

## MEXICO CITY'S FIGHT AGAINST AIR POLLUTANTS. A WAR WITHOUT END

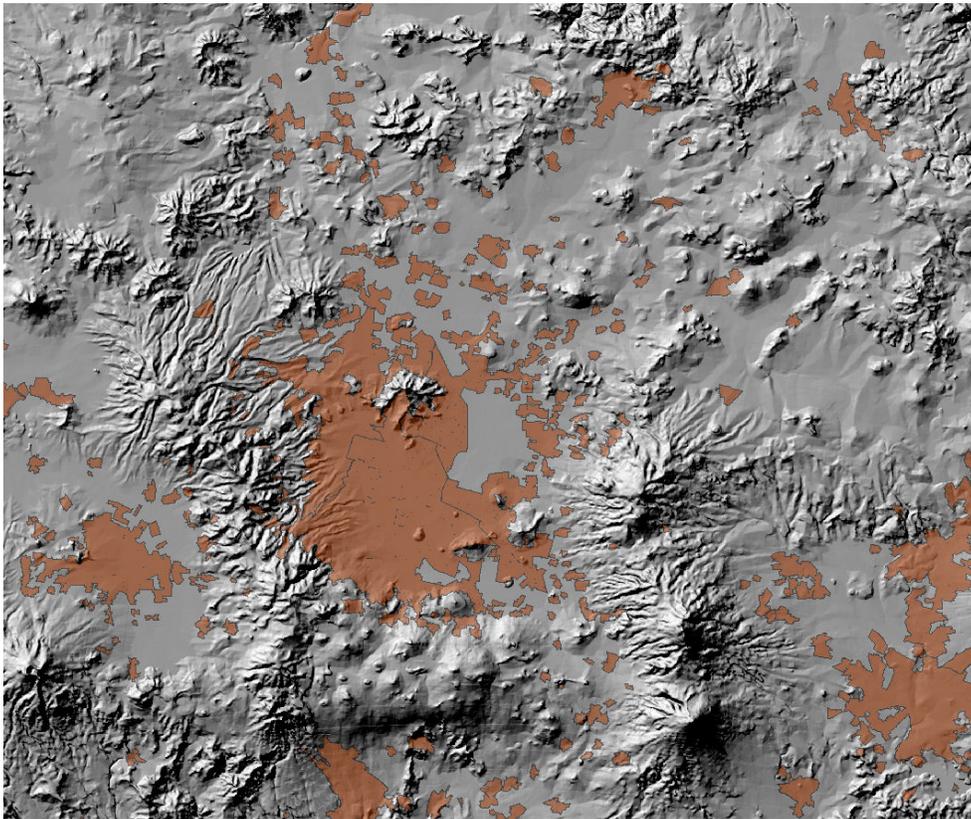
### INTRODUCTION

In 2008 the population of Mexico City was estimated in 19.6 million, covering an area of 1554 km<sup>2</sup>. and a density of 135 inhabitants per hectare. Located in a valley surrounded by mountains with an average altitude of 2150 meters (ASL)

Because of the direction of high winds, solar radiation, 3.6 million vehicles, fuel quality, physical infrastructure of streets and avenues and being an enclosed territory, the **air pollution is a major problem.**

In this City, every year more than 2.5 million tons of pollutants are emitted to the air, 84% incited by motor vehicles and as a consequence 6 out of 10 days some pollutant is higher than the standard established to prevent damage to human health, this causing enormous cost in public health derived from respiratory ailments of susceptible groups of the population.

### MEXICO CITY INSIDE THE VALLEY OF MEXICO



SOURCE: *Instituto de Ingenieria. UNAM*

In 1985 this problem was very severe, therefore, many people thought Mexico City had no future unless pollutants such as lead, sulphur, carbon dioxide and others could be controled at levels that did not represent a danger to, the health of people and animals.

In response to this urban crisis, the authorities of the City fostered a long term strategy to cope with air pollution. Different programs were implemented, being the most significant:

1. ATMOSPHERIC MONITORING SYSTEM..
2. ONE DAY A WEEK NON CIRCULATION PROGRAM.
3. VEHICULAR VERIFICATION PROGRAM
4. METRO MODERNISATION AND CONSTRUCTION PROGRAM
5. A METROBUS SYSTEM
6. RENOVATION AVENUES TO PREVENT TRAFFIC CONGESTIONS
7. NATIONAL PRODUCTION AND IMPORTATION OF GASOLINE FREE FROM LEAD
8. THE RENOVATION OF VEHICLES THROUGH AN EXTENSIVE POLICY OF BANK LOANS AND NATIONAL CAR PRODUCTION PRIVILEGING FOUR VALVE MOTORS.

