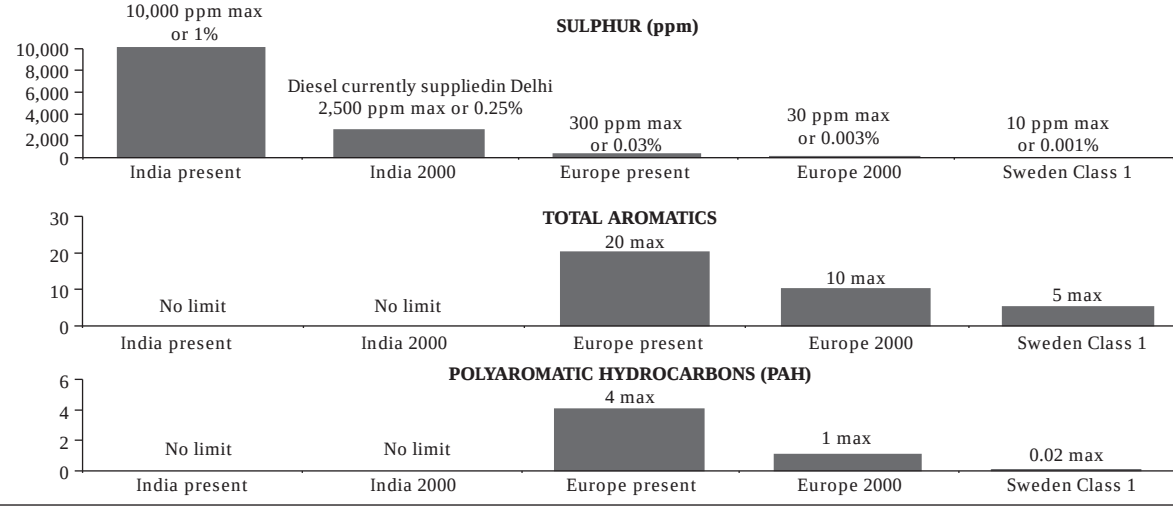
Some significant parameters which make diesel fumes extremely toxic like the aromatics and PAH content are not even proposed to be regulated in India (see Table 13 and Graph 13).

Studies carried out in Sweden show that when Swedish Class 1 diesel was used on Swedish buses as compared to Swedish class 3 diesel, which was somewhat close to the quality of diesel being currently used in Delhi, nitrogen oxides emissions

Graph 13: Indian diesel standards versus European diesel standards

The quality of diesel used in Delhi is extremely poor. It is very high in sulphur, total aromatics and polycyclic aromatic hydrocarbons as compared to international standards

Compared to the best diesel available in the world, that is, Swedish diesel, the 2500 ppm diesel now available in Delhi has 250 times more sulphur and nearly 8 times more than the diesel used widely in Europe. European and Swedish standards for diesel quality are far stricter than that of India even though the use of diesel in comparison to petrol is far higher in Indian cities like Delhi.



Source: Walter Knecht, European Engine Technology for Commercial Vehicles.

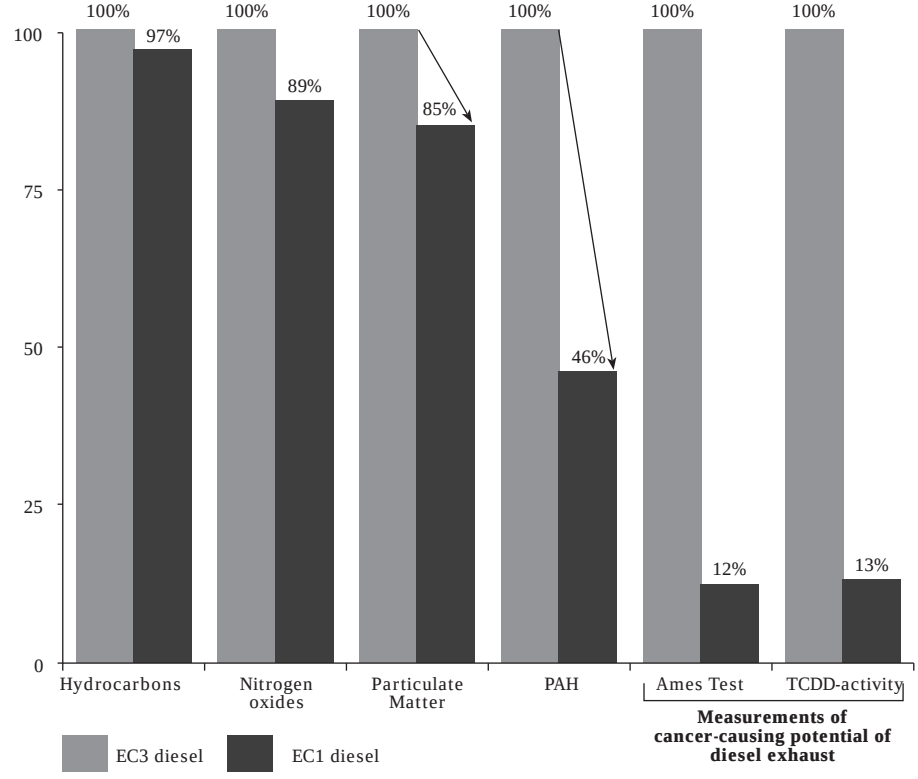
dropped by 11 per cent, particulate emissions by 15 per cent, but because of the limits specified for aromatics and PAH in the diesel, PAH levels fell by 54 per cent. And, as a result, the cancer-causing potential of the diesel exhaust, as determined by the Ames test and the TCDD-activity test, dropped by 87-88 per cent (see Graph 14).

