A comparative analysis between the I/M programme of Rio de Janeiro and the one in Phoenix

A.A.Abreu & S.K.Ribeiro
Transport Engineering Programme – COPPE – UFRJ – Rio de Janeiro, Brazil

ABSTRACT: Vehicular inspection and maintenance programmes (I/M Programmes) intend to guarantee the proper work of the new technology developed for road vehicles to reduce the growth of emissions of the main air pollutants related to the road transportation sector. This paper presents the main characteristics of an I/M Programme through a comparative analysis between the operation parameters of Rio de Janeiro's I/M Programme and Phoenix's I/M Programme, one of the most important in USA.

RÈSUMÈ: Les programmes d' inspection et manutention de véhicules (programme I/M) a pour objectif garantir le correct fonctionnement de la technologie employeé aux vehicules pour limiter le croissance de l'émission de pollution dû l'usage d'énergie au secteur du transport. Cette communication presente les principaux caractéristiques de un programme I/M et faits une analyse comparatif entre le programme I/M du Rio de Janeiro et le programme I/M de Phoenix: le plus important programme I/M des États Unis

1 INTRODUCTION

As nations develop economically and population rises, the demand for energy, consumption goods, sanitation, housing and transport grows. This growth in energy demand causes an increase in fossil fuel consumption, which accounts for most of the total of different pollutants in the atmosphere (Lora, 2000).

In transports, fossil fuels are utilized in a variety of forms: be it in building infrastructure, in vehicle production or even in manoeuvring these vehicles through internal combustion engines. With the number of motorized vehicles worldwide growing at a rate of 5% per year, much faster than the world population growth, which is of 2% per year (WHO, 1999), the emission of pollutants that cause great environmental impacts also grows.

Thus the urgent need for the implementation of vehicular emissions reduction and control measures is seen in order to minimize the costs generated by the effects of pollution on the environment and on the health of the population. One of these measures is the implementation of inspection and maintenance programmes for automotive vehicles in use (I/M Programmes).

The State of Rio de Janeiro has a distinctive role on a national scale in pollution control of vehicles on use, as it was the first Brazilian state to comply with the resolutions of the National Council of Environment– CONAMA (Conselho Nacional do Meio Ambiente) 18/86 e 07/93 in concerns to the creation and definition of basic directives and emission standards for the implementation of I/M Programmes. On January 30th 1997 the State of Rio de Janeiro, through the implementation of the Pollution Control Plan per Vehicles in Use (PCPV, Plano de Controle da Poluição por Veículos em Uso), put into practice a programme that inspects vehicles focusing on noise and gases emissions, whose directives and standards are firmly based on the I/M Programmes and standards established by the Environment Protection Agency (U.S. EPA).

Before this fact, this article aims to present the main characteristics of an I/M Programme realising a comparative analysis between the I/M Programme in Rio de Janeiro and one of the main I/M Programmes in the United States, the one in Phoenix, Arizona. Such analysis is based on the operational standards of the referred Programmes. This analysis is expected to be able to provide subsidy for an evaluation of the Rio de Janeiro I/M Programme in order to direct the implementation of these programmes in other States.

2 CHARACTERIZATION OF THE I/M PROGRAMMES

The I/M Programmes aim to verify the adequate functioning of the emission control systems of the automotive vehicles. Within the emission control systems more commonly installed in gas engines there is a device in the supply system that allows the re-circulation of the fuel vapours (evaporative emissions) from the crankcase to the air admission, to burn this vapour in the engine itself; a canister with charcoal that absorbs the evaporative emissions of the tank and carburettor; the oxygen drill (λ drill) that controls the air/fuel ratio; catalytic converters that act on the exhaust tube's emissions causing chemical reactions that transform HC and CO into CO_2 and water and NO into N_2. (Peirce et al., 1998).

