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THE COMPREHENSIVE PROGRAM FOR AIR POLLUTION REDUCTION IN TEHRAN (TRANSPORTATION SECTION)

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ABSTRACT

One of the key elements effecting air pollution today is the increase in the number of motor vehicles. Consequently, the resulting problems arising from new forms of large scale air pollution need to be emphasized. Various measures have been taken to cope with it, but no advanced industrial nation has found a solution to the puzzle of air pollution.
At present, air pollution is one of the most vital environmental issues challenging Tehran. As a result, **The comprehensive program for air pollution reduction in Tehran(transportation section)** was started because of critical situation of Tehran's air pollution at the first half of the 2000's in order to accurately identify the actual magnitude of the problem and present a series of appropriate action plans on specified periods.

Key Words: Comprehensive plan, Emission control, Air pollution reduction, Transportation.

1. INTRODUCTION

One of the key elements effecting air pollution today is the increase in the number of motor vehicles. Consequently, the resulting problems arising from new forms of large scale air pollution need to be emphasized. Thus, the exhaust from these vehicles has brought in its wake distinct, never-before-seen varieties of air pollution. Motor vehicles rapidly increased following the high economic growth period of the 1960s. The growth encompasses both gasoline and diesel vehicles. Various measures have been taken to cope with it, but no advanced industrial nation has found a solution to the puzzle of air pollution. As far as exhaust emissions from motor vehicles is concerned, the influence of lead compounds contained is gasoline, and the carbon monoxide in exhaust emissions, has become ever more hazardous with the increase in the number of motor vehicles. It was following this development that the regime for comprehensive regulation of exhaust emissions from motor vehicles was initiated as a measure to control air pollutants. At present, air pollution is one of the most vital environmental issues challenging Tehran. This has been the case over the last few decades. As a result, integrative studies were undertaken because of critical situation of Tehran's air pollution at the first half of the 1990's in order to accurately identify the actual magnitude of the problem and present a series of appropriate action plans on specified periods.

The main body of these studies has been implemented with the cooperation and support of national and international experts and financial sources that include:
A) The plan for reducing transportation related air pollution in Tehran (The responsible organizations are the Municipality of Tehran and the World Bank (Swedish Consultants)).
B) The Integrative plan for reducing the air pollution of Greater Tehran (The responsible organizations are the Municipality of Tehran and JAICA, Japan)
C) The plan for exhaust emission control from motor vehicles in Tehran (The responsible organizations are the Ministry of Industry and the Academy of Science of the Islamic Republic of Iran)

The Executive Committee of air pollution reduction of Tehran is located in the Department of the Environment (DoE) and has studied on final results and above plans. The necessary action and executive plans must be extracted from the above studies .This committee and its expert members shoulder the grave responsibility for integrating of the final results of this scheme. The above committee has presented executive plans covering seven subjects (New Vehicles, Old Vehicles, Public Transportation, Fuel, Maintenance and Inspection Center for vehicles, Traffic Management and Training) that are approved from the Council of Ministers to be executing from 2000. The Executive Committee of Air Pollution Reduction is convened according to executive directive, Note 82, the act of second five – year plan and concluded the members; High Council of Environmental Protection, Ministry of Industry and Organization of Development and Renovation of Industries, Ministry of Oil, Ministry of Interior, a Province, Ministry Post, Telegraph and Telephone, Municipality of Tehran (Air Quality Control Company, Inspection and Maintenance Center and Exclusive Bus Company), Ministry of Health, Treatment and Medical Training, Disciplinary Force of Islamic Republic of Iran, Islamic Republic of Iran Broadcasting and Department of Environment .

