



Mitigation Measures for Vehicles Exhaust Emissions

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ABSTRACT

Motor vehicle emissions have shown to be of hazardous health influences. Its impact is amplified in urban areas such as the Greater Cairo region. It is reported that the number of motor vehicles in Cairo is increasing at a rate of approximately 30,000 per year reaching 1,300,000 vehicles in the year 2000. Consequently, reducing motor vehicle emissions has become a major objective of environmental management activities in Egypt. In this context, Egypt's strategies include adoption of emission standards for new vehicles, enforcing emission standards for in-use vehicles, introducing proper low emissions tune-up techniques for gasoline and diesel powered engines, and encouraging cleaner alternative fuels.

The Ministry of State for Environmental Affairs (MOE) coordinated the apprehension of official approvals from the main and concerned stakeholders to adopt the European Emission Standards (EURO 2) for new vehicles, effective Jan 1, 2002. Accordingly, the Egyptian Environmental Affairs Agency (EEAA) is currently developing the relevant set of emission limits for vehicles licensing and on-road testing.

In order to establish a system for enforcing emission limits, the Government of Egypt (GOE) and the United States of America (USA) are jointly implementing the Cairo Air Improvement Project (CAIP). Among other components, CAIP includes two components namely, implementation of a vehicle emission testing and tune-up program (*VET*); introduction of compressed natural gas (*CNG*)-fueled public buses.

The overall objectives of the CAIP/VET program are to achieve vehicle emissions reduction and improved vehicle fuel efficiency. The VET program will employ an officially licensed network of test-only facilities strategically located throughout Greater Cairo region, in order to provide convenient emissions testing for vehicle owners. The facilities will be operated by private sector contractor(s) selected by the GOE. In advance of constructing the testing network, CAIP/VET has designed an On-Road Testing program for Vehicles (ORT) and for motorcycles (MORT). Forty thousand (40,000)

vehicles have been tested, and the compliance rate with the existing GOE emissions standards is in the order of 63%. On the other hand, more than 2,000 motorcycles were tested as of June 1999, providing a factual insight on the proper mitigation measures to reduce emissions from two-stroke engines.

The Inspection and Maintenance of Transit Buses (IMTB) is another initiative aimed mitigating the PM content of exhaust emissions of transit buses in the Greater Cairo region. The IMTB program is jointly implemented with Cairo Transport Authority (CTA) and the Greater Cairo Bus Company (GCBC). The program shall ultimately contribute to better-tuned diesel transit busses. Baseline Data Collection is being concluded with 3800 transit buses/mini-buses tested.

1. INTRODUCTION

The Government of Egypt under its ambitious leadership has managed to apprehend significant economic growth and development over the past years to be acknowledged by several international organizations as one of the fastest growing economies in the region. The country's development is a direct function of its emphasis on social and economic advancement through efficient management and allocation of both human and natural resources.

Accordingly, the demand on means of transportation has increased in the last 10 years. The GOE strategic plan for improving air quality includes several approaches aiming at the reduction of air pollution through regulating exhaust emissions. In this context, Cairo Air Improvement Project was launched. CAIP is funded and supported by the Ministry of Environment, the Egyptian Environmental Affairs Agency (EEAA), the Ministry of Petroleum Office of Energy Planning (OEP), the Governorates of Greater Cairo and the United States Agency for International Development (USAID). The aim of this project is to characterize and reduce air pollution in the Greater Cairo region. The project includes five components working to reach this goal; Vehicle Emission Testing and Tune-up program (VET); introduction of compressed natural gas (CNG)-fueled public buses; relocation and upgrading of secondary lead smelters (LPA); particulate matter and lead monitoring (AQM); and campaigns to increase public awareness (PACP).

The VET, CNG and IMTB activities of CAIP are the most relevant to GOE approaches to mitigating mobile source emissions.

2. EMISSIONS REGULATIONS FOR NEW VEHICLES

Recent studies have proven that the Egyptian vehicle population has rapidly increased due to improving living standards and augmenting economic growth. Prices for new vehicles have dropped dramatically over the past years as foreign automotive manufacturers started to assemble some relatively cheap and small vehicle types in Egypt. Prices of vehicles are expected to decrease further with the application of the General Agreement on Tariffs and Trade (GATT).

