

AIR QUALITY MANAGEMENT IN TEHRAN

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Abstract: Tehran is the capital of Iran with total area of about 700 Km². Mountains surround North and East of the city. Due to increasing population, urban and industrial development, the city is faced with an air pollution problem. First, Author introduces summary of current air pollution situation, legislation, regulations, standards and management system. Secondly a brief description of air pollution reduction programme which are being implemented now, has been explained. Some reasons that has caused the action plan to not progress as the planned timetable approved by the government of Iran has been described. A few suggestions for solving the problem and some parameters of successful and failure experiences are mentioned.

Keywords: Ambient Air Quality, Emission standard, Type Approval, Conformity of Production, Inspection

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1. INTRODUCTION

Tehran is one of a few capitals of the world, which is not located around the river or even close to sea. Mountains surround the city from North to the East. Figure 1 shows the situation of Tehran; the city is divided into 21 districts. The total area of the city is about 700 Km². There are four accurate seasons, with the annual mean rainfall at about 230 mm. The annual mean temperature is 17°C. The highest temperature is 39°C in summer and (-6)°C in winter (Asadollah-Fardi, 2001). There is no rain for about 6 months of the year.

Tehran is a political, industrial and economical city. Air pollution in Tehran is increasing due to rapid increase in population and development of industry. Twenty years ago, about 98.7% of the population of the city lived in Municipality of Tehran (MOT) area but in recent years it has decreased to 67% and about 33% of the population has moved to the suburbs. It was predicted that the population of the MOT and the suburb will increase to 9, 14.2 million respectively by 2002 (JICA, 1997). The growth of the population in the MOT over a period of hundred and ten years is shown in Figure 2. The strongest growth, proportionately, was experienced during the period from the end of World War II until 1966 with an annual growth of over 6 percent. The strongest growth was experienced during the period from middle of 1960 to the end of the 1970, during this period the growth was over 200,000 persons per annum (SWECO, MTC, 1997)

The MOT is under supervision of the city council whose members are voted on by general election. Mayor of Tehran is appointed by approval of the members of the city council. A summary of organisational structure of the MOT is shown in Table 1, Duties of an organisation and four companies are relating to Air Pollution Control directly or indirectly are within the different branches of the MOT these are as follow:

One) Air Quality Control Company (AQCC),

Two) Tehran vehicle Technical inspection Bureau (TVTIB),

Three) Tehran Traffic Control Company (TTCC),

Four) Tehran Traffic and Transportation Organisation (TTTO) and

Five) Relocation and Systemising of Urban Industrial and Trade Occupation Company (RSUITOC) (Table 1).

According to Environmental Act 1973 and Clean Air Act 1995 the Department of Environment (the DOE) is responsible for controlling Air Pollution in Iran. A part of organisational structure of the DOE which is relating to air pollution Control is shown in Table 2 (for a complete chart refer to Asadollah-Fardi 2000 and 2001). The AQCC (owned by the MOT) carry out planning, research, public awareness and Type Approval, Conformity of Production of new motorbikes, Tehran Provincial Directorate (TPD) and office of Air Pollution of the DOE in Tehran carry out planning, executing, industrial inspection, enforcement, co-ordination, monitoring and Type Approval, Conformity of Production of vehicles engine factories.

1.2. Air Quality Situation

According to data collected by the AQCC and the DOE, Tehran is one of the worst cities in the world in terms of Air Pollution. Among the two types of emission sources, mobile sources are much worse than stationary sources. Japan International Co-operation Agency (JICA) predicted that about 71% of Air Pollution in Tehran is produced from mobile emission sources. The increase of urbanisation in Tehran will increase energy consumption, which will increase air pollution relating to stationary emission in future (JICA 1995).

Table 3 shows the amount of energy consumption in Greater Tehran Area (GTA) and Iran. To date, two items (natural gas and fuel oil) may be changed due to increase of implementation of gas pipe-line in Tehran and other cities.