Nowadays, not just in the developed countries, but also in Brazil and other developing countries, all new vehicles are built complying with restrictive standards of pollutants emission. However it is only possible to maintain this low emissions profile if the emission control systems, as well as the engines, are working properly. An automobile equipped with a modern emission control system that has a broken catalytic converter or an oxygen drill (λ drill) not regulated can have CO emissions twenty or more times higher than supposed to (Faiz *et al*., 1996). Furthermore, even if the automobile's engine or its emission control system is flawless, trough the years they will naturally decay. Therefore, the I/M Programmes intends to certify that the vehicles are keeping "clean" during their utilization periods.

There is also the concern with the vehicles that are currently in use that were built in times where pollutant emission control didn't exist. The percentage of pollutant vehicles increases with age, with 30% of American automobiles with five years of use being excessively pollutants. The same is also true for 50% of the automobiles with seven years of use (half the American fleet in the year 2000 had more than 7 years of use (DOE, 2002)). The identification of such vehicles isn't easy, as in most cases the pollutant emissions aren't visible and don't affect the vehicle's drivability, the implementation of an I/M Programme to identify them becomes necessary, making the user provide the relevant repair in order to pass the re-inspection. According to the World Bank (Faiz *et al*., 1996) the identification of vehicles with maintenance problems, followed by the adequate repair in an I/M Programme can lead to a 30% to 50% reduction of the average emissions.

2.1. Brief history of I/M Programmes

The first I/M Programmes were introduced in the United States in the 70's as an attempt to solve visible emission discrepancies between the certification of new vehicles and the vehicles in use. The Clean Air Act (a federal law that aims to improve the air quality in United States' territory) amendments in 1970 presented the I/M Programmes as an option to improve air quality, but the first Programme wasn't implemented until 1974 in New Jersey.

After a decade of experience with the first I/M Programmes, it became clear that they were only minimally contributing to reduce vehicular emissions (Glazer *et al*., 1995; *apud* Harington *et al*., 2000). In answer to this, the Clean Air Act amendments of 1990 passed the responsibility of developing a new Quality I/M Programme, which should be mandatory in metropolitan regions with air quality vehicular emissions related problems, onto the U. S. EPA (regulated in 1992).

2.2. I/M Programme types

The categorization of I/M Programmes by type is related to the place of inspection and maintenance of the vehicle. The I/M Programmes can be categorized as centralized and decentralized, although a few have mixed characteristics.

All the inspections in the centralized I/M Programmes are carried out in one of the few major inspection centres operated by the government or private operators, hired by the government itself, while repairs are left up to the users to be done in private shops. In these Programmes the inspection centres are built with the purpose of attending a large amount of vehicles, which results in a cost reduction, allowing for the use of more sophisticated equipment and a wider range of procedures. These centres use computerized and automated inspection equipment and procedures that assure the vehicle user orientation and safety. Their subjective decisions are automated, minimizing a potential human error or even a results fraud. Furthermore, the inspection standards as well as the test results are filed in a computer and printed out for the user. Information on the probable cause of the vehicle's failure is also printed out, orienting the mechanic and cutting repair costs. Due to more experience and standard training of the staff, inspections in centralized centres are generally more effective (Faiz *et al*., 1996).

In the decentralized I/M Programmes both the inspections and the failed vehicles' repairs are done in private shops. Even though the private shops are authorized and licensed by the government, they are not run under their direct control. This may present fraud opportunities both for the user (vehicles in conditions to be approved failing so that they can be "fixed") and the government (approval of a vehicle which should fail, in order not to receive fines or simply to lure a client). In an attempt to repress frauds, the decentralized I/M Programmes in the United States adopt emission analysers that incorporate large automization of the inspection process. Furthermore, well run decentralized I/M Programmes incorporate extensive inspection audits, both open and private, in an attempt to turn frauds into a risky activity. Still, frauds and bad inspections are possible and even common. Studies by the U. S. EPA show a rate of over 50% of inadequate inspections in decentralized I/M Programmes (Faiz *et al.*, 1996).

2.3. Inspection procedures

The I/M Programmes in the United States are run according to the national environmental policy implemented by the U.S. EPA. Each State develops it's own State Implementation Plan (*SIP*) that will regulate and apply the policies of the U.S. EPA. According to this environmental policy, the operation of an I/M Programme requires established inspection procedures to be followed by inspection centres. A typical Quality I/M Programme inspection procedure includes pollutant emissions measurement tests in the vehicles' exhaust tube. However evaporative emissions tests as well as visual inspections of the emission control systems and the functional inspection of some of these systems may also be a part of the procedure.

