Chapter 6:

Transportation and Air Pollution

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Overview

The transportation sector is a major source of air pollution in the Mexico City region, accounting for nearly all CO, more than 75% of its NOx, 35% of VOC, 24% of SO\textsubscript{2}, and 41% of PM\textsubscript{10}. Yet transportation is also a critical enabler of economic activity and beneficial social interactions.

The challenge facing the Mexico City region is to realize the benefits that transportation can provide without incurring the negative impacts that can also result from the “vicious cycle” of urban transport, as illustrated in Figure 6.1. Through transportation-facilitated activities, economic growth is enabled; this economic growth, in turn, creates transportation impacts, most often manifested through increasing trip rates, rising motorization, shifts towards more rapid travel modes, and growing trip distances. These transportation effects themselves then produce economic impacts, but often also negative “external” effects, such as congestion, air pollution, and accidents.

![Figure 6.1 The Vicious Cycle of Growth](image)

Not only do such negative effects undermine the effective provision of transportation services, they also themselves can further inhibit economic growth, representing lost resources in the form, for example, of wasted time and impaired health. It is at this stage of the urban transport “cycle” where conflicts most often emerge. On the one hand, some form of investment or intervention is needed to reduce transportation’s negative impacts and continue enabling economic growth. On the other hand, many interventions are rendered difficult or impossible due to constraints such as resistance by stakeholder groups whose special interests are adversely affected or simply lack of financing. The dilemma arises of how to mitigate or eliminate transportation’s negative effects while continuously allowing it to serve its role as backbone to the urban economy. A detailed evaluation of the MCMA transportation system is presented as Annex 4.
Urban Growth and Transportation Demand

This dilemma becomes most pressing under conditions of rapid urban growth. Between 1970 and 1995, the ‘central city’ area’s population declined by between 1.7 and 2% per year, while the successive “rings” around the city absorbed a growing share of the city’s population, as explained in Chapter 4. The area immediately around the central business district, while still growing, declined from 3.6 % per year growth during the 1970s to just over 0.5% growth by 1995. While the first ring still concentrates the greatest single share of the MCMA’s population, more distant areas are experiencing the most rapid growth.

Under current trends, the population of the MCMA will increase by 2% per year between 1995 and 2020 – faster than the nation’s expected growth of 1.7% per year. By 2020, the MCMA population will reach 26 million, 1/5th of the country. Including the “corona” of cities, the entire Megalopolis will contain 27% of the nation’s population, some 36 million people. On the current trajectory, the urbanized/urbanizing municipalities of the State of Mexico will undergo the highest rates of growth (approximately 4% per year). In so doing, the State of Mexico will greatly increase its share of the regional population from roughly equal to that of the DF in 1995 to nearly double by 2020.

The government has developed alternative growth projections for the region, based on general objectives of fostering regional development, taking advantage of existing urban infrastructure, reducing current growth tendencies in the EM, and protecting ecologically sensitive areas from further settlement. Under this scenario – the so-called “programmed growth” plan – the government would be able to alter somewhat the current patterns of growth as shown in Figure 6.2. But the specific regulatory mechanisms, public investments, and incentives for private development that are necessary for achieving this alteration have not yet been put in place.

![Figure 6.2 Population Growth in Mexico City](image)

Land Uses

Economic influences have had an important role in the formation of the urban space and land uses in the region, particularly the relationship of the DF with the EM and the rest of the “Megapolis.” Five major highway arteries intended to link the City with the rest of the country
became corridors of development (focusing an important share of shopping centers, etc.) and have also contributed to the DF’s increasing importance as a center of finance and technology. The result has been a polycentric urban form, yet with still heavy dependence on central city functions. Within the Greater MCMA, the DF contains 49% of the entire urbanized area, 47% of the housing, 31% of industry, and 81% of mixed/commercial land uses. The DF is expected to continue serving as a major point of concentration of commercial and services land uses, while the EM will absorb an increasing migration of industry and housing. Chapter 4 provides a more detailed discussion of the linkage between land use, transport and air pollution.

Passenger Trips and Mode Share in the MCMA

Based on the available documentation (COMETRAVI, v6, 1999), in 1994 approximately 29.1 million vehicle trip segments (tramos de viaje) were made in the MCMA. Regarding the spatial distribution of trips, 54% of these MCMA trips were concentrated within the DF, 26% occurred between the DF and the EM, and 20% occurred within the state of Mexico (COMETRAVI, v6, 1999; p. 2). In terms of trip attractions, the city center accounts for the single largest share of trips – 23%, and roughly half of these trips were generated internally. The next largest areas in terms of trip attraction included a northern area of the DF and two large portions of the EM one in the west/northwest and the other directly north of the city center. These areas accounted for 11 – 14% of trips attracted. Trip distribution is shown in Figure 6.3.

Figure 6.3  Trips between D.F. and E.M.
When examined according to mode, the majority of public transport trips were to and from the city center, while automobile trips were much more dispersed in their destinations. For automobile trips less than half were for work, 27% were for shopping, and 25% for other social activities. Figure 6.4 shows changing trip patterns by mode during the decade of 1988 through 1998. In terms of overall mode share, using the COMETRAVI data on trip segments in 1994, “lower occupancy” modes have gained the largest market share. Colectivos have over 50% of trip segments and autos & taxis another 20%. Among the “high occupancy modes,” the metro accounts for only 13% of all trips, and urban & suburban buses have 10%.

Future growth in passenger travel demand depends heavily on economic conditions, which influence overall trip-making behavior (i.e., trip rates) and modal choice. According to official projections, overall trip segments in the MCMA will increase from 29 million in 1994 to nearly 37 million by 2020. Virtually all growth is projected to occur in the EM, increasing from 9.6 million to 16.4 million consistent with population growth as shown in Figure 6.2. In the case of the DF, the increase will be very small, from 19.5 million to 20.5 million. Table 6.1 below shows these projections, assuming constant mode share.