Since 1995 the AQCC and the DOE have monitored some parameters of Air pollution continuously. Figure 3 shows the locations of air pollution monitoring stations in Tehran. Figures 4 and 5 show daily variation of SO₂, NO₂, CO, and PM-10 for 2002.

Total budget for Air pollution reduction from March 2002 to March 2003 is about 5.4 millions dollars that include the budget of office of executing integrated master plan programme, the office of Air Pollution, the AQCC and Energy Conservation Organisation and the TPD

Figure 1 Map of 21 districts of the Municipality of Tehran (the MOT)

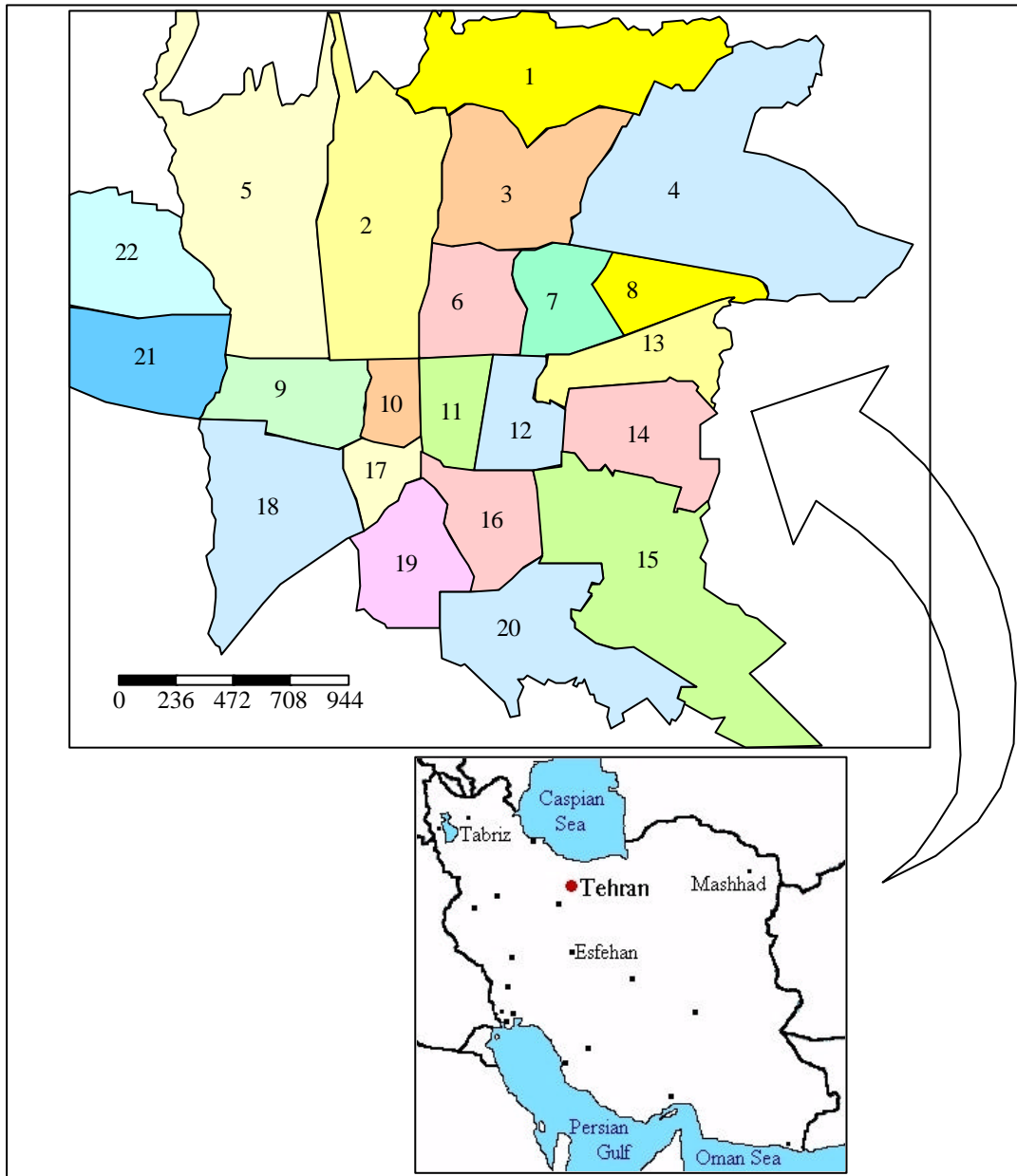