This shows the importance of using high quality fuels and setting appropriate standards. In simple words, this means that the diesel exhaust in Delhi has a 8-9 times higher potential to cause cancer than the best diesel available in the world (see Graph 14).

The auto industry is reported to having told a meeting organised by the Association of Indian Automobile Manufacturers that it cannot meet the year 2000 norms set by the government of India unless better quality diesel is made available than the one proposed by the Ministry of Petroleum. Petroleum Secretary T S Vijayaraghavan, however, told the meeting that he cannot make any allocation of financial resources in the next 5-10 years for upgradation of refineries to produce low sulphur fuel. It was pointed out that Rs. 5,700 crore was required to reduce the sulphur content to 0.25 per cent in all refineries in India. Another Rs. 10,000 crore will be required to bring it further down to 0.05 per cent.

Graph 14: Differences in emissions from Swedish buses using EC1 and EC3 diesel

Control on PAH and aromatics content of diesel reduces the cancer-causing potential of the exhaust by 87-88 per cent.



EC1 = Environmental Class 1 diesel EC3 = Environmental Class 3 (0.3% sulphur) diesel (which is slightly worse than the diesel used in Delhi today)

NOTE: Tests done on Braunschweig cycle tests.

Source: Ecotraffic, Stockholm.

F.3 CLEAN DIESEL IS NEITHER GOOD NOR GOOD ENOUGH

Unfortunately, even if India were to move towards cleaner diesel, there is new and disturbing information that particulate pollution does not go down much and, in fact, the threat to public health may even increase.

Studies in Sweden show that there is limited reduction of particles by using the world's best diesel fuel, that is, EC1 diesel with 0.001% sulphur. Studies conducted on an advanced city bus in Sweden showed that moving from EC3 diesel (0.03% sulphur which is about equal to the diesel used in Delhi) to EC1 diesel (with 0.001% sulphur diesel), the total quantity of particle emissions went down only by 15 per cent (see Graph 14). Even with clean diesel fuel the total quantity of particles do not seem to go down much. It is doubtful that even this reduction will take place with antiquated Indian technology (Peter Ahlvik 1999, Ecotraffic R&D AB, Sweden, *personal communication*).

A recent study conducted in California comparing emissions from a new diesel engine running on older diesel fuel, and on an improved, reformulated diesel fuel (required in California since 1993), revealed that the newer fuel only slightly reduced emissions of nitrogen oxides and particulates (Gina M Solomon *et al*, 1998, *Exhausted by Diesel: How America's Dependence on Diesel Engines Threatens Our Health*, Natural Resources Defense Council Inc., California p12).

But the most worrying is a recent report published in 1999 in a leading monthly review of worldwide developments in automobile technology, *Automotive Environment Analyst*; which states that "*Contrary to most current thinking, switching to ultra-low sulphur, the so-called 'city diesel' fuel might affect exhaust emissions in such a way as to worsen rather than ease respiratory health problems.*" The conclusion was put forward at an Institution of Mechanical Engineers seminar held in London on "Diesel engines — Particulate control" by Dr Omar Hayat, managing director of ChemEcol (UK) Ltd who has conducted studies on diesel engines.

He said that even when the total quantity of particles may go down, the number of

There are limits to diesel technology. Industry has yet to resolve the problem of lowering both nitrogen oxide and particulate matter emissions at the same time

MICHEL LIPCHITZ / AP PHOTO

particles can go up. The greater the number of particles in the emissions, the smaller will be their average size and more deeply will they be able to penetrate the respiratory tract. He concluded, "On aggregate, switching from regular to ultra-low sulphur fuel reduced average particle size significantly" (Anon 1999, Diesel Particulates — Controversies Grow, in *Financial Times Automotive Environment Analyst*, UK, February, p17-18).

G. Diesel engine quality

Automobile manufacturers may fuss over poor diesel quality but the fact of the matter is that, due to extremely lax mass emission standards in force, diesel engines currently produced and proposed to be produced in India are extremely outdated and highly polluting. The mass emission norms orginally scheduled to be enforced in India in 2000 are the Euro I norms which were enforced in Europe way back in 1992. Since then Europe has moved on to Euro II norms in 1996 and will be enforcing Euro III norms in 2000 (see Table 14). Thus, it is clear that even the diesel engines which are to be introduced in 2000 are going to be very poor by international standards.

Table 14: Comparison of Indian and European norms for diesel passenger cars

The norms proposed for 2000 for diesel engines are the same as those which were imposed in Europe 6-7 years ago.

	Indian 1996 norms[1]	**Indian 2000 norms[1]**	**European 1994 norms (Euro I)[2]**	**European 1997 norms (Euro II)[2]**	**Proposed European norms for 2000 (Euro III)[1]**	**Proposed European norms for 2005 (Euro IV)[1]**
Gross vehicle weight (kg)	1470-1700	1251-1700	1251-1700	1251-1700	1251-1700	1251-1700
Carbon monoxide (gm/km)	6.27-7.7	6.00	6.00	1.25	0.64	0.53
Hydro-carbons + Nitrogen oxides (gm/km)	2.42-2.97	1.60	1.60	1.00	0.56	0.30
Particulate matter (gm/km)	No norms	0.22	0.22	0.12	0.05	0.025

Note: Norms are for Conformity of Production

Source: 1) Central Pollution Control Board 1998, Dieselisation of Private Vehicles, *mimeo*.

2) CONCAWE Report No. 6/97

We have to also see the Euro norms in the international context. The strictest standards for diesel engines in the world are California standards which are even stricter than the standards applied in the rest of USA. US standards, in turn, are far stricter than European standards (see Table 15).