From an environmental quality and transportation efficiency perspective the projected continued dominance of public transportation and low level of trip-making activity are welcome. However, such projections are unlikely to be realized without strong and successful intervention on behalf of the government. Even moderate sustained economic growth over this period would have important effects on trip-making behavior, both in terms of trip-rates and mode share since people tend to choose private automobiles and taxis as their income increases.
Table 6.1: Daily Motor Vehicle Trip Segments in the MCMA

<table>
<thead>
<tr>
<th></th>
<th>1994</th>
<th></th>
<th>2020</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Trip Segments</td>
<td>Mode Share</td>
<td>Trip Segments per Capita</td>
<td>Total Trip Segments</td>
</tr>
<tr>
<td>MCMA</td>
<td>29.1</td>
<td>1.7</td>
<td>37.0</td>
<td>1.41</td>
</tr>
<tr>
<td>Public</td>
<td>24.0</td>
<td>82%</td>
<td>30.6</td>
<td>83%</td>
</tr>
<tr>
<td>Private</td>
<td>5.1</td>
<td>18%</td>
<td>6.4</td>
<td>17%</td>
</tr>
<tr>
<td>DF</td>
<td>19.5</td>
<td>2.29</td>
<td>20.5</td>
<td>2.28</td>
</tr>
<tr>
<td>Public</td>
<td>15.9</td>
<td>82%</td>
<td>16.7</td>
<td>82%</td>
</tr>
<tr>
<td>Private</td>
<td>3.6</td>
<td>19%</td>
<td>3.8</td>
<td>19%</td>
</tr>
<tr>
<td>EM</td>
<td>9.6</td>
<td>1.11</td>
<td>16.4</td>
<td>0.95</td>
</tr>
<tr>
<td>Public</td>
<td>8.1</td>
<td>84%</td>
<td>13.8</td>
<td>84%</td>
</tr>
<tr>
<td>Private</td>
<td>1.5</td>
<td>16%</td>
<td>2.6</td>
<td>16%</td>
</tr>
</tbody>
</table>

Sources: COMETRAVI, v6, p. 26; per capita estimates based on “trend” population projections from CdM

Freight Trips
As the locations of residence, employment, and recreation drive passenger travel, the placement of commercial and industrial facilities with respect to areas of demand drives freight travel. The prominence of Mexico City in national economic activity with over a third of the nation’s GDP, reinforces the importance of freight travel in the metropolitan area. Cargo trips can be broadly divided into intra-urban and inter-urban categories. In the latter, a significant portion are “through-trips” with the MCMA as neither origin nor destination. Intra-urban trucks’ trip market share increases as trip-length decreases. Laws in the metropolitan region prohibit especially large trucks (by weight) from making deliveries during daytime hours. Overall, about 29% of freight originates in delegations of the DF, 12% in EM municipalities, and 59% outside the MCMA.

Transportation Supply
Roadways and Road Vehicles
During the last twenty years, the provision of highway infrastructure has struggled to keep pace with the massive population expansion. During the early to mid-1970s, the major accomplishments included the construction of the “Circuito Interior” (first ring road) as well as several feeder roads towards the west. A major development was the implementation of the ejes viales in 1979-80. This created a system of high capacity boulevards through downtown. In the early nineties the Periférico, the DF’s beltway, was completed along with other road modernization projects, many of which focused on introducing grade separations to improve flow on key routes. More recently, major construction activity has included a new toll highway in the west/northwest (La Venta-Lechería), highway expansion in the north (Cuautitlán-Tlalnepantla), and both road expansion and new construction in the east. As of 1995, the entire northern half of the Third Ring was completed (but as a toll highway), with the southern half under construction. Future highway construction is most restricted in the north and northwest, due to topography. In the north, this most affects transportation among the relevant municipalities of the EM, while in the northwest the effects are most profound on transport.
between the EM and the DF. Overall, roadway connections between the EM and the DF continue to suffer due to major variations in road design capacities and continuity.

As Table 6.2 indicates, there are significant disparities between the DF and EM. Whereas roadways cover 28% of the DF, the comparable coverage is only 12% in the relevant municipalities. The inequity of infrastructure supply, particularly with respect to the population and trip distribution, highlights a basic cause of the congestion problems that contribute to mobile source emissions in the EM.

### Table 6.2: Summary of Transport Infrastructure in the MCMA

<table>
<thead>
<tr>
<th>Type</th>
<th>DF</th>
<th>EM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Roads</td>
<td>198.4 kms (67% controlled access)</td>
<td>352 kms highways</td>
</tr>
<tr>
<td>“Ejes” Viales</td>
<td>310 kms</td>
<td>47 kms (Vías Rápidas Urbanas)</td>
</tr>
<tr>
<td>Principal Roads</td>
<td>552.5 kms</td>
<td>616 kms</td>
</tr>
<tr>
<td>Secondary Roads</td>
<td>8,000 kms (8150)</td>
<td>250 kms</td>
</tr>
<tr>
<td>Metro</td>
<td>178 kms</td>
<td>-</td>
</tr>
<tr>
<td>Trolleybus</td>
<td>377 kms</td>
<td>-</td>
</tr>
<tr>
<td>Light Rail</td>
<td>26 kms (13 in each direction)</td>
<td>-</td>
</tr>
<tr>
<td>Parking spaces</td>
<td>126,257 spaces (10,000 lots)</td>
<td>-</td>
</tr>
<tr>
<td>Traffic Signals</td>
<td>1,973 electronic</td>
<td>298</td>
</tr>
<tr>
<td></td>
<td>870 computerized, 58 mechanical</td>
<td></td>
</tr>
<tr>
<td>Bus shelters</td>
<td>2,347</td>
<td>290</td>
</tr>
<tr>
<td>Contraflow lanes</td>
<td>13 lanes</td>
<td>186 kms</td>
</tr>
<tr>
<td>Parking Meters</td>
<td>1,535</td>
<td></td>
</tr>
</tbody>
</table>


**Level of Service**

As part of the development of the COMETRAVI reports, a consultant team conducted field surveys of 30 major intersections and 14 principal travel corridors to estimate levels of service. Seventy-three percent of the intersections had serious traffic delays during peak travel times. The average delay at these intersections ranged from 85 to 180 seconds. At a corridor level (based on travel speeds during peak period), the levels of service are, in general, more acceptable; only 2 of 14 corridors analyzed had poor levels of service.