Table 1 Some part of the constitutional chart representing the MOT in Iran

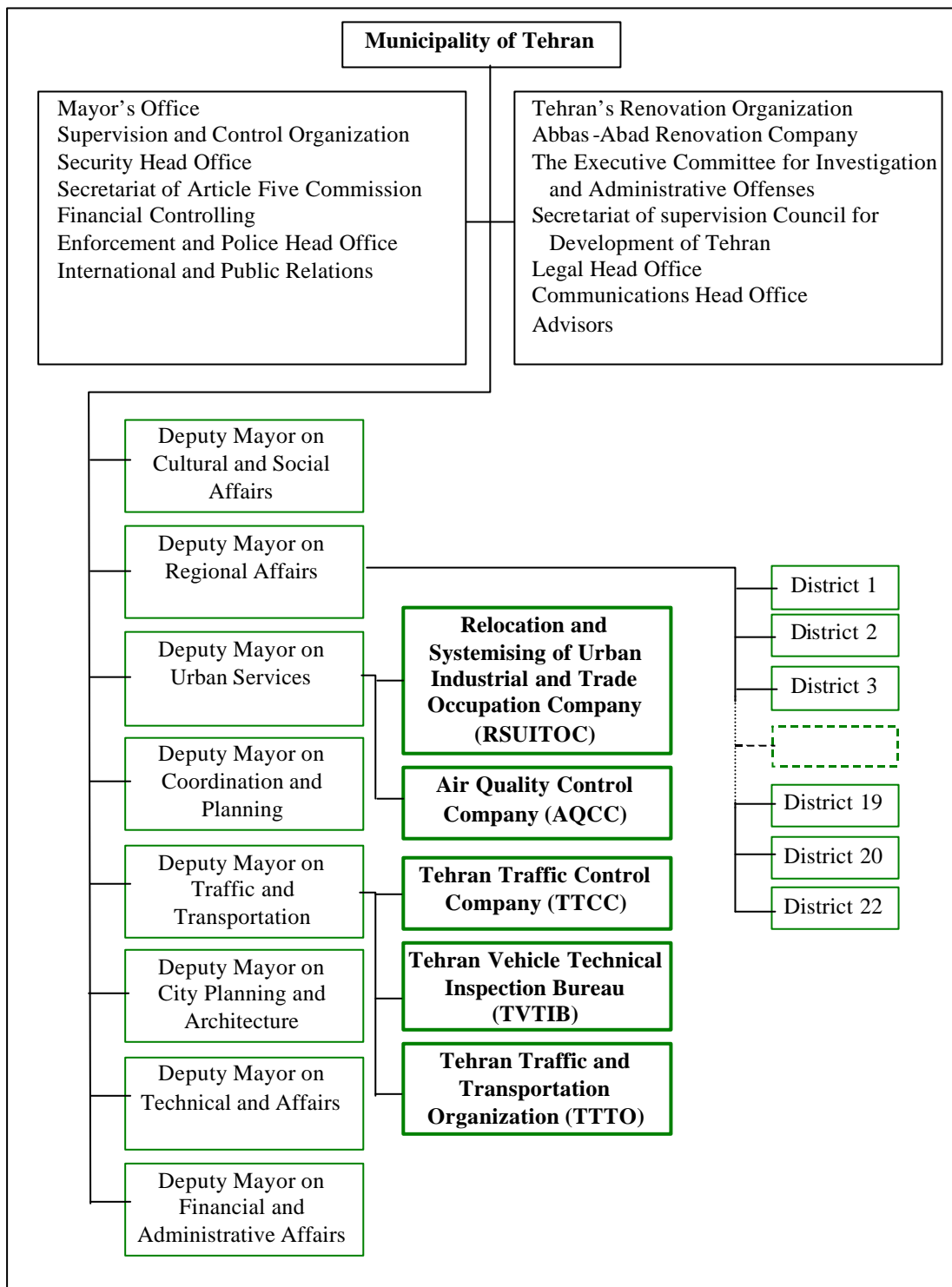


Table 2 Some part of the constitutional chart representing the Air-Pollution Research Section in Iran

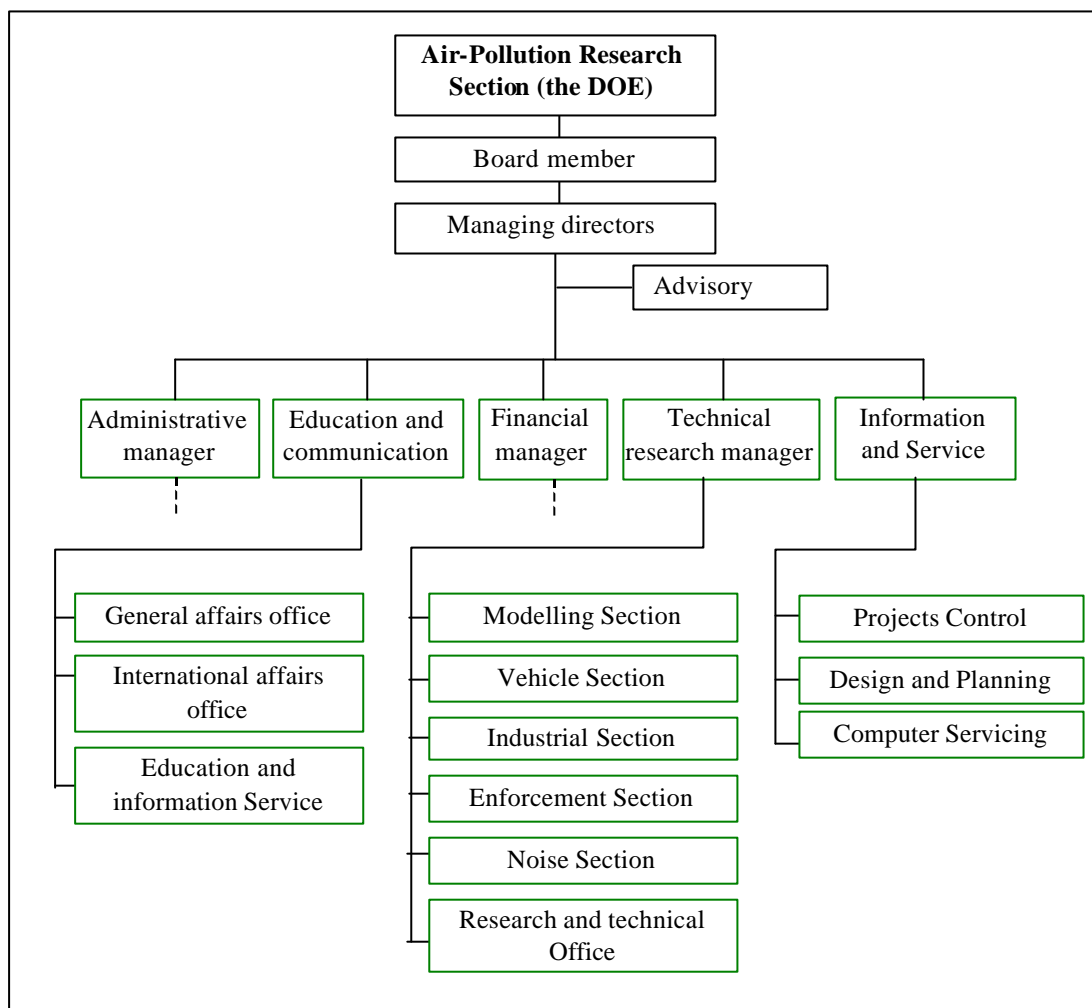


Table 3 Amounts of Energy Consumption in Greater Tehran Area (GTA) and Iran (1997)