Table 15: Strictness of different international standards for diesel vehicles

Place	Strictness of standards	Possible reasons
California	Strictest in the world/Stricter than even the US standards	Suffers from smog
USA	Less strict than California but stricter than elsewhere	
European Union	Less strict than USA	Strong diesel manufacturers' lobby
India	Lagging behind 7 years even in comparison to EU standards	

European standards are lower than that of USA presumably because one of the world's biggest manufacturers of diesel engines, Puegeot, is a French conglomerate. Many Indian manufacturers who are going in for diesel versions of their cars in India are collaborating with Puegeot for diesel engine technology.

A CPCB analysis points out, ".....the present Indian norms for diesel cars are very much relaxed than European norms..... There is no limit for PM in current Indian norms whereas European norms specify 0.1 gm/km. ...In India, the 2000 CO norms for diesel passenger cars are more relaxed than gasoline passenger cars whereas in Europe the diesel passenger car norms are more stringent than gasoline passenger cars." The analysis concludes that "existing diesel vehicles are more hazardous than petrol vehicles in the Indian context." (Dieselisation of Private Vehicles, November 1998, Central Pollution Control Board, *mimeo*).

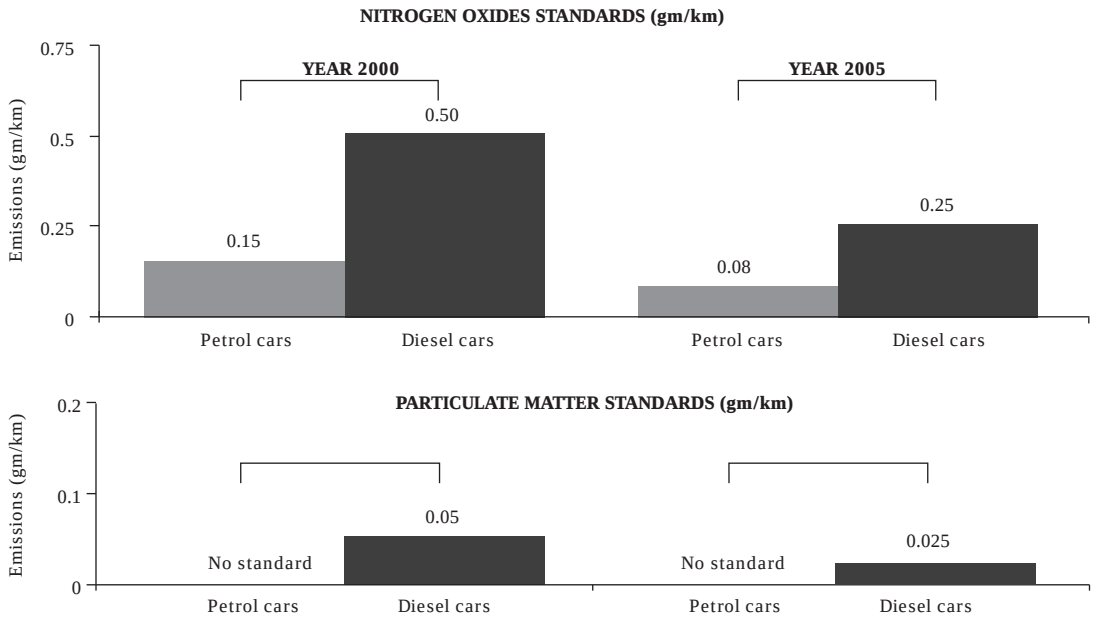
While it is true that diesel vehicles are 10-20 per cent more fuel efficient than petrol vehicles, they are far more polluting, especially of particulate matter and nitrogen oxides, both of which are serious air pollutants in Delhi.

Will diesel engines become cleaner in the future? If we compare the standards that are being set in Europe for the years 2000 and 2005 for diesel and petrol cars, we find that even Europe, with the best of technology, has not come to grips with the problem of particulate matter and nitrogen oxides emissions from diesel vehicles effectively. This is evident from the fact that the limits set for these emissions from diesel vehicles are several times more than the levels allowed for petrol vehicles (see Graph 15). European proposals applicable from the years 2000 show that even in Europe, with the best of technology, diesel vehicles will emit 3.3 times more nitrogen oxides than petrol vehicles. At the same time, diesel vehicles have been set a particulate matter standard for 2000 of 0.05 gm/km whereas no standard has been set for petrol cars because petrol cars have very small particulate emissions. Generally, diesel cars emit one to two orders of magnitude more particulates than petrol cars, which means 10-100 times more than petrol cars (see Graph 15).

Moreover, diesel vehicle manufacturers have still not been able to resolve the problem of lowering both nitrogen dioxide and particulate matter emissions from diesel engines at the same time. Changes needed in engine parameters to reduce nitrogen dioxide emissions tend to increase particulate emissions and vice versa. Therefore, a manufacturer who designs diesel engines has to choose between high nitrogen dioxide emissions or high particulate matter emissions (see Table 16) (Michael Walsh and Jitendra J. Shah 1996, *Clean Fuels for Asia: Technical Options for Moving toward Unleaded Gasoline and Low-Sulphur Diesel*, The World Bank, Washington DC).

Graph 15: Comparison of European norms for diesel and petrol vehicles

Even with the best of technology, diesel vehicles in Europe will emit 3 times more nitrogen dioxides than petrol vehicles in the years to come and 10-100 times more particulate matter.



Source: Decision of the joint European Parliament and Council meeting on June 30, 1998.