**Parking**

Of an estimated (1994) 3.6 million parking spaces in the MCMA, 39% are on the street, 5% are in publicly owned lots and buildings and 56% are in privately owned lots and buildings. Of the latter, most are at residences. While there does not seem to be an overall shortage of parking supply in the city, there are discrete points of deficit, particularly in the downtown areas of the DF. In the DF, the estimated parking deficit – primarily due to work and commercial trips – equals approximately 56% of the total amount of paid parking available in the DF. Except in some of the dense center city areas, parking fees have generally not been high enough to serve as a disincentive to driving.
Vehicles

Vehicle fleet
Data inconsistencies are present in the records of vehicle fleet size and composition since no metropolitan registration system is in place. In an attempt to reconcile vehicle fleet registrations with the 1994 travel demand survey, the consultants for COMETRAVI provided estimates for vehicle fleets in the DF and the EM. These are shown in Table 6.3. According to these estimates, there are some 3.5 million vehicles in the MCMA. The DF has the great majority (75 – 80%) of all vehicle types in the MCMA, except for trucks, which are roughly split equally between the DF and the EM.

Regardless of the large uncertainties regarding the size, composition and age of the vehicle fleet, the low fleet turnover in the MCMA is evident when 1999 vehicle inspection data is compared to on-road vehicle age distributions from some cities in the United States.

Table 6.3: Estimates of Fleet Size MVMA (1994)

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>DF</th>
<th>EM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses</td>
<td>6,180</td>
<td>2,000</td>
<td>8,180</td>
</tr>
<tr>
<td>Urban</td>
<td>2,800</td>
<td></td>
<td>2,800</td>
</tr>
<tr>
<td>Suburban</td>
<td></td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Other Private</td>
<td>3,380</td>
<td></td>
<td>3,380</td>
</tr>
<tr>
<td>Colectivos</td>
<td>88,500</td>
<td>26,100</td>
<td>114,600</td>
</tr>
<tr>
<td>Microbuses</td>
<td></td>
<td>10,500</td>
<td>10,500</td>
</tr>
<tr>
<td>Combis</td>
<td>88,500</td>
<td>15,600</td>
<td>104,100</td>
</tr>
<tr>
<td>Taxis</td>
<td>21,500</td>
<td>5,000</td>
<td>26,500</td>
</tr>
<tr>
<td>Private Cars</td>
<td>2,262,000</td>
<td>577,000</td>
<td>2,839,000</td>
</tr>
<tr>
<td>Freight Trucks</td>
<td>195,500</td>
<td>184,000</td>
<td>379,500</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>29,000</td>
<td>10,000</td>
<td>39,000</td>
</tr>
<tr>
<td>Vehicles in Transit</td>
<td></td>
<td></td>
<td>165,000</td>
</tr>
<tr>
<td>All Vehicles</td>
<td>2,602,680</td>
<td>804,100</td>
<td>3,571,780</td>
</tr>
</tbody>
</table>

Private Cars
Most references suggest that the automobile fleet in Mexico City has been growing at a rate of 6% per year. However, according to other data, the automobile fleet increased by an average of 10% per year between 1976 and 1996. The estimate of the faster growth rate also claimed that the motorization rate (vehicles/capita) increased by over 5% per year: from approximately 78 autos per 1000 people in 1976 to 91 per 1000 people in 1986 and 166 in 1996.

Taxis
Regarding the number of taxis, COMETRAVI estimates 26,500 taxis registered in the region, 20,000 of which are in the DF. Approximately 8,000 of these are fixed site taxis – i.e., typically operating from a taxi stand. Nonetheless, other estimates place the total number of taxis in the MCMA at 81,000 - 10,000 of which are fixed site taxis. The confusion may result from how colectivos are classified. The higher estimates, from vehicle registration and inspection maintenance databases, do not have a separate classification for colectivos, which have been called “fixed route taxis.”
**Buses**

The bus system in the MCMA has undergone several significant changes since the late 1970s. The historically privately owned and operated bus companies reached the brink of collapse by that point and in 1981, the government of the DF took over all 19 companies operating under its jurisdiction. The state-owned Ruta-100 bus company was created to provide a clean and efficient service, operating at fixed stops, with good maintenance practices, an integrated fare policy, and well-defined routes and hierarchies. However, R-100 fell victim to the dual pressures of labor union demands and the further opening of the public transport market to colectivos/minibuses. It was declared bankrupt in 1995.

Since the demise of R-100, the government has undertaken various efforts to concession out new bus services to the private sector. However, Mexico City has grappled relatively unsuccessfully to date with reviving vibrant private sector participation. The challenges to successful concessioning of bus services come from the ongoing competition from the Colectivo oligopoly and the government’s inability to guarantee a transparent market for potential bus company investors/operators. The bus fleet has shown a precipitous decline over the past 20 years from some 15,000 (split almost equally among DF and EM) in 1976 to a little over 2,500 in 1996 and 825 in 1998 for DF.

Outside of the DF (in the EM), the so-called suburban buses are operated exclusively by the private sector. In general, these services are prohibited from entering the DF (as DF services are also prohibited from crossing into the EM), although recent initiatives under the auspices of COMETRAVI have aimed at developing and approving operation of “Metropolitan Routes,” allowing companies to offer cross-jurisdictional bus services. The suburban buses also provide important feeder services to Metro terminal stations.

**Colectivos**

A convergence of liberalization policy, employment policy, poor management of alternatives (i.e., Ruta-100) and the decaying institutional capacity to handle the transportation demand in the DF led to an explosion of the ‘informal sector’ public transportation system – represented by colectivos or “fixed route collective taxis.” Originally, colectivos were shared sedan taxis (operating on fixed routes); over time the fleet evolved into vans (i.e., 12-seaters) and now

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*Figure 6.6  1999 Taxi Age Distribution in DF from Inspection Maintenance Data*
minibuses (up to 25 seaters). By 2000, in the DF, 84% of colectivos were minibuses with an average age of six years.

In the mid- and late-eighties, expansion of the colectivo network provided a massive employment source and a vast expansion of the network of transportation services. In a rapidly growing metropolis, colectivos —many of which carried a half dozen passengers or less— provided nearly ubiquitous and rapidly responding service. In some cases, bus networks could not respond quickly enough and in other cases it was unmanageable to send buses into unpaved, unplanned roads in areas of irregular development. Thus, colectivos provided access for entire segments of society.

The typical operating structure of colectivo service is the person-vehicle: the individual owner makes micro level decisions regarding vehicle maintenance, drivers, etc. However, larger route operations decisions are made by route associations. Vehicle owners are not necessarily concession owners; concessions are often owned by another layer in the route association hierarchy. In the DF, there are 103 registered routes, operated by some 27,000 vehicles. In the EM, there are 94 registered colectivo companies and 172 route associations. In total, there are an estimated 22,000 kms of total colectivo route coverage in the MCMA, nearly equally split between the EM and the DF. In 1991, approximately 60% of colectivo services passed a Metro station, suggesting that the colectivos provide an important feeder service.