In order for the inspection procedure to contribute to an effective I/M Programme, ideally, the emission tests run in inspections should be defined showing high correlation to the real emissions that occur on the streets. It is also necessary for these tests to have established failing standards (maximum emission standards to be complied with by the vehicles in order not to fail the tests) according to the inspected vehicle's technical capabilities and to the emission standards for which the vehicles were projected. In general, the failing standards are set to various levels so that it accommodates passed, present and future emission control technologies as well as reaching the planned emissions reductions.

2.3.1. Emissions tests for vehicles with otto cycle engines

2.3.1.1 Exhaust tube emissions tests.

For the exhaust tube emissions in vehicles equipped with otto cycle engines, the HC, CO and NO_x emissions are analysed, basically being divided in two types of tests: the slow gear test and the dynamometer test.

The slow gear test, the most utilized in I/M Programmes, is a simple, cheap test that doesn't require sophisticated equipment. As the name demonstrates, it measures the emission concentrations of HC (in ppm) and CO (in percentage) through the exhaust tube while the parked vehicle is running on a slow gear. Additionally, in this same test, the same measurements can be taken under the same conditions but with the engine unloaded at 2500 rpm. An infrared non-dispersible analyser is enough to run the test.

Originally the slow gear test was developed for vehicles with little or no emission control, thus being capable of detecting the vast majority of the badly tuned engines and the ones containing some kind of flaw. Generally theses vehicles are equipped with carburettors or mechanical systems of fuel injection, in which the air-fuel ratio (A/F ratio) in slow gear is equal to the A/F ratio of the engine submitted to loads. This way, the measurements of HC and CO emissions in slow gear and at 2500 rpm present a reasonable indication of the produced emissions in normal operating conditions, in the vehicles with mechanical control system of the A/F ratio.

On the other hand, this test does not show satisfactory results for vehicles equipped with electronic control systems of the A/F ratio (λ drill). Such systems alter the A/F ratio throughout the vehicle's operation. Due to this, a vehicle equipped with λ drill, with low emissions at low gear or at 2500 rpm can, in principle, have unacceptable levels of emissions in other modes of operation. Studies by the U.S. EPA (Pidgeon *et al.*, 1991) prove that such vehicles would be approved in the tests even though they produce high emissions.

Although the slow gear tests are vastly utilized, they present a low correlation between results obtained and emissions measured in real conditions. Furthermore, the slow gear test isn't efficient in NO_x measurements, once significant measurements of these pollutants have to be run with the engine submitted to loads (Samaras, 1997).

The slow gear test may cause two types of errors during an inspection of the I/M Programme: the omission and the delegation errors. The omission error occurs when the inspection approves a vehicle that would definitely fail a more rigorous test, while the delegation error occurs when a vehicle fails without having excess pollutants emission or has a flawless engine. Omission errors reduce the efficiency of I/M Programmes while delegation errors unnecessarily increase the costs to the user, possibly resulting in increased emissions, as while trying to repair the emissions control system the mechanic may damage it.

To effectively control vehicular emissions, it is necessary to evaluate them under real operational conditions. Baring this in mind, the United States elaborated a vehicular emissions control strategy based on tests that measure the emissions while real world like driving conditions are reproduced. Such tests, like the FTP-75, are done with the aid of a dynamometer that simulates the loading of the vehicle and its inertia and are run on the certification of new vehicles. As these are long tests, it isn't possible to utilize them in I/M Programmes. Maintaining the idea of simulating real operational conditions, shorter tests, based on the certification tests, were developed. These tests are divided in two groups: the fixed state and the transients. The fixed state tests are run with the vehicle in motion at a constant speed while in the transient tests the vehicles reach a variety of speeds.