Table 16: The NO_x - Particulate trade off

Most of the techniques for reducing Particulate Matter (PM) and Hydocarbon (HC) emissions result in higher Nitrogen Oxide (NO_x) emissions

Changes in engine design to improve emissions	**Affect on NO_x and particulate emissions**
Turbocharging	Increases NO_x emissions but reduces particulates
Fuel injection retard is an effective way of reducing NO_x emissions	Increases fuel consumption, smoke and hydrocarbon emissions
Exhaust gas recirculation technique	Can significantly reduce NO_x but may double particulate emissions

Source: Michael Walsh and Jitendra Shah 1997, *Clean Fuel for Asia*, World Bank, USA.

G.1 EVEN CLEAN DIESEL ENGINES ARE DIRTY

Even more worrying is the information that when efforts are made to design diesel engines to reduce the total quantity of particulate matter in diesel exhaust, the particles become smaller and their number goes up dramatically which poses a serious health hazard because then the particles can go even deeper into the lungs. According to the Health Effects Institute based in Cambridge USA, despite a substantial reduction in the weight of the total particulate matter, the total number of particles from a 1991-model diesel engine was 15 to 35 times greater than the number of particles from a 1988 diesel engine when both engines were operated without emission control devices (Gina M Solomon *et al* 1998, *Exhausted by Diesel, How America's Dependence on Diesel Threaten Our Health*, Natural Resources Defence Council Inc., California,

May 1998). Thus, newer diesel engines may be emitting a smaller quantity of particles but not fewer particles.

After recognising diesel particles as a toxic air contaminant and a carcinogen in August 1998, the California government in November 5, adopted a plan to require gasoline and diesel-fueled light duty vehicles to meet tighter emission standards beginning in 2004. Most notably, for CO, HC and NOx, vehicles will be required to meet identical standards regardless of the fuel used. According to Michael P Walsh, former director of the US Environment Protection Agency, "these requirements will effectively eliminate light duty diesel sales in California unless there is a significant technological breakthrough."

The particulate emission standard for diesel cars in California in 2004 will be 0.01 gm/mile or 0.00625 gm/km (Michael P Walsh, March 1999, Global Trend in Diesel Emissions Control — A 1999 Update, SAE Technical Papers Series, Society of Automotive Engineers, USA, *mimeo*). Even though different countries specify different driving cycles to measure vehicular emissions, the enormous strictness of the California standard can be understood by simply comparing it with the Indian 2000 standard of 0.18 gm/km for diesel cars. This standard is 29 times than what California will achieve in 2004. And this is when Californian cities use much less diesel in comparison to petrol than Delhi. In other words, one new diesel car in India will be almost equal to 29 new diesel cars in California in 2004.

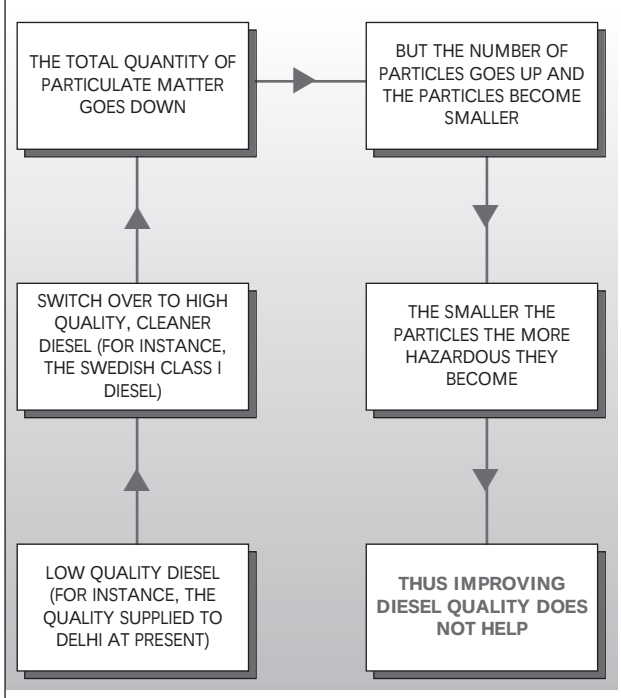
Moreover, California standards state that manufacturers will have to certify that these emissions will be met for at least 80,000- 2,40,000 km running of the vehicle, depending on the type of vehicle. India has no 'emission warranty' provided by manufacturers, unlike the US, and, therefore, diesel vehicles in India only have to meet high emissions standards at the factory gate. But then there is no guarantee that the cars' emissions will not deteriorate rapidly after, say, one year of use.

Diesel paradox: cleaner the diesel technology, deadlier is the particulate emission problem. Efforts to improve engine design and also the fuel quality reduces the total quantity of particulate matter but the number of the finer particles goes up dramatically which poses a serious health hazard

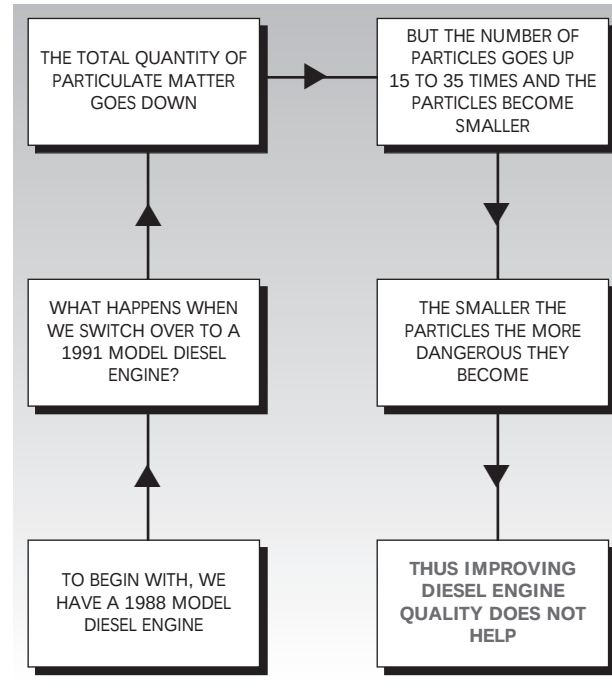
AMIT SHANKER / CSE

ARE THERE ANY OPTIONS BUT TO BAN DIESEL CARS?