In terms of operations, the structure of the colectivo system has important implications. Due to the atomized, individual ownership, there is significant competition within the market, which produces dangerous driving habits and high accident rates. There is also often poor coordination of vehicle scheduling and frequencies. Furthermore, the lack of formal, technically capable, larger-scale businesses makes it much more difficult for owners to take advantage of scale economies in operations (i.e., maintenance, repairs, replacements, financing) – the subsequent inefficiencies are ultimately passed on to system users in the form of higher fares. Chronic service problems include: failure to obey operating rules, excess supply during off-peak hours, high waiting times (to ensure vehicles filled to capacity) at terminals, and competition among operators. Typically, vehicle operators do not operate under contract, work six-day weeks and 10-hour shifts, without benefits or accident insurance.

The colectivo system is described in greater detail under Annex 11 "Institutional Restrictions to the Implementation of a Public Policy in the Collective Transport of the City of Mexico: The Case of Collective Taxis with Fixed Routes."

Delivery and Freight Vehicles

As shown in Figure 6.7, the Mexican truck fleet is old and the turnover rate is slow. Any measure to reduce emissions from the truck fleet by only introducing new technology in new trucks will take a long time to be effective.
Carga Mercantile uses the right Y-axis, all other classifications use the left Y-axis.

Figure 6.7 Age Distribution of Delivery and Freight Vehicles

Rail Transit

Metro

Since the original construction of three lines in the late sixties, the metro network has grown to nearly 200 kilometers. In the late seventies, President Portillo pushed for a prolonged expansion of the network, at 15 kilometers per year, so that the system would consist of over 400 kilometers by the year 2010. Although opposition from public transport operators in the 1970s and financial crises in the mid-eighties and mid-nineties hampered planned developments, there are now a dozen lines, covering an urban area of approximately 300 km². A key characteristic of the system is the fact that the original three lines (just 1/3 of the network length) carry a majority (65%) of all ridership. These lines have by far the highest peak (and off-peak) ridership levels and in general the most frequent peak and off peak services.

Despite these extensions, the concurrent addition of train units (trains are composed of nine cars), and 20% increase in energy use over the same time period, Metro ridership has remained stagnant and indeed has actually decreased in recent years. Furthermore, as mentioned earlier, Metro mode share has decreased from a peak of 25% in 1983 to below 15% in 1995 (see Figure 6.4). A major reason for the decline in ridership is that while the population of the city is mobile and has expanded further from the urban core, it is far more difficult for the subway to grow. Data from COMETRAVI indicate that the Metro fares covered approximately 50% of operating costs during 1992 – 1993 and the Metro required a subsidy of 37% to cover its operating costs in 1995.

The most recent development has been the creation of two new lines that will enter the EM. The importance of this development highlights a critical feature of looking to major capital investment, such as metro expansion, as an option for emissions reduction. Unlike surface modes such as buses and especially colectivos, it takes a very long time to plan, develop and deploy a new metro route. Because colectivos can respond nearly immediately to new growth patterns, they develop a fast hold on new market sectors. In addition to critical institutional
barriers, this has made it difficult for the metro to reach the rapidly growing residential areas outside of the DF without coordination with other modes. As the experiences of the lines built after the initial three routes indicate, placement of metro service is fundamental to the mode’s future success.

Metro is run by a relatively independent authority – the Collective Transport Service (STC) – under the responsibility of the DF’s SETRAVI. STC apparently has significant autonomy in network planning and evaluation and has done its own travel forecasting exercises for planning purposes. Some Metro critics suggest that the system itself has contributed to urban sprawl, in which case system expansion is undermining its own viability. Others suggest that there has been an overall failure to effectively incorporate land development into Metro line development. These are arguments for putting the Metro planning function into an independent planning authority, overseeing all strategic transportation planning for the region (i.e., COMETRAVI).

Light Rail
The MCMA’s light rail system is a 13 km, one line system with 18 stations. Two cars comprise an individual train. The line runs from the southern terminal station (Tasqueña) of Metro Line 2 south/southeast into the delegación of Xochimilco. The light rail system has undergone slight supply expansion since 1992, with 1 km of line and four cars added to operations. As a result, annual vehicle kilometers of travel have increased by 40% to 1,649 by 1998. Ridership has also increased since 1992, from 6.9 million per year to 15.7 million per year in 1998, a 127% increase. Despite this long term increase, there has been much fluctuation – annual ridership apparently reached 32.3 million in 1996 – suggesting inconsistencies in the source data. According to COMETRAVI, light rail operations require a 60% subsidy to cover operating costs.

Vehicle Activity
Extrapolation of current trends in vehicle activity will lead to unacceptable congestion and huge economic costs. Annual traffic externality costs have been estimated by COMETRAVI at $7 billion dollars. Traffic congestion and accidents are responsible for 85% of the total. However, an accident reporting system is not in place at the metropolitan level for a proper quantification of transport-related accidents.

Failure of the Mexico City public bus system, little or no growth in metro ridership, coupled with the spread of the urban population, have encouraged an explosion of the ‘informal sector’ public transportation system – represented by colectivos. This has resulted in an increase in lower-density public transport traffic. Private automobile ownership has also increased sharply resulting in an overall large increase in low passenger density traffic and causing rapidly growing congestion.

Colectivos are a popular transportation mode because of the many stops that they make to take on and drop off passengers. However, colectivos are more expensive, more hazardous, and less comfortable than other public transport. Frequent stopping and hazardous driving contributes to congestion in Mexico City. Much of the taxis’ driving time is spent looking for passengers. Emission control equipment on colectivos and taxis are not generally well maintained.

Truck traffic in Mexico City contributes to congestion because of vehicle activity and double parking during delivery. Circumferential (bypass) roads around Mexico City do not exist now. As a result heavy-duty trucks that are attempting to go beyond Mexico City must go through the
city. Cargo terminal location is not optimized for traffic and emission minimization. Better cargo terminal placement could encourage heavy-duty trucks to unload cargo for local transportation by smaller trucks with better emission controls.