In this paper is presented how the authorities of Mexico City in conjunction with its citizens cope with this problem.

## **MEXICO CITY'S ATMOSPHERIC MONITORING SYSTEM (SIMAT).2007**

### ***AIR POLLUTANTS***

Air pollutants are classified in CRITERIO POLLUTANTS and NON CRITERIO POLLUTANTS, the firsts are considered obnoxious to human and animal health. Its name was given after the result of various evaluations regarding air pollution published in the United States of America. The objective of these classifications is to establish permissible levels to protect human and animal health and for the preservation of environment. Nowadays CRITERIO POLLUTANTS adopted by many countries are: (NO<sub>2</sub>) Nitrogen Dioxide, (O<sub>3</sub>) Ozone, (CO) Carbon monoxide, (SO<sub>2</sub>) Sulphur Dioxide, (PM) Suspended particles and (Pb) Lead.

MEXICO CITY'S ATMOSPHERIC MONITORING SYSTEM was initiated in 1966, with 4 stations located in different sites of the city to measure sulphur dioxide and suspended particles in the air with diameters superior to 10 micros.

Nowadays this system is integrated by 4 operative subsystems: a) The Automated Monitoring Atmospheric Net (RAMA); b) The Manual Monitoring Atmospheric Net (REDMA); c) The Meteorology Net (REDMET) and d) The Deposit Atmospheric Net (REDDA), with an additional Mobil Monitoring Atmospheric Unity.

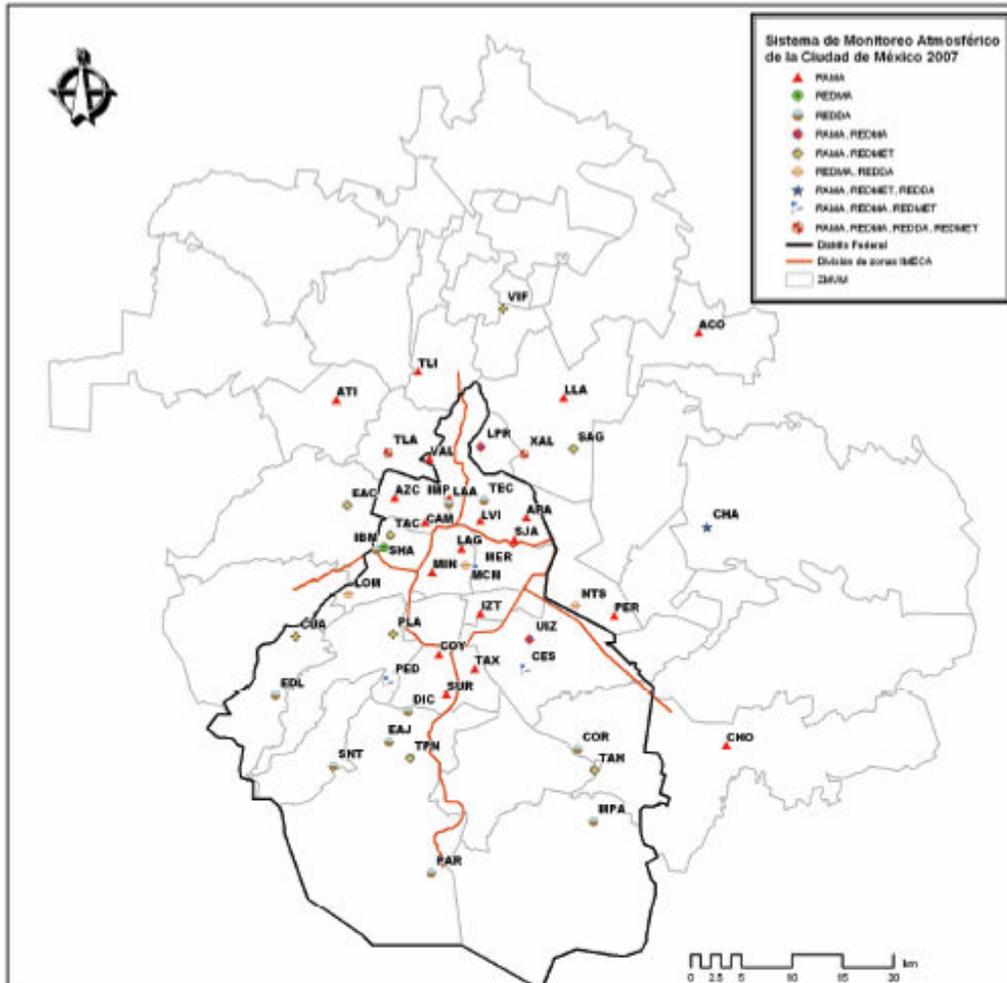
RAMA is composed of 36 remote stations, 24 located in the Federal District and the rest in the conurbated municipalities of the State Of Mexico. These stations measure in a continuous fashion quantities of CO, SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub> y PM<sub>2.5</sub> in the air. Measures of PM<sub>2.5</sub> started in 2003 in 8 stations.