The First Plan Proposition - New Vehicles
One of the most important parameters for designing, manufacturing and selecting vehicles in developed countries is fuel consumption and pollutant level emissions. The electronically controlled fuel injection system is the most widely used technology by manufacturers of petrol/gasoline vehicles worldwide. The balance maintained in the operation, outlet and inlet chambers, the increased number of valves for the continuous augmentation of volumetric efficiency of the engine, has well-proven its relative efficacy for the auto industry. High quality spare parts, material used, dimensions and design are other effective measures bearing on actual engine operation.
Executive Plans:
- Light-duty vehicles
ECE-15.04: Regulation ECE 15-04 was applied to both gasoline and diesel-fueled light-duty vehicles, whereas earlier regulations applied only to gasoline-fueled vehicles. This standard within Cabinet Approval No. 017812/T/79394 dated: May 19th, 1999 (29/2/1378), in execution of Articles 8 and 11 of the Air Pollution Prevention Law approved on April 23rd, 1995 (1374/2/3) by the Islamic Republic of Iran Consultative Assembly, is applied for exhaust gas emission standards for

imported and new gasoline-fuel cars and vans. The whole national production vehicles complied with the standard limits.
ECER-83: The ECE did not adopt emission standards requiring three-way catalytic converters until 1988 (ECE regulation 83), and then only for vehicles with engine displacement of 2.0 liters or more. Less stringent standards were specified for smaller vehicles, in order to encourage the use of lean-burn engines. We also required that new standards to implement further reductions in exhaust emissions. Therefore, new vehicles needs to updated limit values for emissions of gaseous pollutants and due to actual emissions limitations in ECE 15.04, did finally upgrade the emission limits. ECE 83 has also approved by Cabinet Approval on February 13th, 1999 (1378/11/24).
In fact, implementations of standard for imported and domestic light vehicles which are equipped to the electronically controlled fuel injection system, new technology and catalysts. Most of the national production vehicles complied with the standard limits.
- Motorcycles (ECE 40.01)
Although the ECE has issued emission standards for motorcycles (ECE regulation 40.01) and now being approved in the Cabinet with approval No. H27433/T/35993 dated: November 3rd, 2002 (12/8/1381). In execution of the Note of Article 6 of the Air Pollution Prevention Law approved on June 26th, 2002 (5/4/1381), it's sufficiently strict to stop producing and transporting of two-stroke engines from 2004 till now and also around 8000 old two-stroke engines replaced with four-stroke engines.
- Heavy-duty engines (Euro 1)
European regulation of heavy-duty vehicle engines has lagged behind U.S. standards for the same reasons as that for light-duty engines. ECE regulation 49.01, for gaseous emissions and ECE regulation 24.03 for black smoke emissions, in effect until July 1992, was comparable in stringency to U.S. regulations from the 1970s, and could be met with little or no effort by diesel-engine manufacturers. The Clean Lorry Directive (91/542/EEC), compulsory throughout the EU, reduces particulate and gaseous emissions for heavy-duty vehicles in two stages. The first-stage standards (Euro 1), which took effect in July 1992, are comparable in stringency to 1988 U.S. standards, while the second-stage standards (Euro 2) are comparable to 1991 U.S. levels. An even more stringent third-stage standard is under discussion, as is a change from the current steady state emissions testing procedure to a transient cycle similar to the one used in the United States. Euro 1 has issued emission standards for heavy-duty engines and approved in the Cabinet with approval No. H20711/T/75660 dated: October 4th, 1999 (12/7/1378). Most of the national production vehicles complied with the standard limits from 2005. On the basis of this standard, it's sufficiently strict to stop numbering the plates of heavy-duty minibuses in Tehran from 2001 and for polluted cities from 2004 as well as heavy-duty buses in Tehran from 2002 and for polluted cities from 2004.
Although, an even more stringent action is implemented for reducing emissions through stop transporting of heavy-duty minibuses in Tehran from 2004 and for polluted cities from 2006 as well as heavy-duty buses in Tehran from 2004 and for polluted cities from 2007.