The dynamometer tests were developed for the evaluation of modern vehicles that utilize advanced emission control systems. The total mass, in grams by mile or kilometre, of HC, CO and NO_x are measured in theses tests, through the capture of exhaustion gases current, as the vehicles in them are submitted to loads. This type of measurement is the most accurate in vehicle emission performance evaluation.

A type of fixed state test commonly used in the United Sates is the ASM 5015 acceleration simulation test. Where the vehicle is driven over a dynamometer, which imposes it a load, at 15 miles per hour (24 km/h). The ASM 5015 test shows a reasonable correlation with the FTP test, effectively identifying vehicles with high NO_x emissions (Faiz *et al.*, 1996).

The most advanced transient test used in the I/M Programmes is the IM240 test developed in the United States in 1989 by the U.S. EPA. The IM240 test is based on the first 240 seconds of the FTP-75 test, being divided in two phases: the phase I with 93 seconds and phase II 147 seconds long. The IM240 test is run with the vehicle being driven over a dynamometer so that it stays on one spot. The vehicle is operated by an inspector following a driving cycle (showed in a video monitor in front of him) that simulates real operational conditions in urban centres. In other words, accelerating and decelerating the vehicle applying different speeds. A cursor showed on the video monitor indicates the vehicle speed and the inspector adjusts it so that the cursor is kept on the cycle's line. (U.S. EPA, 1994).

The IM240 test requires a more sophisticated and expensive test equipment, different to the one used in the slow gear and fixed state tests. In these tests, the pollutant emissions mass is determined by collecting all the exhaust gases' flux released by the exhaust tube. The flux is collected by a device known as Constant Volume Sampler that dilutes the exhaustion with fresh air thus reaching the official test results in grams per mile (U.S. EPA, 1994).

The IM240 test is about three times more accurate than the slow gear test in identifying vehicles that exceed the emission limits, drastically reducing the omission and delegation errors (Faiz *et al.*, 1996).

Another short test based on the FTP test is the IM147 test. This test comprises of nothing more than phase II of the IM240 test (147 seconds long) repeated three times in a row. In the year 2000 the Arizona Department of Environmental Quality (ADEQ) proposed the use of this test as an alternative to the IM240 test run at the Metropolitan Region of Phoenix Arizona that was constantly failing the limits of air quality.

2.3.1.2. Evaporative emissions tests.

Evaporative emissions account for half the total amount of vehicular HC emission. Two common flaws in the system that controls this type of emission are vapour leaks from the fuel tank and malfunctioning of the charcoal recipients that absorb the evaporative emissions of the tank and carburettor. The U.S. EPA has specified a functional test of the charcoal recipient and a pressure test to verify vapour leaks to be applied in I/M Programmes along with the dynamometer tests. As very few vehicles are programmed to have evaporative emissions absorbed in slow gear and at 2500 rpm there is no way to check the proper functioning of the absorption systems of such emissions in slow gear tests (Faiz *et al.*, 1996).

Since 1971, the automobiles' fuel tanks have been designed as a closed system in which the fuel vapours can't escape into the atmosphere. The system is sealed and pressurized so that the excess vapour is conducted to an active coal recipient. The active coal recipient test is used to determine whether the vapours from the fuel tank stored in the active coal recipient, are being properly conducted to the engine where they'll burn. If the system as a whole has any flaw, the active coal recipient may become saturated and release hydro carbonates into the atmosphere (U.S. EPA, 2001a).

While the pressure test checks all the fuel tank's closed system for leaks that allow fuel vapours out to the atmosphere. A pressure drop method is used to monitor system pressure loss (U.S. EPA, 2001a).

2.3.2. Emission tests for diesel cycle engines

Generally, tests run in diesel cycle engine vehicles inspection focus on smoke emission. The smoke may be measured in a variety of ways, including partial and complete flux opaque meters. The partial and complete flux opaque meters collect a continuous sample of exhaustion gases and lead them to a chamber where the light ray that cuts through it is measured.