**Fleet Aging and Turnover**

There is a strong correlation between vehicle age and emissions for two reasons: older vehicles have less sophisticated emission control equipment (the oldest vehicles have no emission control equipment) and the condition of the emission control equipment deteriorates over time and use. Emission standards are set according to emissions per distance traveled. The more a vehicle travels, the more emissions are released.

Emission controls on high use vehicles, taxis and colectivos, are therefore of particular concern. Although taxis and colectivos are supposed to be no more than eight years old, the regulation has not been strictly enforced. Fifteen percent of the taxis and colectivos that were inspected in the DF in 1999 were nine years old or older. Based on inspection and maintenance records for the second inspection in 1999, few taxis were purchased since 1993. To meet the taxi and colectivo age limit regulations, a considerable rejuvenation of the fleet will be required starting next year. Such a program is not likely to happen without some subsidy since taxi and colectivo owners are generally considered by banks to be a high credit risk.

**Vehicle Emission**

For the 1.15 million private automobiles inspected in the DF in the last half of 1999:

- 43% were older than 1991, the year when catalytic converters were first required,
- 30% were 1991-1993 models, equipped with catalytic converters,
- 23% were 1994-1998 models, with computerized control, and
- 4% were 1999 models, equivalent to US Tier 1 standards but without warranty.

In the USA newer model year vehicles are not only built to have lower emissions when first used, their emission deterioration rates have been observed to be much lower. Vehicle emissions standards in Mexico have lagged behind vehicle emission standards in the USA. In Mexico, 1999 vehicle emission standards are equivalent to 1994 vehicles in the USA, and 1994 vehicle emissions standards in Mexico are like 1991 vehicles in the USA. Manufacturer warranties on vehicle equipment affecting emission control systems in light duty vehicles have been in place in the US for many years, and the age limits have been increasing for emission control components. Mexico has no required manufacturer warranties.

The introduction of new vehicles into the Mexico City vehicle fleet was slowed by the 1994 peso crisis. During the early 1990’s, however, private automobiles surged in numbers so that by 1994 the MCMA fleet was 84% private vehicles, 11% freight trucks, and 3% colectivos.
New vehicle technology and improved fuel standards in the 1990’s have reduced on-road emissions. Comparing a remote sensing study in 1991 with one in 2000, the 2000 fleet CO emissions (pounds CO per pound of fuel) are 1/3, and tailpipe HC emissions (pounds HC per pound of fuel) are 1/9 of the 1991 fleet. Comparing the 2000 remote sensing study in Mexico with 1999 remote sensing in three cities in the US shows Mexico City fleet CO is about three times what was seen in the US and HC about 30% higher. Higher emissions than the US in the recently measured Mexico City fleet are not surprising given that the fleet has more older vehicles and the new emission control technology was introduced later in Mexico than in the USA.

<table>
<thead>
<tr>
<th>Year Measured</th>
<th>Mexico City</th>
<th>Mexico City</th>
<th>Riverside, California</th>
<th>Denver, Colorado</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>4.3</td>
<td>1.67</td>
<td>0.55</td>
<td>0.45</td>
</tr>
<tr>
<td>CO%</td>
<td>2100</td>
<td>247</td>
<td>200</td>
<td>130</td>
</tr>
<tr>
<td>HC (ppm)</td>
<td>Not measured</td>
<td>1,330</td>
<td>370</td>
<td>600</td>
</tr>
</tbody>
</table>

One of the sources of uncertainty in the emissions inventory for mobile sources is the proportion of evaporative emissions with compared to tailpipe emissions. Approximately half of the fleet of vehicles in the MCMA does not have controls on evaporative emissions.

Data on trucks in Mexico City is also uncertain. The truck fleet in MCMA is estimated at about ¼ of the truck fleet in Mexico. The truck fleet in Mexico is old and does not turnover rapidly. Twenty-eight percent of the truck fleet is over 15 years old.
Fuel Quality

Gasoline quality in Mexico has improved considerably in the last decade, especially with respect to lead (unleaded first offered in October, 1990, and leaded gasoline no longer produced or sold from September 1997). Diesel quality has been improved also, especially by lowering sulfur content. A comparison of 1998 Mexico City gasoline and diesel fuel quality with USA and European fuels is shown below.

Table 6.6. Fuel Quality Comparison: Reformulated/Oxygenated Gasoline

<table>
<thead>
<tr>
<th></th>
<th>Pemex Magna Mexico City</th>
<th>USA Reformulated</th>
<th>USA California</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aromatics, %v</td>
<td>23</td>
<td>20</td>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>Olefins, %v</td>
<td>9</td>
<td>7</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Benzene, %v</td>
<td>0.9</td>
<td>0.7</td>
<td>0.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Sulfur, ppm</td>
<td>380</td>
<td>160</td>
<td>30</td>
<td>250</td>
</tr>
<tr>
<td>Oxygen, %w</td>
<td>1.6</td>
<td>2.0</td>
<td>2.2</td>
<td>0.6</td>
</tr>
</tbody>
</table>


Table 6.7. Fuel Quality Comparison: Reformulated/Oxygenated Gasoline

<table>
<thead>
<tr>
<th></th>
<th>Pemex Diesel Mexico City</th>
<th>USA East Coast</th>
<th>USA West Coast</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetane Index</td>
<td>55</td>
<td>45</td>
<td>49</td>
<td>51</td>
</tr>
<tr>
<td>Aromatics, %v</td>
<td>26</td>
<td>38</td>
<td>23</td>
<td>40</td>
</tr>
<tr>
<td>Sulfur, ppm</td>
<td>400</td>
<td>320</td>
<td>210</td>
<td>388</td>
</tr>
<tr>
<td>Temperature 90% DFF, C</td>
<td>339</td>
<td>317</td>
<td>310</td>
<td>340</td>
</tr>
</tbody>
</table>

Both Europe and the USA are planning to have considerably lower sulfur levels in gasoline and diesel fuels within the next ten years to enable more sophisticated emission control equipment in trucks and automobiles. Achieving these low sulfur levels from Mexico’s heavy, high sulfur crude oil will require a significant capital investment in refining processes.

A decision on the level to which sulfur should be reduced in Mexican gasoline and diesel fuel is complex. In Mexico the oil company, Pemex, is a national company, so investment in refining capability directly affects available government income. Also, the fraction of the total vehicle emissions that comes from older vehicles is much larger in Mexico than in the US or Europe. Political and financial resources for improving the environment may be better spent on removing older vehicles than on reducing sulfur in fuel to extremely low levels to enable very low emissions from new vehicles.