%

Energy wise			Sector wise		
Item	GTA	Total Iran	Item	GTA	Total Iran
Electricity	8.5	5.5	Manufacturing	46.6	23.7
Liquid Natural gas (LNG)/ Liquid Petroleum Gas (LPG)	40.8	36.7	Commercial & Household	32.6	26.7
Fuel oil	43.9	51.7	Transport	11.4	17.9
Others	6.8	6.1	Energy Conversion	9.4	21.3
			Others		10.4
(Total)	100.0	100.0	(Total)	100.0	100.0

Figure 2 Population in Tehran municipality 1891 -2001.

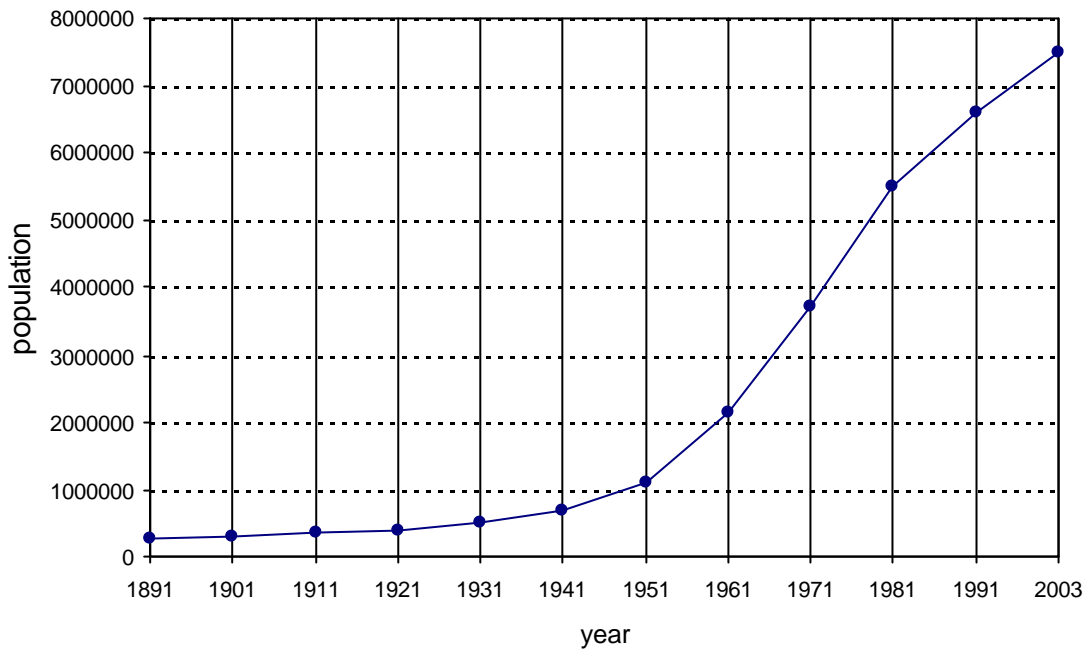


Figure 3 Locations of air pollution monitoring (continuous and real time) station in Tehran (the DOE and the AQCC) (Asadollah-Fardi, 2001)