As of today locally manufactured and imported vehicles are not subject to any emissions standards that would guarantee their compliance with international emissions regulations applied in the developed countries.

Studies on the potential for bringing new vehicles in compliance with any of the international environmental regulations have proven that no one designated entity was vested the authority of issuing regulations enforcing such compliance on local manufacturers and importing agencies.

The Ministry of Environment (MOE) and the Egyptian Environmental Affairs Agency (EEAA) identified entities vested the authority of taking the needed institutional decisions and undertaking the needed executive procedures that will ensure compliance of new vehicles with the necessary environmental regulations. These entities include the Ministries of Environment, Interior, Petroleum, Industry and Mineral Resources, Trade and Supply, in addition to the Federation of Egyptian Industries, representing the local manufacturers, and the Federation of Egyptian Chambers of Commerce, representing local importers.

In light of the Egyptian laws and regulations and by coordination with the above listed entities the selection process of the appropriate emissions regulations and the needed complimentary executive actions, applicable in Egypt, was initiated. The formal approval has been made, verifiable by the signatures of their Excellencies the aforementioned Ministers and Presidents of the identified federations, to develop the necessary measures and implementation procedures to ensure compliance of locally manufactured and imported vehicles as of January 1, 2002 with the European Emission Standards EURO-2.

3. ENFORCING VEHICLE EMISSIONS STANDARDS OF LAW NO. 4 OF 1994

Enforcement of the emission standards of Law No.4 of 1994 necessitates the establishment of a Vehicle Emission Testing, Tune-up and Certification Program (VET). The program is to inspect in-use vehicle population in Greater Cairo. The CAIP VET program is being implemented within the framework of a Memorandum of Understanding (MOU) that was signed by the Minister of the Interior and the Minister of State for Environmental Affairs. The MOU included a three-phase program for implementation: on-road testing (ORT), operation of three model vehicle emissions and safety testing centers, and a testing network to be established and operated by the private sector.

3.1 VET Program

The overall objectives of the CAIP/VET program are to achieve vehicle emissions reduction and improved vehicle fuel efficiency. The program to be implemented under CAIP is designed to reach the following objectives by conclusion of the project.

- ❑ A system in place to test and certify emissions of vehicles applying for registration renewal/issuance.

- ❑ A capacity to improve fuel efficiency by 10 percent and reduce emissions through increasing tune-up capabilities for gasoline-powered passenger cars and diesel-powered public transport buses.

Discussions regarding VET program approaches for Greater Cairo have focused on the design of a program to improve vehicle emissions. Several Egyptian and U.S. experts, including representatives from the US EPA, have conducted analytical studies in an effort to settle on the design of the VET program. Additionally, there are many program design feature options, which have profound effects on the test system operating efficiency and cost effectiveness. All of these warrant extensive review and discussion amongst stakeholders for the VET program.

3.1.1 Preliminary Conceptual Design/Recommendations

After reviews of past development work on vehicle inspections for emissions in Greater Cairo, limited meetings with stakeholders, GOE representatives, members of local governmental units and private sector parties, a plan to meet the area's needs has been formulated.

The following represents a conceptual description of the Cairo VET program design. Included are assumptions regarding network and test type, enforcement and oversight provisions, etc. provided to serve as a basis for the detailed final design.

- 1. Institutional Setting** - Cairo VET will employ an officially licensed network of high volume, test-only facilities strategically located throughout the greater Cairo region in order to provide convenient testing for vehicle owners. No tune-ups or repairs will be performed at these facilities. The facilities will be built, owned and operated by private sector contractor(s) selected by the GOE.
- 2. Network Design** – Based upon vehicle registration information, the greater Cairo area will be divided into zones, coordinated with the existing Traffic Authority boundaries. These zones will be the basis for bidders' responses to the EEAA tender offer in that a single service provider will be selected for each zone. All vehicles within that zone will be required to undergo testing at one of that contractor's facilities.
- 3. Vendor Selection** - Proposals submitted in response to the tender issued will be evaluated by uniform selection criteria and weighting technique defined in the tender offer. This assessment will comply with all GOE procurement requirements and will include at least two parts, a technical evaluation and a cost review for each potential contractor.
- 4. Types of Tested Vehicles** - Gasoline and diesel powered vehicles registered in the greater Cairo area (Cairo, Giza and portions of Qalubiya) will be tested for emissions.