**Inspection and Maintenance**

The Vehicle Verification Program (VVP) was the first obligatory and massive measure that was applied in the MCMA, starting from 1988, with the specific purpose of reducing the contamination generated by the vehicles in circulation. All the vehicles that circulate in the ZMVM should be verified every six months, according to their terminal number of badge or color of their registration sticker. The owners of a private or company vehicle, have two months of term to verify their vehicle in every biannual period, according to a predefined calendar. The maintenance of the vehicles is the proprietor’s responsibility. The maximum permissible limits of emission have led to stricter measures: a) The vehicular fleet has been modernized. b) The Vehicular Verification Program has been coupled to the program Hoy No Circula. Depending on the model year, the type of fuel and their emission levels, the vehicles can obtain different level of exemptions (made known through the kind of sticker awarded) from the Program. c) Alternative fuels have been introduced for service vehicles; and d) control measures have been introduced to encourage the retrofit of catalytic converters.

**Organization of the System**

The Vehicle Verification Program in the MCMA uses centralized testing stations. Stations are located both in the Federal District and in the EM. Equipment and methodology are the same, but administration is different, since different juridical frameworks govern each. Private vehicles registered in the DF and the EM can be verified in any VerifiCentro in the MCMA. Vehicles of intensive use, such as taxis and colectivos, must be verified where they are registered. As of September 2000, 161 Verificentros are operated in the MCMA, 84 of those were installed in the EM and 77 in the DF.

**Procedures**

The test procedures and the permissible maximum limits of emission are established by the Secretary of Environment, Natural Resources and Fisheries (SEMARNAP) in the federal government. Program requirements have become stricter since the program was started in 1989. Starting with two manual gas analyzers (CO and HC) in 1989, progressively different technologies have been introduced. Currently the VerifiCentros are using ASM dynamometer tests similar to those used in California’s Smog Check II, and measure five gases (CO, HC, NOx, CO2 and O2).
Relevant Statistics of the Program

In the MCMA around three million verifications are carried out each semester. Fluctuations in the number of vehicles inspected exist from one half-year to the next half-year. There are two explanations for these changes: (a) deficiencies in inspection information handling and/or (b) some drivers are avoiding the program. Among other anomalies, it has been observed that the percentage of vehicles verified in Verificentros of the EM that don't have catalytic converter is much bigger that in the DF. On the one hand, this could indicate that a bigger share of the high emitting vehicles is located in the EM. On the other hand, it could also be a sign that many vehicle owners intentionally verify their vehicles in the EM.

As the number of Verificentros in the EM increases, the number of inspections in the DF has diminished and that of the EM has increased. In 1997 - 2,123,545 vehicles were verified in the DF. During the first semester of 2000, this figure went down to 1,407,252, or 34% lower. More than 7000 thousand vehicle owners decided not to verify in the DF, instead they verified in the EM, either for convenience or because it is easier to obtain the verification sticker in the Verificentros of the EM. Data for the number of inspections in the EM is not available.

Figure 6.10. Verifications carried out in the Verificentros of the Federal District by type of Sticker (1998-1999)

Figure 6.11 shows the decrease in the tests in the Verificentros of the Federal District by number and type of vehicle per model year. A disproportionate share of the model years are vehicles equipped with a carburetor and those that found it difficult to pass the verification test with the CAM-97 procedure (ASM or PAS 5024-2540).
Audits and Calibration

VerifiCentros operations are audited through:
- a) Internal Systems of control and surveillance at a distance:
- b) Inspect with an official visit to the VerifiCentros
- c) Voluntary Certifications (ISO-9002).
- d) External Audits.

The vehicular verification is reinforced by checking for visible pollution on the road by the governments of the DF and the EM, the PROFEPA and the Secretary of Communications and Transports coordinately. The targets of this program are trucks and urban and suburban buses. Table 6.8 summarizes the strengths and weaknesses of the Vehicular Verification Program.

Key Trends

The following trends are matters of concern for future development of the Mexico City mobility system:

- Rapid and intensifying dispersion of activities across the MCMA, resulting in new trip patterns/interactions among the DF and EM which the current transportation system does not adequately satisfy;
- Trends in mode share evolution away from high capacity modes towards low capacity modes (colectivos and autos);
- Conflict between colectivo and bus viability, driven by the massive growth in colectivos, political clout of their owners/operators, and subsequent difficulty in successfully concessioning out bus services;
- High levels of subsidies for DF-operated public transport modes (metro, trolleybuses, light rail), combined with stagnant or declining patronage;
Great disparities in infrastructure provision and institutional capacity between the EM and the DF; infrastructure-oriented transportation plans, with a supply expansion focus and apparent failure to account for subsequent trip generation, changes in land use, and air pollutant generation.

Great apparent disparities between the EM and DF in terms of trip-making rates of residents, both currently and in the future;

Related to the previous point, apparent inconsistencies and uncertainties relating to actual trip data (both actual and especially future projections);

Inconsistent data related to vehicle fleet size, growth, and distribution across geographic areas and across end-uses (i.e., colectivo vs. taxi);

Lack of sufficient resources and authority for centralized planning, data collection, and modeling for the MCMA.
Table 6.8. Weaknesses and Strengths of the Program of Vehicular Verification

**Strengths**

**Institutional**
- The Metropolitan Environmental Commission (CAM) assists, it discusses and solves matters of interest among the two entities, DF and EM.
- The governments of the Federal District and of the State of Mexico have created administrative units (area addresses) with personal, team and specific procedures to assist the operational necessities and program administration.

**Regulations**
- A set federal standards and local regulations that give full juridical support to the program.
- The standards have led to more strict emission level requirements for vehicles to pass the tests.

**Developed Infrastructure**
- A network of 161 VerifiCentros distributed geographically, with on-line systems of control, image and homogeneous regulations exists. Capacity, technological, administrative and managerial, are in place to verify vehicles twice a year. This capacity can handle all vehicles that drive inside and through the Valley of Mexico, estimated in near 3.5 million vehicles.
- A network of companies also exists at the local level that can supply equipment and maintain it.