### ***IMECA***

The Metropolitan Quality Air Index (IMECA), is design to inform each hour, the condition of Mexico City's air. If the IMECA is higher than 100 points, it means that the health of its inhabitants is at risk.

IMECA is calculated with measurements of O<sub>3</sub>, NO<sub>2</sub>, CO, SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and considering what is defined on the Environmental Technical Norm for the Federal District (NADF-009-AIRE, 2006), its values and colors are related to recommendations in relation to outdoor activities.

**AIR MONITORING STATIONS IN THE MEXICO CITY METROPOLITAN AREA**



**SOURCE: Secretaría de Medio Ambiente del D.F.**

The evolution of this IMECA Index from 1990 to 2007 is shown in the following chart.

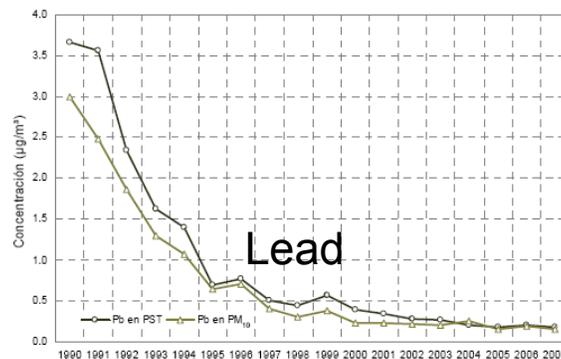
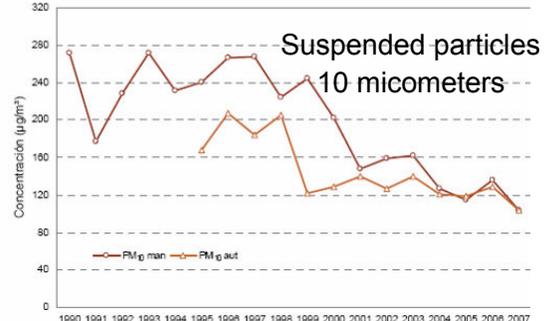
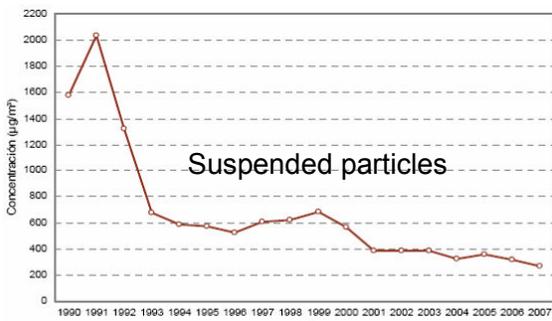
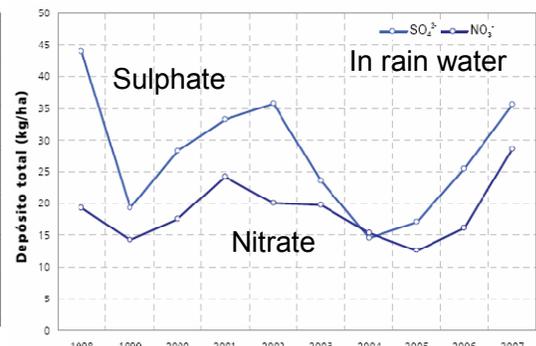
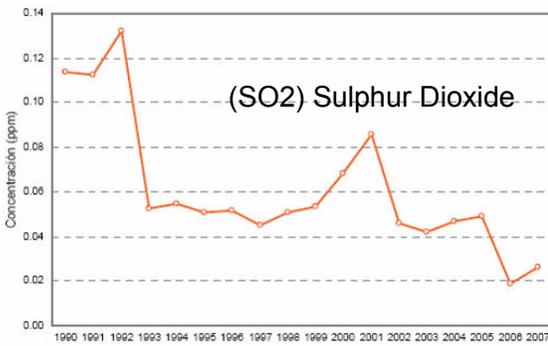
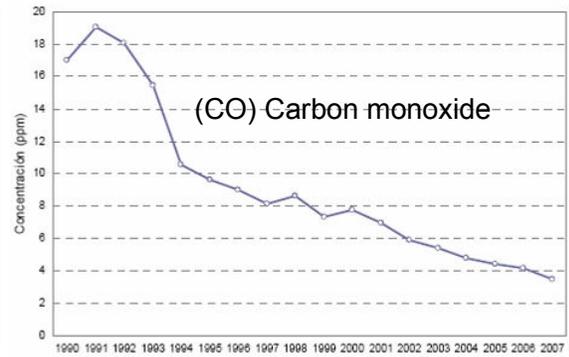
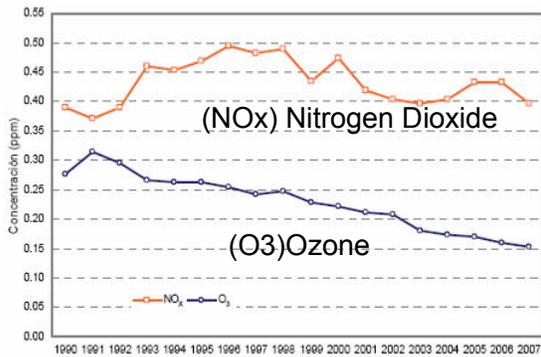
**NUMBER OF DAYS WITH IMECA VALUES HIGHER THAN 100 POINTS**