Is it possible to reduce the health effects of diesel emissions? There are two main options — improving diesel fuel and/or improving diesel engines. But experts are finding that neither of them help. They, in fact, worsen the health effects



IMPROVING DIESEL FUEL QUALITY DOES NOT HELP, SAYS A UK STUDY



IMPROVING DIESEL ENGINE QUALITY DOES NOT HELP, SAYS A US STUDY

Particulate emission control devices for diesel vehicles are still in a developmental stage. They are not yet commercially viable and their effectiveness is still dubious.

The new diesel cars which will come onto the Indian market will have no catalytic convertors as compared to petrol cars. In any case, catalytic convertors will go bad quickly when diesel has as much as 0.25% sulphur, which is the quality of diesel supplied in Delhi. Low sulphur is necessary in diesel for catalytic convertors.

Furthermore, catalytic convertors reduce carbon monoxide and hydrocarbons in diesel cars but not particulate matter and nitrogen oxides. To reduce PM, another device called particulate traps is needed but it is still at an experimental stage.

H. Air pollution problems caused by diesel in Europe

Diesel vehicle manufacturers only point out that European countries have allowed private diesel cars. So why can't India?

Walsh, who has studied the current trend in sales and use of diesel-fueled vehicles in different countries, argues that these trends reflect the relative importance these countries place upon different pollutants and environmental benefits they hope to achieve. Since the diesel engine is more fuel-efficient, several Western companies have promoted diesel cars to lower levels of carbon dioxide emissions, driven by concerns regarding global warming (Michael P Walsh. March 1999, "Global Trends in Diesel Particulate Control — 1999: Update, 1999 SAE International Congress and Exposition", USA, *mimeo*).

But, at the same time, governments are beginning to counter this industry response to the global warming problem by tightening diesel emission standards concerned by the health effects of diesel particles. As a result, there are wide differences in the trend in sales in diesel cars from country to country even within Europe.

It is important to note that particulate matter was not considered a serious problem in Western countries until recently. The European Union does not even have an ambient air quality standard for particulates and is considering one only now. Moreover, particulate standards were invariably built on total quantity of particulate matter but now there is growing concern about the size of particles and the recognition that there is no safe level of particles.

Carbon dioxide is not a primary concern in India as of today because India as yet has no international commitment to reduce carbon dioxide emissions. On the contrary, the concentration of diesel-related pollutants such as particles and NO_x is very high in severely polluted cities like Delhi.

Meanwhile, there is new evidence to show that diesel cars may not even help prevent global warming. Diesel cars are more damaging to environment and health than gasoline cars, according to a study by the Swedish Environmental Protection Agency (SWEPA). SWEPA study holds that the argument that the diesel cars contribute less to global warming than gasoline cars, is false. While the authors acknowledge that diesel cars do use 20-25 per cent less fuel and, therefore, emit less CO_2 per kilometre, they argue that the diesel cars emit 15 per cent more CO_2 per litre than gasoline cars, and as a result the overall effect on CO_2 emissions is 'negligible' (Anon 1998, *Financial Times Automotive Environment Analyst,* Issue 47, London, UK, December, p8).

The growing use of diesel cars in countries like France is also leading to serious pollution problems. European countries, under pressure from their diesel engine manufacturers, are, therefore, paying a heavy price for allowing diesel vehicles in larger numbers than USA. There are more powerful diesel manufacturers in Europe than in Japan, Korea or USA.

This bad air pollution picture emerges clearly in France, where diesel cars are high in numbers because of the presence of Peugeot, the world's leading manufacturer of diesel engines.

Here are some highlights of the air pollution in Paris over the last few years:

i) **JULY 1994:** The authorities announce that the air in Paris is so polluted by ozone that it is dangerous to breathe. The resulting pollution alert, the first in the capital's history, sends shockwaves throughout France.

ii) **OCTOBER 1995:** Nitrogen dioxide levels soar to a new record on a hot day.

iii) **MAY 5, 1996:** Some 4000 people take to the streets in Paris, on France's first national anti-air pollution day. A French engineer even suggests installing 70,000 small fans costing US$ 80 million to blow away car exhaust fumes.

iv) **MARCH 11-13, 1997:** Paris authorities issue a pollution alert as warm sunshine and low winds push nitrogen dioxide to dangerous levels. Action by police to keep motorists within strict speed limits leads to traffic jams. Paris mayor asks people to use buses and trains. The Prime Minister announces that half of all vehicles will be banned in Paris when pollution reaches dangerous levels.

v) **SEPTEMBER 30, 1997:** High pollution levels lead to unprecedented restrictions in Paris. It is announced that only cars with odd-numbers will be allowed to circulate in Paris region and public transport is made free. Even-numbered cars, if caught, will be fined $150 (900 francs) and immobilised. About 1,000 extra police are deployed to check cars. But the government can not pick up the courage to fine car owners. It only distributes leaflets explaining the rules.

vi) **OCTOBER 12, 1997:** Paris authorities warn people with respiratory problems to take special care when ozone levels again reach high levels.

vii) **FEBRUARY 1, 1998:** French cabinet approves a plan which says that when pollution alerts are announced only vehicles made after 1993, the year when catalytic convertors became mandatory, or those powered by batteries or natural gas will be allowed on the roads. These cars will get green stickers.

viii) **AUGUST 15, 1998:** Police urge Parisians to leave their cars at home after high temperatures lead to high ozone levels over the French capital.