Effective Plan on Air Cleanliness :

- Increase of total output of engine, reduction of fuel consumption and amount of pollutants like as Co, Hc , Nox , Particles etc. are the most important environmental and economical factors for manufacturing companies,
- Potential environmental benefits influences reduction of undesirable effects on human health ,
- The economic impact of reducing fuel consumption and new vehicles by at least 40% and 80%, respectively, would allow the export of standardized domestic vehicle

Responsible Organizations:

Ministry of Industry and Department of the Environment

The Second Plan Proposition - Old Vehicles

The last scientific research indicates that 71.2 % of Tehran's air pollution is caused by its vehicle fleet. One of the most important causes for this is related to average age of the vehicle and the level of engine efficiency depreciation in traffic. The average age of vehicles and buses, respectively, was 15.5 and 12.5 years old in 1997. The majority of vehicles operating in the transportation system, whether light or heavy vehicles, were manufactured well before the latest standards of energy consumption and exhaust emissions became primary considerations in vehicle design and production worldwide. In this case, the necessity of compile and implement numerous plans must be widespread regarding old cars (gasoline) and the range of applications is expanding for each type of vehicles .

Executive Plans:

- Use of catalytic conversions

Triple catalytic conversions are used for 25000 public vehicles (less than 10 years old) of private business sections based on paragraph "a" of note 12 for National Budget Act within approval No. 26303/T/3902 dated: April 23rd, 2002 (3/2/1381).

- Repair and maintenance of vehicles

Over than 11 contracts based on paragraph "a" of note 27 for National Budget Act within approval No. 24895/T/20760 in 2001 (1380) and also paragraph "a" of note 12 for National Budget Act within approval No. 26303/T/3902 dated: April 23rd, 2002 (3/2/1381) are being concluded.

- Phase-out plan for old vehicles

It's prepared the plan through DoE and presented to the Cabinet. At last, approved as by-law with Cabinet Approval No. H22175/T/2508 dated: April 13th, 2003 (24/1/1382) in 7 articles. At the first step, we've established of Working Group based on 7th article of by-law to accelerate and supervise the execution procedures. The decrees and implementations of the WG are being:

- Executive directive on Article No.2 of by-law (Definition of old vehicles)
- Executive directive on Article No.4 of by-law (Preferred discount in commercial profits for vehicles importing in lieu old vehicles phase-out as an encouragement mechanism)
- Executive directive on Article No.7 of by-law (To be sufficiently strict to stop and limit using of old vehicles)

- Decree on determining the ages of old vehicles within approval No. H30830/T/25280 based on National Budget Act dated: September 26th, 2004 (4/7/1382)
- Making decision on how to phase-out the old vehicles regarding to Cabinet Approval No. H30589/T/47843 dated: November 17th, 2004 (26/8/1383)
- Legal prohibition for getting annual label of Inspection and Maintenance throughout the last 5 years for the old age of vehicles
- Coordination with vehicle manufacturers in order to public awareness clearly on old vehicle phase-out and presenting the progressing report
- Legal announcement of facilities for qualified vehicles
- Contemplation of the related proposals through private and public sections

Effective Plan on Air Cleanliness:

Emissions reduction of any kinds of pollutants that may cause to reduce 22.5% carbon monoxide(CO) emissions, 20% incomplete combustion of hydrocarbons and NOx (HC+NOx) emissions. Hence, according to the scheme daily petroleum per usage will be reduced by one million liters in Tehran, representing 20% of the total energy consumed by the transportation sector.

Responsible Organizations:

Municipality of Tehran and Ministry of Industry

The Third Plan Proposition-Public Transportation

Tehran is one of the most polluted cities in the world. Globally, for more than 40 years now, experiments in the use of alternative fuels has been most widespread in the public transportation, taxi and bus, sector. Investigations have been shown that taxis and other public transport sectors are the greatest source Tehran's air pollution. A the same time, the use and applications of alternative fuels are growing .The vehicles that consume one type of alternative fuel as well as vehicles that can use a flexible mix of fuels have also been developed and are currently in use. Many modes of vehicular transportation can realize greater efficiency, cost and environmental benefits by supplementing their current fuel with an alternative fuel or by completely switching to an alternative fuel . This switching is implemented in section of public transportation fleet based on Cabinet Approval No. 20711/T/75660 dated: October 4th, 1999 (12/7/1378), and Paragraph 2 of 19th Approved by Environmental Protection Supreme Council - Iran on October 1, 2000 (9/9/1379)