**Weaknesses**

**Unequal Administration and Operation**
- The VerifiCentros of the DF are relatively better equipped and operate better than those of the EM, especially in the municipalities adjacent to the metropolitan area.
- The DF only uses its Ecological Police to enforce the program on the road, while the EM operates surveillance with the traditional body of highway or traffic police.
- The EM VerifiCentros are linked physically and businesswise to vehicle repair shops, which induces corruption.
- The SCT does not have authorized VerifiCentros.
- There is a migration of verifications from the DF to the EM; where there’s evidence that the verification is lax.
- There is no appropriate coordination between the environmental authorities and the police.
- There is no program of social communication on TV and radio that motivates and informs drivers the purpose and regulations for vehicular verification
- There are a network of shops who tune up vehicles prior to the verification whose services are not regulated and they are linked with acts of corruption, adjusting vehicles temporarily to pass the test.
- The administration changes inside the government, with or without changes of political party. This has caused a lack of continuity in the administration and design of the program.

**Technological delay**
- The verification of diesel vehicles is ineffective
- There are no tests for evaporative emissions control systems.
- The software used has not been linked with the registration of cars at local and national level.
- The on-line control centers of the DF and the EM are not interconnected to each other and they don't recover the files of the VerifiCentros automatically.
- The SCT doesn't possess consistent and accessible on-line registrations of its verification activities
- The attention to the public in the VerifiCentros is not always good. There is too much turnover and too little training of personnel in the VerifiCentros.
- There are no plans for the introduction of new support technologies as: dilution tunnels, remote sensors, test of evaporative emissions, detecting of CFC's leakages, I/M 240, as well as dynamic and loaded tests for diesel vehicles.

**Scarce or Null On Road Surveillance**
- There is not an effective detention and sanction to vehicles that don't possess an effective sticker of vehicular verification. In the face of the absence of strict enforcement on the road, many drivers no longer carry get their vehicle tested.
- The diesel vehicles with a federal license plate are the main originators of visible black smoke, however, the SCT doesn't enforce the requirement to not have black smoke.

**Robbery of official stationery (certificates and stickers)**
- So far in the year 2000 there have been registered 29 acts of robbery of stickers that caused 14,048 stickers to be on vehicles without proper testing having been done.
Proposed Policies

In developing policy options for the transportation, mobility and the environment in Mexico City, it is useful to consider the following framework:

Land-use patterns drive transportation demand, both for people and freight. While transportation and mobility are fundamental to economic activity and growth, this same transportation also is a fundamental cause of urban air pollution; indeed, the transportation sector in Mexico City is the largest anthropogenic contributor to the urban air pollution problem. The key question is how one balances the mobility needs of the population of the Mexico City Metropolitan Area (MCMA) with the environmental impacts of transportation activity. We consider this in a situation in which land-use patterns in the MCMA are increasingly spread out, with new population centers arising on the periphery, causing still greater transportation demand.

To address this critical linkage in the environmental issues facing Mexico City, it is important that we consider a number of policy strategies using an integrated policy assessment to ascertain the potential impact of sets of options. Since we expect continuing economic growth in the MCMA, which will drive transport demand still higher, creating a transport system in proper balance with the environment will be a difficult and complex task not achievable through the implementation of any one option, but only through the concerted, integrated implementation of many on a number of dimensions. From a public health risk stand point, the priority is to implement policies able to reduce mainly NOx and PM, which are considered the most important pollutants, as discussed in Chapter 3.
Following are a set of policy areas in which the MCMA can work to create a sustainable transportation/mobility/environmental system. While much is known, much is still clouded by lack of understanding and data of the driving forces, and much research still remains.

1. Fleet Composition and Operations

Mobility is provided by and emissions caused by the variety of fleets operating in the MCMA. Trucks, buses, colectivos, taxis and private cars are the major operating fleets.

When one considers fleets of vehicles, the fact that transportation vehicles can have a negative environmental impact, even if not operated, is important. For example, the evaporative characteristics of cars, even when stationary, need to be considered when one does an analysis of automotive fleets.

Of particular importance are the emissions caused by trucks operating on diesel fuel. Strategies directed to retrofitting those trucks to limit their emissions and also creating incentives to get older trucks off the road can be very valuable. It is worth noting that with the truck fleet, the tension between economic development and mobility is at its strongest. The movement of goods in and around Mexico City is fundamental to economic growth in the region, but the environmental impacts associated with providing freight mobility are high indeed.

Similar strategies can be directed to the bus, colectivo and taxi fleet, as well as the private automobile fleet -- vehicles owned by individuals. Again, strategies directed toward removing the older, higher-polluting vehicles from the region and creating new car standards that will reduce emissions as well will be quite useful. Continued improvement of emission control technology on new vehicles including durability and warranty repair and stronger enforcement of inspection and maintenance regulations will be of great importance.

Indeed, the private automobile is a major cause of air quality issues in Mexico City. Policies directed toward attracting people from those private automobiles toward less polluting modes will be highly leveraged. This directs us to our next major policy option.

2. Public Transportation

Enhancements to public transportation are of fundamental importance.

Here we would include making the colectivo system — a system whose service quality is often high, but whose collateral effects are often negative — more effective. This small-vehicle, high-frequency strategy provides a high-quality of service, valued by the citizens of Mexico City, but also has a negative effect upon congestion. Designing strategies to take advantage of the strong points of the colectivo system, while ameliorating the weak ones is worthwhile.

Developing an effective strategy to improve the performance characteristics of the Metro and the services it offers will be essential as well. Both the above strategies are examples of initiatives that better use what we already have for transportation in Mexico City.

Further, it is important to think more explicitly about intermodal public transportation service
3. Fuels

Air quality impacts of various vehicles are closely tied to the fuels they use. Improvements in the fuel to lower sulfur content and other changes can have an important effect on air quality, even without reductions in vehicle miles traveled.

Pemex has sought $5.8 billion in private investments to modernize its six refineries and boost production. This program has significant potential environmental benefits as well as broader economic benefits for the country. The major goals of the refinery program include: producing better quality and cleaner-burning fuels; reducing imports of gasoline; meeting domestic demand for jet fuel, diesel, gasoline, and other fuels; and increasing the profitability of its refineries.

Further, the development of natural gas as a potential fuel for transportation activity is a strategy worth studying.

4. Infrastructure/Technology

The provision of new infrastructure can have a positive effect on both the environment and transportation/mobility. Again, relating to the impact of trucks on air quality in Mexico City, the provision of infrastructure that would allow trucks simply passing through the city to bypass the congested core of Mexico City would have both congestion reduction impacts as well as air quality impacts.