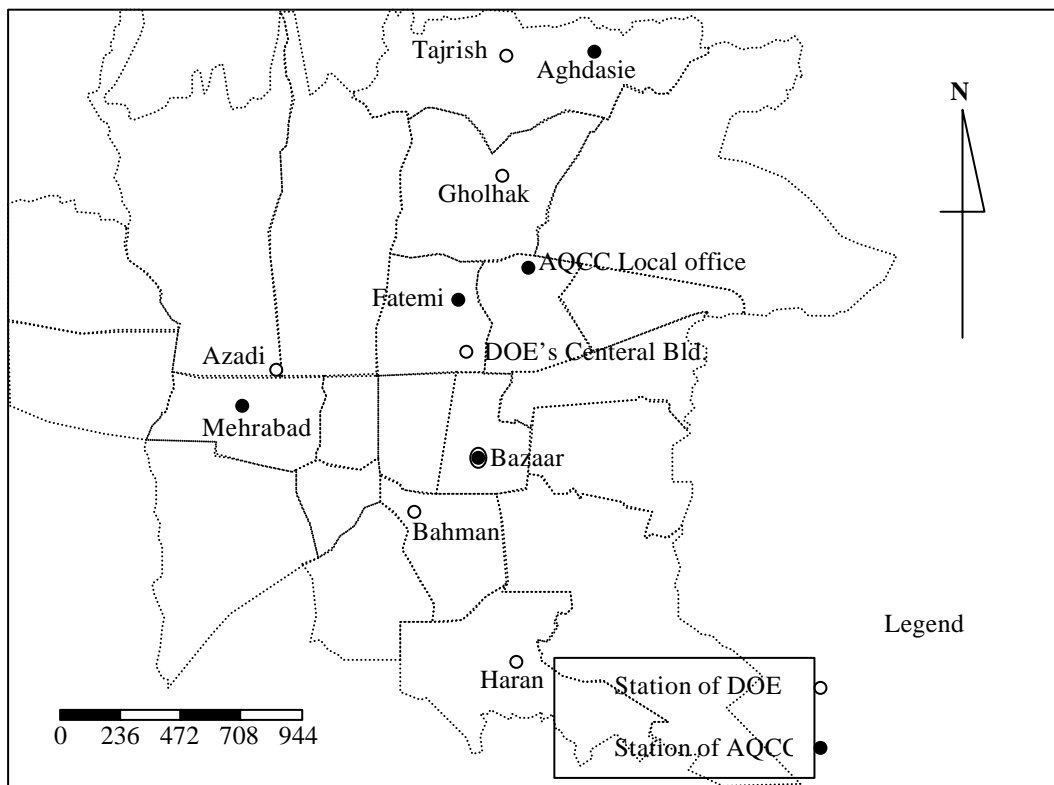


Fig.4 & 5

Figure 4 variations of Air Pollution parameters during 2002 for Fatemi station

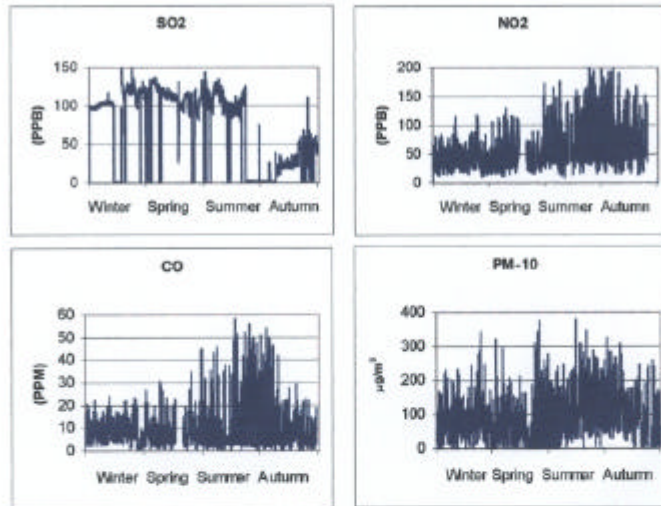
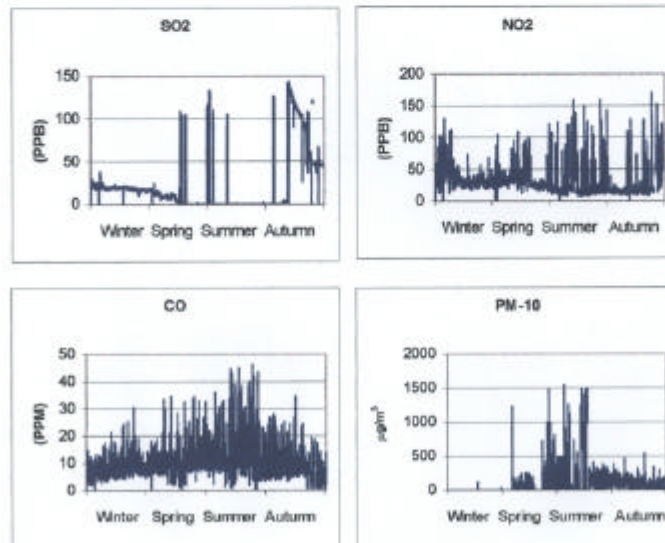