Executive Plans:

- Increasing number, up to 1700, of CNG buses in urban transportation fleet: It's not succeeded completely, because assessed value of bus tickets pro rata real value to be in low rate.
- Improvement of public transportation through railroad transportation systems: It's running the light rail/metro lines, 1 and 2, and increasing other ones especially line 4.

Effective plans on Air cleanliness:

- The efficient use of the reserves of gas and economization of the use of other fuels
- Remarkable reduction of air pollution in Tehran
- Reduction of exhaust emissions especially in taxis
- To accelerate city transportation time to help realize economic benefits

Responsible Organizations:
- Municipality of Tehran (Exclusive Bus Company), Municipality of Tehran, and Ministry of Industry, Ministry of Interior

The Fourth Plan Proposition-Fuel
Fossil fuel consumption includes the different kinds of fuels like as petrol ,diesel, kerosene, mazote, liquid petroleum gas and compressed natural gas .The following measures play a major role in controlling and reducing Tehran's air pollution:
Executive Plans:
1-Quality improvement of current fuels
a- Unleaded gasoline
The lead content of gasoline has been eliminated, whereas the whole fleet of vehicles uses normal petrol from 19th Jan. 2001. This achievement was the result of a collaborative program involving key stakeholders like as Department of the Environment, Ministry of Oil and automobile manufacturers. Unleaded gasoline is being as a successful strategy to reduce vehicular emissions that is obvious to be yielded health benefits to the population in Iran. Unleaded gasoline causes to improve the emission standard level.
b- Super gasoline
Super gasoline is obtained from commingle of imported gasoline, intermediate gasoline, MTBE (Methyl tertiary butyl ether) and green color. It's distributed due to its cost equally to normal gasoline at populated and big cities.
c- Licensed additives
In the long and mid term periods, the lead content of gasoline must be removed completely and the idling of motors compensated by additives like as MTBE and preferably ETBE. MTBE is produced in Petrochemical Refinery of Bandar Imam
d- Reducing Sulfur Content in Diesel and its standardized
The sulfur in diesel fuel is a significant contributor of emissions of sulfur oxides. These oxides consist of about 90% sulfur dioxide (SO2) and up to 10% particulate sulfates (SO4). The SO2 is converted to particle sulfate in the atmosphere, which further worsens PM problems. Under favorable conditions, this conversion can involve a majority of the SO2. Diesel fuel must be improved from two points of view. The first is to reduce sulfur (from 7,700 PPM to less than 500 PPM) sulfate and particles gases and increase the age of engine life while providing particle filters and catalytic converters. It's been implemented from 2000.
e- Natural Gas Standard
One of the most important factors for CNG plan and quality improvement of fuels is being to have this standard for buses and minibuses.
f- Gas station sites
It's established 107 gas stations for CNG vehicles and will do consider being activated 72 gas stations, be activating 35 gas stations. Also, there are 45 gas stations to be under construction and other 15 gas stations at the initiated phase for utilization.
2- Use of Alternative fuels
- Compressed Natural Gas (CNG)
Typically, natural gas has a high octane rating, and should be used at a high compression ratio in a spark – ignition engine to offset the replacement of air

resulting from the gaseous state of this fuel. The use of natural gas in diesel engines requires modifications for proper combustion. The gas must be lacking in water, oil and sulfur compounds that prevents freezing, obstruction and corrosion in cylinders and connector components. The thermal energy of natural gas must be sufficient to maintain and reduce, respectively, engine power and pollutants emission .
In fact, the following measures are performed:

- Producing new CNG buses around 1500
- Use of 200 CNG buses in fleet of Exclusive Bus Company
- Use of 1500 CNG minibuses for urban transportation fleet
- Planning for use of 15000 CNG Taxis in urban transportation fleet

Effective plan on Air Cleanliness:
The use and applications of alternative fuels and vehicle modification, if fuel modification is in conformity with vehicle quality promotion and use of alternative fuels, the Third Five – Year Plan for Socio-Economic and Cultural Development on Pollutant Reduction shall be successfully achieved in Islamic Republic of Iran. According to the plans of the Ministry of Oil in order to promote the quality and production of petrol (80 % of normal petrol with octane rating 92 and 20% of non-leaded gasoline with octane rating 95) there is a need to construct the Ket Craker, isomeration and bensat units in our domestic refineries.
Responsible Organizations:
Ministry of Oil and Department of Environment (DoE)

The Fifth Plan Proposition-Inspection and Maintenance Center for vehicles
Inspection and maintenance centers for vehicles have been in existence for some 50 years in developed countries. The primary objectives of the above plan include improving vehicle safety, traffic congestion and air pollution diminution. Supervision of vehicle safety and quality, accident reduction ,development establishment, regulation and preparation related to vehicle manufacturers quality and allowable vehicle emission will be achieved through standard, public training. Fuel consumption will also be optimized .All of the above plans can be realized by instituting precise and regular inspection and maintenance centers .
Executive Plans:
-Plan for the establishment of mechanized inspection and maintenance centers for vehicles: At present, it's established 6 mechanized inspection and maintenance centers and another one will be establishing. The capacity of the mentioned centers estimated 5000 vehicles per day.
Effective Plan on Air Cleanliness:
If we succeed in fully executing the inspection and maintenance plan for motor vehicles in Tehran, one result would be economization of fuel consumption by 15% of total fuel charge and a reduction of exhaust emission pollutants (CO, HC) by 50 %.
Responsible Organizations:
Department of the Environment, Municipality of Tehran, and Department of Traffic
In order to understand the impact of the random checking for plan of vehicles, the trilateral committee consisting of Department of the Environment, Municipality of Tehran and Department of Traffic has devised a scheme. The guidelines and

responsibility distribution among the committee members have been prepared, circulated to other official bodies and made known to the public at large.

The Sixth Plan Proposition-Traffic Management

Traffic regulation including allowing certain types of vehicles in particular zones, restrictions on timing for vehicular traffic, particularly heavy vehicles is effective not only with respect to increasing the efficiency of the traffic signaling system, but also in reduction of pollutants arising from traffic .Modern techniques of traffic control depend on systems of sensitive electronic technologies that collect and process real-time motion data. At last, it allows the easing of traffic congestion. Many factors are effective in reducing pollutants of all varieties (gases and exhaust emission) including: traffic plan areas, traffic systems and regulatory rules inclusive of traffic signs, traffic lights and controls for stopping on the streets, time of day or night, location and age limitations for vehicles, their number and type.

Executive Plans:

Two main factors should been concentrated on as the most important determinants as follows:

-Parking Policies: One of the major deficiencies is being that we have not clear Parking Facility Policy. At present, it is installed 2500 Parco meter and because of not allocation of funds, it's postponed our plans for installation.

- Intelligent Traffic Light: It's installed only 350 Intelligent Traffic Light and because of not allocation of funds, it's postponed our plans for installation.

Effective Plan on Air Cleanliness:

Parking is defined as using the streets for temporary stoppage of vehicles during the day or night. The streets must be free and unimpeded for vehicle operators. Provision of parking services generates income whether in the form of parking meters and / or monthly subscription payments in streets with high residential congestion or parking garages/lots. These facilities help to reduce the time and distances vehicles spend in traffic, cut fuel consumption and emitted pollutants.

In consequence in plan's execution, through the use of " Intelligent Traffic Lights ", we can provide the possibility of unimpeded traffic flows through the" Green Waves" created by continuity of green traffic lights .