We may ask why is this happening repeatedly in France? **Several French experts believe that the cause is diesel engines, which have been described as the "engines of the devil".**

According to a newspaper report on the air pollution problems in France, "....diesel fuel.....accounts for nearly half of all sales at the pump. And car makers have blocked measures to discourage diesel engine cars, which one newspaper called "**engines of the devil**". Unlike in Germany, where environmental groups won strict anti-pollution measures last year, environmentalists here are not particularly powerful. But they have been vocal, staging marches to protest construction of new garages as well as government policies that encourage automobile use." (Anon 1996, France Gets Tough On Pollution: Dirty Air Warnings Pit Industry, Voters, in *Washington Post*, April 7, 1996, Washington Post Co, Washington)

European countries are also beginning to rethink diesel. A recent Dutch study, for

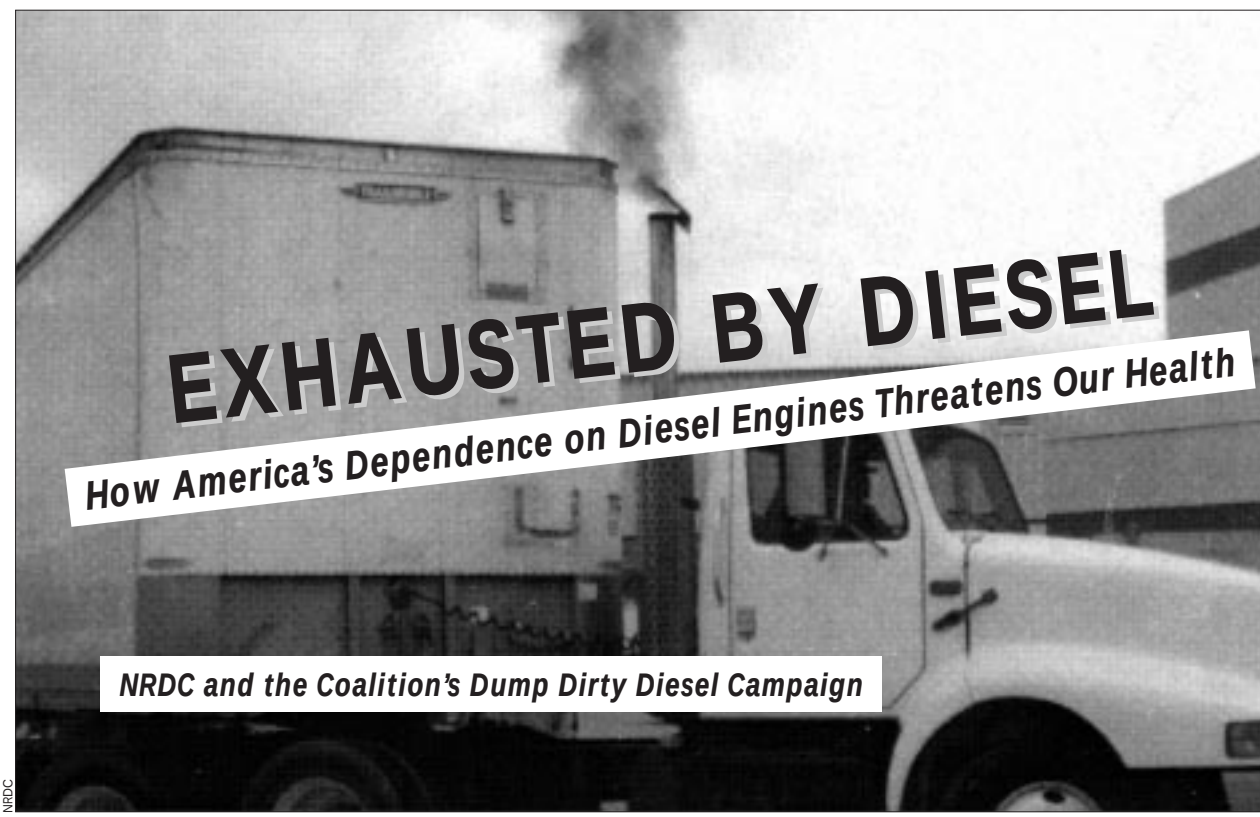
MICHIEL WIJNBERGH

Some countries have allowed the number of diesel cars to increase to combat global warming as diesel is more fuel efficient. But scientific evidences mount to show that diesel may actually contribute to global warming in addition to aggravating the problem of urban smog

instance, which has tried to evaluate the optimum fuel mix for the country's road traffic in the year 2010, from an environmental point of view, has concluded that the proportion of diesel should drop from 57 per cent in 1997 to 43-46 per cent in 2010 with the proportion of petrol going up from 36 per cent to 43-45 per cent and that of gaseous fuels like LPG and CNG should go up from 7 per cent to 9-14 per cent. The study recommends that the percentage of passenger cars run on diesel should drop by more than half and even that of light commercial vehicles by over a third. The study recommends city buses and coaches, distribution trucks and refuse collection vehicles should move towards the use of CNG and LPG (Michael P Walsh 1998, Dutch Study Assesses Optimal Fuel Mix, in *Car Lines*, issue 98-5, Arlington, USA, October, p4-5).