|                              |                   | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|------------------------------|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| O <sub>3</sub> <sup>13</sup> | No de días        | 328  | 353  | 332  | 324  | 344  | 324  | 327  | 322  | 320  | 300  | 323  | 296  | 300  | 285  | 237  | 233  | 214  | 220  |
|                              | Promedio de horas | 5    | 7    | 6    | 5    | 5    | 5    | 5    | 4    | 5    | 4    | 4    | 4    | 4    | 3    | 2    | 2    | 2    | 2    |
| NO <sub>2</sub>              | No de días        | 29   | 13   | 8    | 28   | 27   | 34   | 80   | 36   | 29   | 18   | 23   | 1    | 0    | 5    | 3    | 3    | 1    | 0    |
| CO                           | No de días        | 29   | 81   | 26   | 2    | 0    | 5    | 7    | 1    | 5    | 2    | 2    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| SO <sub>2</sub>              | No de días        | 4    | 2    | 15   | 0    | 0    | 0    | 2    | 0    | 0    | 0    | 7    | 17   | 3    | 0    | 0    | 0    | 0    | 0    |
| PM <sub>10</sub>             | No de días        | ---  | ---  | ---  | ---  | ---  | 92   | 180  | 153  | 189  | 20   | 45   | 49   | 19   | 56   | 16   | 17   | 36   | 35   |
| PM <sub>2.5</sub>            | No de días        | ---  | ---  | ---  | ---  | ---  | ---  | ---  | ---  | ---  | ---  | ---  | ---  | ---  | 67   | 182  | 192  | 156  | 138  |

**SOURCE: Secretaría de Medio Ambiente del D.F.**

In terms of pollutants the trends are as follows:

**MEXICO CITY: AIR POLLUTANTS CONCENTRATION TRENDS, (90 Percentil). 1990-2007**



**SOURCE: Secretaría de Medio Ambiente del D.F.**

Lead is a pollutant resulting from the fuel used in vehicles, since this product is not consumed in the combustion process it is emitted to the air in the form of "particulated" material.