5. **Test Procedures** – Measuring HC and CO concentrations at idle will be employed for gasoline powered vehicles. Diesel vehicles will be tested for exhaust opacity during unloaded engine free acceleration.
6. **Emission Standards** - The standards for HC, CO and particulate/visible smoke will be based upon the statutory requirements of Law 4 of 1994. An appropriate Ministerial decree will be required to specify the test measurements for all vehicles to be included in the program, the testing mechanism and the applicable fines for non-compliance.
7. **Program Management** - Oversight of the VET testing contractor(s) will be performed by EEAA, Traffic and Governorates with respect to contractual obligations, testing accuracy, test procedures, employee training, etc.
8. **Technical Center** – Through the CAIP effort, a technical center will be designed and constructed on land provided by EEAA. The Technical Center will house test lanes similar to those in the network, more advanced emissions testing equipment and EEAA program oversight personnel.
9. **Compliance Enforcement** - The Traffic Departments of Greater Cairo will be key to test requirement enforcement.
10. **Fees** – A financial analysis to determine reasonable fees is currently underway through the CAIP. Proposed test costs will be included in the evaluation of vendor responses to the tender offer along with assessment of vendor experience, facility convenience, etc. as noted above.
11. **Inspector Training and Certification** – Initial training materials will be developed under the CAIP. Trainers will be trained in all aspects of VET station operations. In addition, each contractor will submit a training plan to the EEAA that will result in adequate testing skills for inspection personnel.
12. **Quality Control** - Test equipment containing internal audit and testing accuracy checks will be specified for the test-network and will be supplied by the CAIP to each private sector testing facility in the network.
13. **Quality Assurance** - Training will be developed under the CAIP to provide EEAA and the Traffic Authorities information on minimizing fraud, waste and abuse in the system. The data processing system will be designed to provide oversight capabilities and adequate system access to GOE personnel.
14. **Public Information and Education** - Effective communication with the public regarding the general program will be provided. Additionally, the test-only contractor(s) will provide test specific information in form and quantity sufficient to address the needs of the Greater Cairo area motorists.

3.1.2 On-Road Testing Program

Within the framework of the Memorandum of Understanding (MOU) signed by the Minister of Environment and the Minister of Interior, the Cairo Air Improvement Project (CAIP) in collaboration with the Egyptian Environmental Affairs Agency (EEAA) and the Traffic Authority implemented an On Road Testing Program for vehicles (ORT).

Program Objectives - The objective of the ORT program is to collect emissions data and create public awareness for upcoming VET requirements.

Implementation – EEAA/CAIP provided 30 gas analyzers for testing exhaust emissions. EEAA hired and trained 30 inspectors. As of February 7, 2000 the inspectors were merged with Traffic inspection teams at the checkpoints located on the main roads (8 checkpoints) other inspectors joined the existing traffic inspection facilities to inspect emissions for a sample of this category. The inspection data are being collected and entered to a specially designed database. A set of reports describing emissions data and failure rates are regularly produced.

Results - The preliminary analysis of the data of the vehicles having non-visible smoke indicates that the overall compliance of this category with emissions limits, as stated in article 37 of the executive regulations of Law 4/94, is in the order of 63%. Failure rates due to violation of CO and HC are in the order of 26% and 21%, respectively. The category of failing vehicle includes cheap popular vehicles makes, as well as expensive ones. The statistical data analyses for the worst polluters (10% of the sample) shows that this category included a wide range of vehicle makes, as well as the whole spectrum of model year up to 1999. In conclusion, test results confirmed the need for an effective low emission tune-up to replace the common performance tune-up.

In addition, EEAA is working with CAIP to develop the capacity of the local vehicle repair industry through placement of similar analyzers in service stations and training of tune-up technicians employed there. Over 40 analyzers are now in area service facilities and are being used to tune vehicles. Both the ORT and tune-up efforts will be continued as the periodic testing program is being implemented.

3.1.3 Motorcycle On-Road Testing

Program Objectives - The objective of the MORT program is to collect HC, CO and Opacity emissions data on two-stroke motorcycles in comparison with four-stroke motorcycles in an attempt to identify and set the needed emissions regulations for two-stroke engines as well as other mitigation measures.