In order for the diesel vehicles' smoke measurements to be significant, the smoke measurements of diesel vehicles must be taken with the engine submitted to great loads. With the vehicles submitted to small loads and in slow gear, the smoke levels are too low and may cover up polluting vehicles. A technique that is widely utilized for loading the engine until reaching a significant smoke level is the so-called free acceleration test. This test loads the engine with it's own inertia as the engine is accelerated (without being in gear) from slow gear up to the maximum engine rotation (full engine) and then is decelerated until it operates back in slow gear (Faiz et al., 1996).

2.3.3. Complementary inspection systems

The 1990 *Clean Air Act* amendments requested for the I/M Programmes to include inspection on the roadways while the vehicles were circulating. The U.S. EPA in 1992 answered requesting shoulder tests and remote sensor inspections besides the periodic inspections conducted in inspection centres (U.S. EPA, 2002b).

In 1996 the U.S. EPA went further, demanding on board diagnosis (OBD) system inspection in the Quality I/M Programmes. The aim of an OBD system is to diagnose and identify pollutant emissions related faults in vehicles equipped with sophisticated electronic systems of engine control. The U.S. EPA regulations require the vehicle's on board computer to be able to detect efficiency loss or flaws in the main emission control equipments and in all computer connected controllers and sensors. The OBD system must also be able to detect ignition flaws (one of the most common causes of faults in catalytic converters).

When any fault is detected the OBD system activates an internal fault code that lights a specific indicative lamp for each equipment, alerting the driver so that the vehicle can be properly repaired. As the OBD system monitors the engine and emission control equipments working under all possible driving conditions, it is capable of covering a much wider variety of checks than any I/M Programme test.

The I/M Programme OBD system inspection consists of two exam types: a visual inspection of the control panel fault indication lamps, and an electronic exam of the on board computer.

3 COMPARATIVE ANALYSIS OF THE RIO DE JANEIRO AND PHOENIX I/M PROGRAMMES

The I/M Programme in Phoenix Arizona started in January 1995, as one of the first Quality I/M Programmes implemented in the United States. This Programme is considered the State of Arizona Government's main strategy to reduce vehicular pollutant emissions and consequently improve the air quality of the Phoenix Metropolitan Region. While the State of Rio de Janeiro's I/M Programme, which is run since July of 1997, is still to this day in its initial stages, with pollutant measurements realized only as an educational procedure.

The comparative analysis between the Rio de Janeiro and Phoenix I/M Programmes in this article is based on a few parameters that characterize their operations. Such parameters are described below, presenting the peculiar characteristics of each of the I/M Programmes analysed. The main parameters to be highlighted are:

- The type of I/M Programme;
- The type of vehicles and model-years covered by the Programme;
- The inspection frequency;
- The types of escape and evaporative emissions tests;
- The existence, or lack of, of visual inspection and of a complementary inspection system;
- The training, or lack of, of inspectors;
- Exemption percentage;
- Whether or not it is mandatory;
- The method used to ensure participation

An I/M Programme, in terms of type, can be centralized, decentralized or a mixture of both types, as already seen in item 2.2. The Phoenix Programme is centralized and has 13 inspection centres with an inspection tax of US$ 27.00 for light vehicles with model-year from 1981 onwards, US$ 27.50 for heavy diesel vehicles and US$ 18.50 for the other vehicles. The Rio de Janeiro I/M Programme is also centralized and has 19 inspection centres in the Metropolitan Region and another 14 in the countryside with an inspection tax of R$57.45 (approx. US$ 19.50).

As far as vehicles covered, the I/M Programmes should include the vehicles related with the pollutants of most interest to the region they're utilized in. In the case of the Phoenix and Rio de Janeiro I/M Programmes, all kinds of vehicles are inspected. In relation to model-years included by the I/M Programmes, they normally tend to be stipulated according to each region's fleet. The more model-years included the greater the efficiency of the I/M Programme. Phoenix's I/M Programme includes model-years from 1967 until 5 years prior to the current year. While the I/M Programme in Rio de Janeiro includes all model-years with the exception of the current year.