One of the greatest successes in the last two decades has been the reduction of lead in the air in Mexico City thanks to the substitution of gasoline with lead to those without it; nevertheless, this achievement in ecological terms has obligated the Nation to import great amounts of gasoline mainly from the United States of America and contributed to a grater imbalance of the deficit concerning international imports and exports.

Considering the results shown in the above graphics, we can conclude that Mexico City has put into practice innovative programs to reduce air pollution.

### **ONE DAY A WEEK NON CIRCULATION PROGRAM**

The objective of the ONE DAY A WEEK NON CIRCULATION PROGRAM (PROGRAMA HOY NO CIRCULA) is to reduce during 5 days of the week 20% of vehicles in the streets. It started in 1989 and restricts the circulation of 20% from Monday to Friday and is implemented according to the terminal number of the plate of each vehicle which is given by the local government.

At the beginning, this program was designed to apply only during the winter, after the rainy season and during contingency days due to thermic inversions which notably increase the pollutants in the air, however, after 1990 the program was established on a permanent basis.

The ONE DAY A WEEK NON CIRCULATION PROGRAM, is based on a compulsory biannual checking of gas emissions of all vehicles in the City. Only those vehicles passing the test are permitted to circulate six more months, the rest must be repaired and checked once again. This procedure is called "Vehicular Verification".

From 1997 and in order to stimulate the buying of new vehicles with higher fuel efficiency and with integrated catalytic converters, those manufactured after 1993 were considered candidates to extent the one day not circulating restriction, this after a satisfactory verification. The result was that in 2003 just 7.6% of all vehicles stopped one day a week instead of the 20% originally planned.

Vehicles which use liquid gas as fuel as well as those used for emergencies are exempted of this program, however after 8 years of service these vehicles have to comply with the Program the same as all others.

The control of this Program is done with stickers of different colors, pasted in the rear windshield. Those vehicles exempted from this Program will get a "00" (**double cero**) **sticker** meaning they can circulate daily. Vehicles 2007 to 2009 fall in this category being obliged to verification at the acquisition and are exempted for 2 years.

**Sticker "0" (cero)** is given to vehicles no more than 8 years old which pass the verification, being obliged to it every six months and been permitted to circulate 7 days a week.

**Sticker "2" (two)** is designed for vehicles with more than 8 years old and which pass the verification, being obliged to verify every six months and permitted to circulate just 4 working days. All these measures have contributed to develop new technologies for controlling pollutant emissions.

The ONE DAY A WEEK NON CIRCULATION PROGRAM has been modified since 2008, with the inclusion of Saturdays as a non circulation day once a month for vehicles with **sticker "2"**

The color of the stickers is related to the last number of plates and to the day the vehicle can not circulate.

| Day       | Last number of the plate | Sticker color |
|-----------|--------------------------|---------------|
| Monday    | 5 or 6                   | yellow        |
| Thursday  | 7 or 8                   | pink          |
| Wednesday | 3 or 4                   | red           |
| Thursday  | 1 or 2                   | green         |
| Friday    | 9 or 0                   | blue          |

### **VEHICULAR VERIFICATION PROGRAM**

The objective of the **VEHICULAR VERIFICATION PROGRAM**, is to induce the preventive maintenance of motors of all type of vehicles, or in the case of motors which fail to pass the verification test to force their users to repair them if they want to keep these vehicles in circulation.

This Program is highly related with the ONE DAY A WEEK NON CIRCULATION PROGRAM because the stickers mentioned above are administered by this Program, hence it is in constant revision.

This revision is necessary to make the Program safer, trustable and precise in such a way that modifications added to the standards, allow to operate the Program considering criteria regarding the emissions and not because the age of vehicles.