In Sweden, sales of new diesel cars have almost disappeared (Michael P Walsh 1999, Gobal Trends in Diesel Emissions Control — A 1999 Update, International Congress and Exposition, Detroit, March 1–4, p1, *mimeo*). The tax differential for diesel in the UK has been reversed in the latest budget and in France, too, where diesel models now account for around half of all sales of new cars, there are also calls for the existing tax advantages of diesel cars to be eliminated (Anon 1998, "Swedish report adds to evidence against green benefits of diesel" in *Financial Times Automotive Environment Analyst*, London, UK, December).

According to Walsh, two developing countries, namely, Brazil and Taiwan have banned private diesel vehicles. Egypt, too, which subsidises diesel to support public transport has banned private diesel cars. The European Union even took Taiwan's decision to a General Agreement on Tariff and Trade (GATT) tribunal but lost because GATT allows national action to protect the environment as long as the measure is both for local and foreign firms.



NRDC

Because government agencies have failed to protect the public from diesel exhaust, in the US — NGOs like National Resource Defence Council (NRDC) and the Environmental Law Foundation have launched the "Dump the Dirty Diesel" campaign

The recent decision of California to adopt the same standards for diesel and petrol vehicles "makes it very unlikely that many diesels will be sold unless there is a significant technological breakthrough," says Walsh. The formal declaration of diesel particulates as cancer-causing substances will make it even more difficult for vehicle manufacturers to introduce diesel vehicles in California.

I. The need to ban private diesel cars

It is necessary to ban the registration of new diesel-based private vehicles immediately in order to prevent their rapid growth in Delhi. It is clear that diesel technology has reached its limits. Even if Indian diesel cars meet Euro I or even Euro II norms, this will be inadequate in dealing with the problem of tiny toxic particulate emissions. Latest evidence shows that even importing or production of cleaner fuel is insufficient. Paris is suffering from smog even when it has clean diesel fuel (0.03% sulphur as compared to Delhi's 0.25% Sulphur) and has 'clean' engines (Euro II and going on to Euro III).

The price difference in India between diesel and petrol is going to lead to an explosion of diesel cars. We must not allow this to happen. Already the toxic tiny particulate matter from diesel has reached critical levels in the city. The Respirable Suspended Particulate Matter (RSPM) reaches 5-6 times above the standard.

The Supreme Court — in recognition of the toxicity of diesel emissions — has already ordered that all public transport and taxis must move to CNG. The Delhi administration has banned the registration of diesel taxis. To allow private vehicles to dieselise would not only undermine the Supreme Court order to reduce diesel use by moving public buses to CNG but would also be a misuse of the fiscal policy that keeps diesel prices low for public transport and agriculture. So, while public transport will move away to CNG, rich car owners will use cheap and dirty diesel.

It is best to reduce the use of diesel to the minimum extent possible because of increasing evidence of the acute cancer-causing potential of diesel-related pollutants and their other health effects.

All this should be avoided by pushing more and more commercial vehicles, which today use diesel into cleaner fuels like CNG or LPG and banning diesel-based private cars which currently use little diesel till diesel-related technology becomes environmentally-friendly in the west.

In the Vellore Citizens Welfare Forum Vs. Union of India (1996) 5 SCC 647, the Supreme Court had emphasised importance of the *"precautionary" principle* and the *"polluter pays" principle*. To protect the environment, the 'precautionary principle' should be given priority over 'polluter pays' principle. Otherwise, polluters would be free to increase pollution on payment of sums of money.

A ban on the registration of diesel driven private vehicles fits well with the Precautionary Principle. ■

CSE Publications: Order Today

STATE OF INDIA'S ENVIRONMENT

Citizens' First Report-1982 (SOE-1)
Hardbound Rs. 290 US $12
Paperback Rs. 190 US $10

Citizens' Second Report-1984-85 (SOE-2)
Hardbound Rs. 490 US $18
Paperback Rs. 290 US $12

Citizens' Third Report-1991 (SOE-3)
Floods, Floodplains & Environmental Myths
Hardbound Rs. 290 US $12
Paperback Rs. 190 US $10

Citizens' Fourth Report-1997 (SOE-4)
Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems
Hardbound Rs. 490 US $18
Paperback Rs. 290 US $12

Citizens' Fifth Report- (SOE-5)
Part I: National Overview
Part II: Statistical Database
Hardbound Rs. 1,590 US $59

Towards Green Villages
A Strategy for Environmentally Sound and Participatory Rural Development
Paperback (Hindi) Rs. 30 US $5

Towards a Green World
Should Global Environmental Management be built on Legal Conventions or Human Rights?
Hardbound Rs. 350 US $18
Paperback Rs. 200 US $10

The Price of Forests
Proceedings of a Seminar on the Economics of the Sustainable use of Forest Resources
Hardbound Rs. 180 US $22

The Challenge of the Balance
Environmental Economics in India,
Proceedings of the National Environment and Economics Meeting
Hardbound Rs. 590 US $22

Water Links
Water Harvesters Directory
Rs. 85 US $6

Global Warming in an unequal World: A case of environmental colonialism
Rs. 30 US $6

CHILDREN'S STORY BOOKS

Chipko Rs. 20 US $5
The Chilika Lake adventure Rs. 65 US $9

STATE OF THE ENVIRONMENT SERIES

The Curse of the White Gold
Paperback Rs. 75 US $7

Protection of Nature Parks: Whose Business?
Paperback Rs. 75 US $7

Slow Murder: The Deadly Story of Vehicular Pollution in India
Hardbound Rs. 390 US $19
Paperback Rs. 75 US $7