The I/M Programmes, in concerns to inspection frequency, run annual or biannual inspections. Normally, the inspection frequency is determined according to vehicles' type and model-years covered by the I/M Programme. In the Phoenix Programme, all diesel vehicles with model-years covered by the Programme as well as the gas vehicles with model-years from 1967 to 1980 must be annually inspected. While the rest of the vehicles must pass biannual inspections. In Rio de Janeiro all vehicles' inspections are undertaken annually.

As for emissions test types, the Phoenix I/M Programme runs the slow gear and the 2500 rpm tests for gas vehicles of model-years up to 1980, and the IM147 test for the model-years from 1981 onwards (until 1999 the IM240 test was run for these vehicles). For the diesel vehicles the smoke opacity emitted is checked through a complete flux opaque meter in a free acceleration test. In this Programme, the evaporative emissions, the active charcoal recipient and the pressure tests are also run. While Rio de Janeiro's I/M Programme utilizes the slow gear and the 2500 rpm tests for all gas vehicles and the free acceleration smoke test with a partial flux opaque meter for the diesel vehicles. The evaporative emissions tests are not carried out in Rio de Janeiro.

The I/M Programmes can opt on the realization of visual inspections that verify beyond the safety equipment, the emission control equipment. In Phoenix's I/M Programme the presence of the catalytic converter, the gas re-circulation equipment, the PCV valve and the λ drill are checked. In Rio de Janeiro only the safety equipment is checked. Apart from the visual inspections and the conventional emissions tests, the I/M Programme in Phoenix also uses complementary inspection systems, such as the verification of the on board diagnoses (OBD) system, which is only run on light vehicles of model-years from 1996 onwards as well as the remote sensors and shoulder tests. Such complementary inspection systems are not utilized in the Rio de Janeiro Programme.

As for training, in the Phoenix I/M Programme all inspectors receive training involving knowledge on: atmospheric pollution, it's causes and effects; the purposes and objectives of the Programme; the Programme's regulations and procedures; the technical details of the applied tests; the functioning of the vehicle's emission control equipment; and on operation, calibration and maintenance of equipments utilized in inspections. In the Rio de Janeiro Programme all employees are also duly trained by the Estate Environmental Foundation (FEEMA, Fundação Estadual do Meio Ambiente). FEEMA's training, a course taught by technicians especialized in vehicles, aims to supply skillfull handling of all equipment necessary to the realization of pollutant emissions tests and to present the basics on air pollution, informing of the various types of atmospheric pollutants, how to measure them and their respective established limits.

The I/M Programmes can exempt some vehicles from the realization of emissions tests. These exemptions occur due to the necessary repair cost, as a way to approve the vehicle owner in the I/M Programme even though the established emission standards weren't met. In the Phoenix Programme such exemptions are only given after the vehicle fails a re-inspection conducted after all necessary repairs are made according to the cause of the failure. In order to obtain exemption it is necessary for the owner of the vehicle to have spent in repairs a value equal to or higher than the estipulated by the I/M Programme as the exemption limit of US$500.00 for heavy vehicles, US$450.00 for vehicles of model-years from 1980 onwards, US$300.00 for vehicles of model-years from 1975 to 1979 and US$200.00 for older vehicles. The exemptions, which cannot be given out to vehicles that have suffered any type of adulteration to the emission control equipments, are only valid for test cycles and cannot exceed the maximum percentage of 3%, of the initial reprovals (U.S. EPA, 2001a). Rio de Janeiro's Programme does not give out such exemptions.

The I/M Programmes can be mandatory or voluntary according to the legislation in force and to the respective region's air quality. The I/M Programme's efficiency relies heavily on the participance of its respective vehicle owners. To ensure the highest participance possible, the I/M Programmes tend to be linked with the vehicle's registration. In Phoenix's case, the I/M Programme is mandatory and the Programme's minimum participance percentage is 96%. To ensure this minimum percentage the State Government determines that the registration renewal for a vehicle in use can only be done if the vehicle is up to date with the inspection. A calendar of inspections (annual or biannual) that clearly determines the time of which the vehicle is to be inspected is the State's responsibility. First the inspection is realized so that afterwards, with the inspections certificate, the owner may register the vehicle. Furthermore, vehicles with outdated inspections are fined as well as being obligated to register the vehicle in the region where it is utilized.