### **METRO SYSTEM PROGRAM**

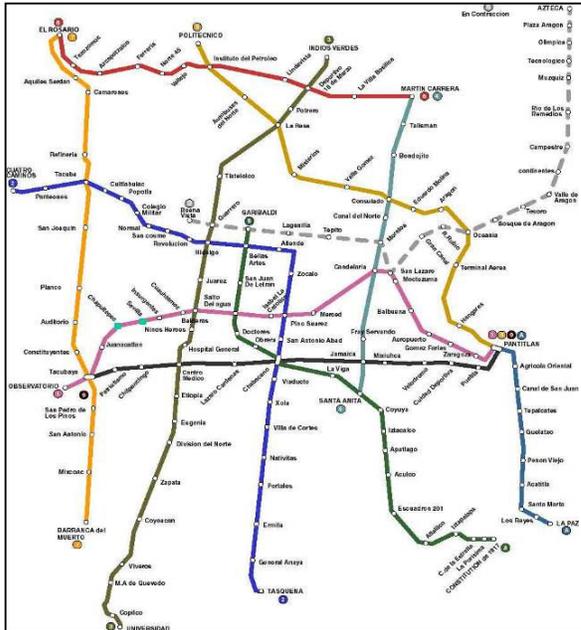
The Mexico City **METRO** was inaugurated September 4, 1969 is a public transport system which gives service to a vast territory of the Federal District and in the last years to some areas of the conurbated municipalities of the State of Mexico. The construction, operation and exploitation of this system is under the direction of a decentralized public enterprise called *Sistema de Transporte Colectivo* (Collective Transport System).

In 2008 it was considered the 3rd in the World in terms of passengers, carrying 4 million a day and 5th in terms of the extension of its routes.

The **METRO** accounts with 11 routes. All its 3 042 cars use pneumatic wheels, except those running on route A which uses iron wheels.

The total extension of the system is 201,4 km (125,14 mi) with 175 stations, 11 of them located in the conurbated municipalities of the State of Mexico, the rest in the Federal District.

Fernando Greene Castillo  
 Mexico City's fight against air pollutants. A war without end  
 45<sup>th</sup> ISOCARP Congress 2009



**SOURCE: Archivo: Mexico City Metro**

This year a new route started construction, named *Linea Bicentenario* to commemorate the bicentenary of the Mexican independence, it is located in the south of the City and will cover 24 Kms. This route will consist of 20 stations and connecting with 4 routes and it is considered that it

would comply with the daily demand of passengers

Future plans for the METRO include the enlargement of 5 existing routes.

**METROBUS SYSTEM PROGRAM**

The **METROBUS** is a bus rapid transit system planned to cover the whole city at a medium term. Its planning, construction, operation and administration, is under the direction of a public decentralized organism named as **METROBUS**.

This System started to be panned on 2003 and initially it contemplated 6 routes with stations each 400 mts, automated prepaid tickets, running in confined lanes and in avenues free from cargo trucks of any kind. It was inaugurated on June 2005

Today the **METROBUS**, consists of 2 routes, each with a distinctive letter and color, covering 48 kms, with 81 stations, 4 of them terminals and 2 of transference, all of them located in the Federal District, one of them crossing the whole city from north to south on the Insurgentes Avenue, the most important located in this entity. The average speed of the **METROBUS** is 40 Km per hour, figure twice the average speed of common public buses.

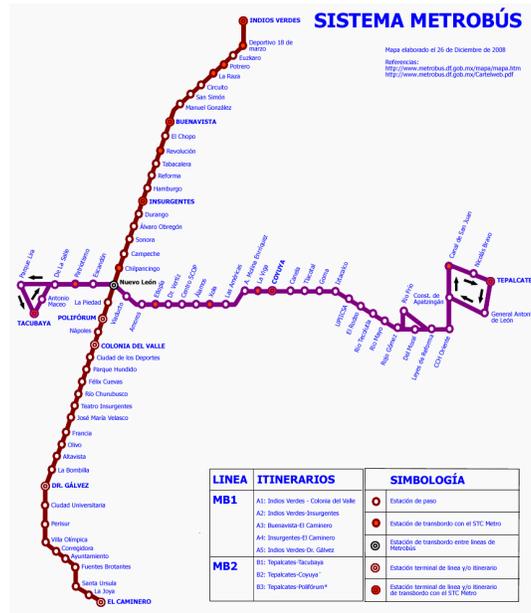


**Metrobus Station**



**Mexico City Metrobus**

**METROBUS SYSTEM**



**SOURCE: Sistema Metrobus**

**RENOVATION OF STREETS AND AVENUES TO PREVENT TRAFFIC CONGESTIONS.**

Since 2001, it was recognized that the main net of roads (avenues) in Mexico City were not enough for the traffic demand. A differentiation was made: a) Main roads (avenues) in which a second floor of lanes, could increase its supply to allow more vehicles to circulate through; b) Roads (avenues) where certain tunnels, bridges, traffic distributors, or any other type of adaptation could increase the traffic efficiency; and, c) New roads, mainly peripheral, in and out the City that detour vehicles from the Central Areas or take care of traffic with destination other than Mexico City.