On the technology side, Intelligent Transportation Systems (ITS) are showing promise around the world in the management of traffic and in congestion reduction. Less expensive and less intrusive than conventional infrastructure, ITS can be helpful in dealing with the transportation and environment issues of Mexico City Metropolitan Area.

One particular application of ITS is pricing as a means for making explicit to drivers the congestion and environmental costs they cause to others (i.e., externalities). By designing and implementing effective pricing mechanisms, demand for motorized trips will be reduced, the need for infrastructure expansion is mitigated, and the urban area is made more compact (in principle). While a difficult strategy to deploy, the MCMA air quality problem offers an ideal platform to introduce such pricing mechanisms to the public and policymakers.

5. Regional Land-Use Strategies

As noted above, the continuing dispersion and absolute growth in the size of the MCMA drive the need for vehicle-miles traveled still higher. The almost totally untrammeled establishment of communities on the periphery creates both mobility and environmental problems. The development of a regionally-scaled planning commission, with strong enforcement capability is fundamental to creating a sustainable transportation/environmental system in the MCMA. We mention this in full recognition of the difficulties in doing so from a political, social and economic perspective. Nonetheless, we should be realistic and recognize that many of the policy strategies noted above may not be effective, without a fundamental change in land-use patterns in the MCMA.
6. Institutions

Transportation and environmental planning are performed by separate organizations. Creating an institutional setting in which organizations can work together to create and deploy viable policy options is crucial. Some of the critical institutional issues are:

a) Transportation and the Environment: A stronger and more effective connection between transportation and environmental planning is important. A regional planning architecture that more effectively links these segments should be developed.

b) Linkages between the DF and EM: Effective institutional connections between the DF and EM is of particular importance in transportation. There are great disparities in infrastructure provision and institutional capacity, and often a literal disconnect between transportation services in the DF and EM.

c) Regulatory: The development of regulatory institutions to properly monitor aspects of the MCMA system, including the politically powerful colectivos, enforcement of inspection and maintenance, etc., is needed.

d) Regional Perspective: As noted in 5) above, institutions capable of deploying regionally-scaled land-use plans are critical.

e) A regional vehicle registration database is considered an essential condition and tool for an appropriate and integrated transport air quality management.

Conclusion

The six areas of policy options outlined above create a web of opportunities for enhancing mobility while improving environmental impact due to transportation systems. As emphasized above, doing so in the context of an integrated policy assessment is of fundamental importance. The main recommendation here is to perform such an analysis, building on studies of individual options described in the report.

The set of options must consider both short-term and long-term effects on the transportation/environmental system and, of course, it is important to consider the cost-effectiveness of the various strategies and the differential impacts on various stakeholders in the MCMA.

Next Steps

A next research step is essential. The development of high-level models can help researchers and policymakers identify and analyze strategies for enhancing the environment in Mexico City while retaining transportation mobility. We envision here straightforward spreadsheet models, which will allow sensitivity analyses to be performed that will give first-order estimates of transportation and environmental impacts of various strategies, both short- and long-term.

We emphasize that we do not here suggest a detailed supply-demand equilibrium network model, but rather, a first-order model that can put valuable evaluative tools in the hands of researchers and policymakers. These models would be developed within the context of the integrated assessment approach already begun by the research team.
Such models would require accurate data if useful policy is to be developed. The study team has been hampered by the difficulties in obtaining useful, accurate and consistent data. Redoubled efforts to obtain such data will be needed.

To close, we emphasize several areas worthy of particular attention:

- **Trucks**: Trucks have profound impact on environmental problems and also are of fundamental economic importance. Strategies directing to retrofitting and modernizing the truck fleet, and providing infrastructure such that bypassing the city center is viable are useful strategies to consider.

- **Automobiles**: The continued motorization of the MCMA is a fundamental issue. Efforts to improve the composition of the fleet from an emission perspective (new car standards, inspection and maintenance, enforcement) are all vital, as are providing non-private car options.

- **Public Transportation**: The enhancement of public transportation services -- colectivos, buses, the metro -- as a mechanism for attracting more ridership and limiting private car use, is a basic and useful strategy. Making the systems we have in place more effective is a reasonable strategy. Improving safety and security on public transport systems and park-and-ride parking lots is essential to attract people out of automobiles and into the public transport system. Surveys of public transport riders and potential riders should be done to learn reasons how public transport mode share can be increased and made more agreeable to its user population.

- **Regional Strategies for Land-Use Planning**: Both mobility and environmental issues are driven by the increasing dispersion of the MCMA. As population grows in absolute terms and specifically at the periphery of the region, a long-term strategy to control untrammeled land use is of basic importance.

- **Inspection and Maintenance**: In order to increase the detection efficiency and control of polluting vehicles, it is necessary to introduce new technologies in the test procedures for the detection of vehicles in the VerifiCentros as well as testing high polluting vehicles on the road. The following actions should be considered: a) regular use of remote sensors to audit the Program; b) introduction of dynamic tests with load for diesel vehicles; c) introduction of tests to monitor the evaporative emission control systems and detect fuel leaks.

  Further, in order to reach better levels of efficiency, the Vehicle Verification Program should be adopted and integrated in its stricter regulations by the three entities responsible for the vehicle fleet in circulation in the MCMA, including the Federal District, the State of Mexico and the Secretariat of Communications and Transports (SCT). It is advisable for the adjacent states with the MCMA, including Hidalgo, Puebla and Morelos, to adopt the same system.

  Considering how complex it may be to accomplish this integration, the following are the more relevant recommendations in the medium term:

  a) Full homogenization of DF, EM and SCT Verificentros management or separation of emission inspection according to registration plates;
b) Implementation of dynamic diesel emission testing at VerifiCentros, specially for those vehicles with federal registration plates;

c) Integration of the Technical Revision of public transport and cargo vehicles to the VerifiCentros, to enhance compliance with both environmental and safety regulations;

d) Implementation of periodic, independent and public audits;

e) Integration of the on-line system of the Verification Program with the registration system of motor vehicles, to enhance compliance level and security against robbery of vehicles and stickers showing a vehicle passed its tests;

f) Centralization of data collection and processing of emission inspection data. The State governments of Mexico and of the Federal District should share and to merge their respective databases.