Rio de Janeiro's I/M Programme is linked to the annual licensing of the vehicles. The inspection is mandatory and happens at the time of the license renewal. Even though it's mandatory, only the safety items' checkup can fail the vehicle refraining it from obtaining the circulation license until it complies with all demands. If the vehicle fails the gases emissions check-up the vehicle still gets the above mentioned license, as the I/M Programme is still in educational stage and doesn't inflict any penalties. There will however, be an observation in the license that the vehicle failed the gas emissions test.

4 CONCLUSION

The environmental problems generated by vehicular emissions have reached a new dimension in world reality throughout the last few years. In this new context, the vehicular emissions occupy a distinctive position in the life of ordinary citizens, the scientists and the governors, of being a reason for everyone, without exception, to worry about.

The adoption of vehicular emissions limits and control measures in Brazil, and above all the implementation of I/M Programmes, shows that our governors have had the preocupation of finding out ways of handling the problem that have had positive results in developed countries, in order to apply them here in a manner that suited the national characteristics of all the involved sectors. Even with all the national effort in fighting the vehicular emissions problem already under way, it is now necessary to intensify them. In order to achieve this, it is necessary for the urban planners and environmental institutions to cooperate in elaborating current transport plans and on future development planning. Also necessary are changes in engine development, a search for always cleaner fuels and a change in the populations behaviour. Only through the awareness of the problem's gravity and the presentation of fair alternatives to the population will the participation of all emission reduction policies be obtained.

Brazil, through the State of Rio de Janeiro, has taken a starting step towards the implentation of I/M Programmes, political will is now needed to continue it's development, maybe even the implementation of a Quality Programme, and for such a Programme to be extended nationwide. It is important for Brazil to stay alert to what is being developed in the field of vehicular emissions, specially in relation to I/M Programmes, around the world and nationally. Through sharing aquired experiences and information, our governors will be able to evaluate the sucess and failure of the many vehicular emissions control measures and adapt to our economic reality those that attend to the need of the country as a whole and to each Brazilian city individually. To propitiate the economic development of our country and the conservation of our environment is the greatest challenge.

REFERENCES

DOE, 2002, *Transportation Energy Data Book - 2002*. Oak Ridge: Oak Ridge National Laboratory.

Faiz, A et al., 1996. *Air Pollution from Motor Vehicles – Standards and Technologies for Controlling Emissions*. Washington: The World Bank.

Harington, W., et al., 2000. Are Vehicle Emission Inspection Programs Living Up to Expectations?. *Transportation Research*, vol 5 D., pp 153-172. Elsevier Science.

Lora, E.E.S., 2000. *Prevenção e Controle da Poluição nos Setores Energético, Industrial e de Transporte*. Brasília: ANEEL.

Peirce, *et al*., 1998. (4 ed) *Environmental Pollution and Control*. Boston.

Pidgeon *et al.*, 1991. *The IM240 Transient I/M Dynamometer Driving Schedule and the Composite I/M Test Procedure*. EPA-AA-TSS-91-1, Washington, D.C.: United States Environmental Protection Agency.

Samaras, Z. ,1997. Inspection and maintenance to reduce emissions of in-use cars: an overview in the European context, *Int. J. of Vehicle Design*, Vol. 18, n. 3 e 4 (Special Issue), pp. 263-279.

U.S. EPA, 1994. *High-Tech Inspection and Maintenance Tests (Procedures and Equipment)*. Fact Sheet OMS 16, Washington, D.C: United States Environmental Protection Agency.

U.S. EPA, 2001a. *I/M Rule – Inspection and Maintenance Program Requirements*. Federal Register Notice, 40 CFR, Part51, Subpart S, Washington, D.C: United States Environmental Protection Agency.

U.S. EPA, 2001b. *I/M Rule – Performing Onboard Diagnostic System*. Report No.EPA420-R-01-015, Washington, D.C: United States Environmental Protection Agency.

WHO, 1999. (1 ed) *Urban Traffic Pollution*. London: World Health Organization, E & FN Spon.