Homicide by Pesticides: What Pollution does to our Bodies
Paperback Rs. 75 US $7

WEALTH OF THE NATION VIDEO SERIES

The Living Word
32 mins Pal VHS
Rs. 750 US $25

Harvest of Rain
48 mins Pal VHS
Rs. 750 US $25

Thar: Secrets of the Desert
52 mins Pal VHS
Rs.750 US $25

The Village Republic
50 mins Pal VHS
Rs. 750 US $25

Set of 4 cassettes
Rs. 2,500 US $90

Our forthcoming directories

- **Health Links:** A Directory of experts on environmental health
- **Natural Resource Links:** A Directory of Government departments and institutions dealing with India's natural resource

CENTRE FOR SCIENCE AND ENVIRONMENT
is a public interest research organisation dedicated to disseminate information about science and environment
41, Tughlakabad Institutional Area, New Delhi - 110 062
Tel: 91-11-698 6399, 698 3394, 698 1110 Fax: 91-11-698 5879
Email: cse@cseindia.org Website: www.cseindia.org

Roll down the window of your bullet-proof car, Mr Minister
The security threat is not the gun. It's the air of Delhi

Hon'ble Prime Minister,

Here is something that just may convince you: while India's Gross Domestic Product has increased two-and-half times in two decades (1975-1995), the pollution load from industries has gone up four times and from vehicles a shocking eight times.

A study by the Centre for Science and Environment shows that the number of people dying due to air pollution went up by almost 30 per cent in four years between 1991 and 1995. An estimated 52,000 people are dying due to air pollution every year — about 10,000 of them in Delhi itself.

One person dies every hour due to air pollution in the city ruled by your party.

In Delhi vehicles are responsible for 70 per cent of the pollution load. Because of the high toxicity of fumes from transport fuel, one out of every 10-15 people living in Delhi is likely to get cancer.

Your government has failed to arrest this deterioration of air quality in Indian cities. Worse still, it contributes to the pollution in a big way by producing low quality fuel in state-owned refineries. Improving fuel quality is a short-term measure which will go a long way. Vehicles using clean fuel will pollute less.

Seeing your government's inability to tackle air pollution, we present you with a peoples' charter for clean air. This will help to immediately improve the quality of the air we breathe.

Mr Prime Minister, 50 years into Independence, please give us our right to clean air. We hope you will take our concern seriously.

Yours sincerely

Centre for Science and Environment
November 2, 1998

PEOPLES' CHARTER ON CLEAN AIR

FOR IMMEDIATE IMPACT

✔ **PRODUCE CLEAN DIESEL, OR IMPORT IT**
Diesel emissions contain deadly particulate matter with traces of the strongest carcinogen known till date. Indian diesel is 250 times dirtier than the world's best.

✔ **REMOVE BENZENE FROM PETROL**
India is moving towards unleaded petrol. But this fuel contains too much benzene. Though we use one hundred times less petrol than USA, the total amount of benzene emissions from Indian vehicles is the same as in the US.

Benzene causes blood cancer and air should have no benzene at all, says WHO. Yet the level of benzene in and around Connaught Place in Delhi is 10 times higher than the European safety limit. If you live in Delhi, your chances of getting blood cancer are twice as high as people living in Bangalore, Chennai and Mumbai.

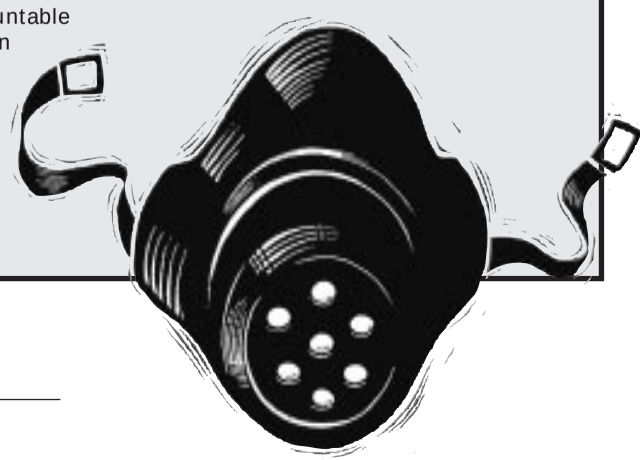
✔ **STOP PRIVATE DIESEL CARS**
Registration of all private diesel models should be banned in cities like Delhi. Cheap government diesel means more diesel cars, including luxury models.

✔ **TAX TO IMPROVE VEHICLE TECHNOLOGY**
Penalise vehicle manufacturers for producing polluting technology. Tax vehicles according to their emission level. Manufacturers will then invest in cleaner technology.

✔ **INTRODUCE EMISSION WARRANTY**
Make the industry accountable for the life-long emission efficiency of all vehicles they produce.

✔ **MAKE EMISSION LEVELS PUBLIC**
Manufacturers must inform buyers of the exact emission levels of their vehicles.

✔ **MONITOR ALL HARMFUL GASES**
Improve air quality assessment. A wide range of poisons are not monitored till date. Alert people about pollution levels in the city. It is done all over the world.



Register your protest to the Prime Minister today
PMO, South Block, New Delhi 110 001
Tel: 301 8939 Fax: 301 6857, 301 9817

Join CSE's Right To Clean Air campaign

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Tel: 698 3394, 698 1124, 698 5879 **Fax:** 698 5879
Email: cse@cseindia.org **Website:** www.cseindia.org

Issued in public interest by Centre for Science and Environment (CSE)