Implementation – EEAA/CAIP provided gas analyzers for testing exhaust emissions. Eight (8) EEAA trained ORT inspectors were used in this effort. As of June 2000, the inspection data were collected and entered to a specially designed database. A set of reports describing emissions data and failure rates are regularly produced.

Results - Based on the scientific facts and field measurements taken, the following can be concluded:

1. It has been shown that emission rates are higher for two-stroke motorcycles than for four-stroke ones. The study emphasizes the pressing need to face this problem, particularly since two-stroke motorcycles make up more than 95% of motorcycles in Egypt.
2. In-use standards can be utilized as a tool to either permit only four-stroke motorcycles or allow both four- and two-stroke ones (applicable to both new and currently in-use motorcycles).
3. It is difficult to enforce two-stroke motorcycles' compliance with emission standards regardless of whether the standards were high or low, due to technical considerations related to the emission type and emission testing procedures.

3.1.4 Tune-up Program

There will be no improvement in air quality unless poorly performing vehicles are repaired before they are returned to service. It is essential that the local tune-up and repair industry be prepared to deal with vehicles that fail the periodic inspections. This is the second part of the CAIP VET effort.

As currently envisioned, a key portion of this work will include EEAA's redistribution of tailpipe testing equipment now in the hands of the Traffic Authorities. A limited number of oil company service facilities in Cairo will receive the emissions analyzers previously acquired by EEAA and station personnel will receive training on the use of these devices, the emissions testing program and vehicle tuning to achieve low emissions.

This development of enhanced tune-up/repair services to achieve air quality improvements through motorist compliance is essential to the program's success. The complete training program based on repair industry needs will be developed, as part of the CAIP but is not a part of this milestone.

4. USE OF ALTERNATIVE FUELS (CNG)

The harmful effects of burning diesel fuel to the ecological system and to health are well known and documented. Nevertheless, diesel fuel consumption increased from 2.6 million tons in 1981-82 to 6.2 million tons in 1997-98. Diesel consumption has nearly tripled in the past 15 years and is expected to reach 8.3 million tons by the year 2002-3.

Natural gas is both abundantly available and environmentally friendly. Known reserves of natural gas have continued to increase since 1985, in contrast to oil reserves, which have remained unchanged for the last two decades. This makes CNG the logical alternative fuel for diesel, especially for the transportation sector.

CNG has already proven itself as a successful substitute for gasoline in the transportation sector in Egypt. The number of privately owned taxicabs that have converted from gasoline to CNG has exceeded all expectations. The Ministry of Petroleum is currently struggling to keep up with the tremendous demand for conversion to CNG.

5. INSPECTION AND MAINTENANCE OF TRANSIT BUSES (IMTB)

Also known as the diesel tune-up program

Objective - The program aims to serve as a short-term approach to reduce air emissions emitted by Diesel fueled Engines/vehicles in Cairo.

The IMTB program primary objective is to enhance inspection and tune-up practices of the transit buses authorities operating in the Greater Cairo area. This alone should lead to a noticeable reduction in emissions resulting from operating heavy, medium and light duty diesel buses in public transportation.

Accordingly, the following are the programs implementation phases, which coincide with the sequence of inspection and tune-up procedures.

Phase 1: Identifying Worst Polluters:

To identify the most polluting buses a simple measurement of smoke opacity on regular basis. Each garage will be able to establish a baseline, for smoke levels and the consequent criteria for identify the most polluting vehicles. This category will be further classified according to the level of tune-up /maintenance requirements.

Phase 2: Diagnostic and Tune-up

The identified polluting vehicles will be further classified in terms of tune-up/repair requirements. A diesel engine analyzer will be used for this purpose. Minor maintenance/tune-up activities can be performed within each garage utilizing “diesel maintenance kit”.

Phase 3: Fuel System Repair

Engines that need major for the full injection system will be directed to “central workshops for such relatively high level of maintenance/repair.

CONCLUSION

The success of a VET program is highly dependent upon obtaining consensus from EEAA, Governorates and Traffic Departments regarding their roles and responsibilities, the approach to design, and implementation of the program. Exceptional public information and education (PI&E) efforts and a funding mechanism that will make the program self-sustaining are also keys to program success.

The successful mitigation measures for mobile sources of emissions require collaboration of the efforts of the government and the public. More specifically Governorates, investors and motorists who are the main stakeholders in achieving a successful program that contributes to sustainable development.