The rate of vehicular stopping and restarting in traffic reduces wear and thus maintenance costs on vehicles. Implementation of the plan anticipates that the installation of any intelligent traffic signal will result in a fuel consumption reduction per day about 5000 liters and the resultant emissions of any type of pollutants.

Responsible Organizations:

Municipality of Tehran and Department of the Environment

The Seventh Plan proposition-Training

Public awareness and training will be one of the most important factors in successful reduction of Tehran's air pollution. The primary topics of training plans are as follows:

-Training programs at the undergraduate on technical, occupational and applied scientific aspects necessary for the inspection and maintenance of vehicles dedicated centers,

-Training programs at the undergraduate levels of applied scientific for repair shops

-Training programs for traffic officers focusing on monitoring plans of air pollution
-Training programs on the correct manner of driving and general utilization of vehicles and their cumulative effect on air pollution reduction
-Training programs on the correct manner of fueling a vehicle and its cumulative effect on air pollution reduction and fuel waste
-Training programs on proper patterns of fuel consumption and promotion of public awareness on the positive impact proper fuel consumption and the negative consequences of air pollution
-Training and consciousness raising plans for women, men and decision makers in positions of public responsibility

The inspection and maintenance center for vehicles have to be technically proficient and staffed by experts who can accurately assess exhaust emission, if we have highly skilled repairmen in Tehran's repair centers. They can influence on vehicles operation, especially with respect to spare parts with high exhaust emissions rates. The correct manner of driving and fueling are as the most essential aspects of vehicle operation and that must be taught by public training courses dedicated to reducing air pollutants. In such cases, the experiences of other countries highlight the importance of this issue. It's reported that the efficient training programs is responsible for a 20% reduction in air pollutants. The public training and public education activities must be concerned with strengthening, and also alleviating or removing respectively, desirable traffic ethics and undesirable practices. It is necessary to provide efficiently and effectively spending funding in order to make optimal use of media facilities such as the Islamic Republic of Iran Broadcasting, new services ,newspapers, textbooks, posters and other information outlets.

According to the executive directive on prevention of air pollution, traffic officers are the essential component in implementing plans for reduction in traffic jams and the resulting emission of vehicular pollutants that are the major source of smog in the atmosphere. Therefore, traffic officers must be versed in and able to pinpoint, motor vehicles exceeding standard polluting emission levels. They should be able to recognize the tell-tale signs of polluting vehicles and understand the technical aspects of how polluting emissions are created in combustion engines plus the technical and non-technical aspects related to pollutants, emissions and pollutant measurement instruments.

Effective Plan on Air Cleanliness:

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Responsible Organizations:

High Council of Ministry of Education, Municipality of Tehran, Department of Traffic, Department of the Environment, Mass Media, Ministry of Education, Ministry of Health, Treatment and Medical Training, Municipality of Tehran, Ministry of Industry, and Ministry of Oil

3. CONCLUSIONS

Regarding to activities plan, we have some progressive actions like as:
Observation of ECE15.04 standard for vehicles in 2002, observation of ECE-R83 for new vehicles (injected vehicles) by 2005, completing the phase-out of leaded gasoline throughout the country in 2002, use of catalytic converters, repair and optimization of vehicles uses, phase-out plan for in-use vehicles, expansion and installation of the CNG system on the public transport, improvement of public transportation system especially railroad transport, feasibility of fuel conversion to cleaner fuels, tightening fuel standards, distribution of low-sulfur diesel, development plan for inspection and maintenance centers for vehicles, plans for traffic management and training for public awareness.

The air pollution research bureau has achieved to remarkable results in the past two decades, reducing some pollutants through cooperation by all levels of government and industry. However, air pollution issue is a remaining concern of our country. It calls for the creation of strategic policy to fulfill environmental quality standards, looking into the environmental monitoring of noxious air pollutants, preventative actions and so on.

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