Considering the above, many actions were taken since 2001 with the following main results:

- Construction of the first phase of the Main Periphery Avenue Second Floor (Periferico), with 6.73 Kms and 6 new lanes.
- Total renovation of the Main Internal Periphery Avenue (Circuito Interior) with 52 Kms. and 10 lanes, these including the construction of 6 new traffic distributors.
- Construction of a detour north of the City (Circuito Mexiquense) with 52 Kms. and 4 lanes.
- Construction of a detour north of the City to avoid entrance of vehicles with destinations different from Mexico City (Circuito Exterior) with 180 Kms. and 4 lanes.

Today in the main Periphery Avenue (Periferico), crossing two of the main conurbated Municipalities of the State of Mexico, a construction of a second floor of 6 lanes is under construction, its first phase to be finished next year with 5.9 Kms. and a second phase of 9 additional kilometers to be finished in 2012.



*Periferico 2d. floor*



*Periferico State of Mexico*

### **THE NATIONAL PRODUCTION AND IMPORTATION OF GASOLINE FREE FROM LEAD**

Catalytic Converters in gasoline motors were introduced in Mexico in 1991, they help to reduce undesirable emissions to the air and one of its characteristics is that they are seriously damaged if the gasoline utilized in the vehicle contains lead tetra ethylic, chemical component utilized to increase octane in gasoline, therefore, the utilization of gasoline free from lead was indispensable.

To deal with this problem, the Mexican Petroleum Company (PEMEX), a state monopoly, introduced 2 new types of gasolines, Pemex Magna and Pemex Premium with 92 and 87 octanes correspondingly.

Because of the constant increase of vehicles in the Country, the gasoline demand passed from 362 thousand to 565 thousand barrels per day from 1990 to 2002, forecasting that in 2010 this demand will rise to 720 thousand barrels per day, this fact compromises Mexico to import annually more than 20% of these products, with a huge amount of money that we pay the United States of America. Mexico City demands approximately 25% of the National total demand.

### **PLANNED FUTURE ACTIONS**

The governments of the Federal District and the State of Mexico, recently signed various agreements to continue with actions to reduce air pollution in the Metropolitan Area of Mexico City, The more important ones are the following:

- The application of the ONE DAY A WEEK NON CIRCULATION PROGRAM on Saturdays.
- The limitation of circulation from Monday to Friday from 05:00 to 11:00, to cars, vans and pick ups with plates from entities other from the Federal District and the State of Mexico, these including foreign plates. If these vehicles display stickers "0" or "00" they are exempt from this requirement that is to say if they are verified and get these stickers. Other vehicles exempt from this requirement are ambulances, fire engines, civil protection vehicles, police cars, funerary hearses, vehicles transporting handicapped people, school buses and vehicles transporting sick parsons.

- The Federal Government on July 2009, started the program for the renovation of vehicles all over the country. This program is directed to vehicles older than 10 years, and it consists in a bonus of one thousand and two hundred American dollars for buying a new vehicle, this, provided that the beneficiary gives up his/her vehicle for destruction.

## **CONCLUSIONS**

1. The air pollution monitoring system is fully established with constant maintenance and working correctly.
2. All the Criterio Pollutants have dramatically declined since the mid 90's, therefore we can assume that the air condition of Mexico City is much better than in the past.
3. Introduction of new gasoline took care of lead and at the present time is practically zero.
4. Considering IMECA day by day, 6 out of 10 days some pollutant is higher than the standard, however on the overall IMECAS are much less now than in the past.
5. The Verification Program and the One a Day None Circulation Program are fully applied and everybody respects them.
6. Mexico City in the last eight years has been provided with many new traffic infrastructures, no doubt this has contributed to make more efficient the traffic conditions.
7. The construction of the Metrobus System and the renovation and extension of the Metro contributes significantly to the reduction of air pollution.

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