Figure 5 variations of Air Pollution parameters during 2002 for Bazar station



1.3. Laws, Regulation, Standards

In 1955, Municipality Act passed by parliament includes one item of section 55 of the law, which relates to Air pollution control (Stationary sources). The DOE according to Environmental Law 1973 has been established. As mentioned before the DOE is responsible for prevention of Air Pollution (stationary and non-stationary).

Clean Air Act was passed by the parliament in 1995. This legislation consist of six chapters and 36 sections and classifies the air pollution sources into the following three groups:

- 1- Motor vehicles
- 2- Factories, workshops and power plants
- 3- Business, domestic and miscellaneous sources

Table 4 shows principal system for Air Pollution Control with brief information relating to legislation, regulations, and standards in Iran. Table 5 illustrates Ambient Air Quality Standard in Iran. Table 6 shows standard for Light Duty Vehicles (LDV) and Light Duty Truck (LDT). For detailed information about stationary Emission standard refer to the DOE 2000.

According to Clean Air Act 1995, the cabinet approved following regulation:

- 1) All importers and producers of 4 stroke engine motorbikes must comply ECE-40-01 standard for 2004
- 2) Timetable for implementation of item above to be changed by recognition of the DOE
- 3) It is the duty of the DOE to reconsider every three years the mentioned standard with contribution of the Ministry of Oil (the MOO) and the Ministry of Industry (the MOI).

2. MAJOR SOURCES OF AIR POLLUTION IN TRANSPORTATION

Numbers of the LDV and the LDT in Tehran, which use petrol is about 2.0 million. These vehicles are major sources of air pollution, Numbers of the LDV that are

related to public transport vehicle is very high. Two parameters of air pollution emitted by these types of vehicles are carbon monoxide (CO) and (Hydro Carbon) HC_(NMHC). Considering CO in Figures 4 and 5 for Bazaar and Fatemi stations, it is clear that the amount of CO during two seasons is higher than standard level.

Buses and minibuses which use high sulphur gas-oil, had problem relating to amounts of SO₂. At present all public buses and minibuses use low sulphur gas-oil and taxis use Liquid Petroleum Gas (LPG) fuel.

Table 7 shows numbers of registered vehicles classified by car type and age.

Up to 1996 all mentioned vehicles used leaded petrol and high sulphur gas- oil but now characteristic of petrol has changed to unleaded petrol.

Major concern of transportation sector of the MOT is as follow:

- Increasing capacity of Public transport (Bus, Minibus, Taxi and underground)
- Persuading people to use public transport
- Changing fuel of public buses, minibuses from low gas-oil to the Compressed Natural Gas (CNG) fuel
- Inspection of all vehicles regularly in each year
- Increasing numbers of Intelligent Traffic Signals (ITS)
- Installation of parking meters on the road side in the city centre
- Providing a common ticket system for public transport to simplify passengers line changes.

There is relatively enough and acceptable laws, regulations and standards. However, effectiveness of them is not properly acceptable. Because executing of some sections of laws and regulations need budget, suitable interaction between the MOT, the MOO, the DOE, the MOI, Traffic police and Radio and Television organisation, a powerful management system to enforce related Authorities, people to comply the laws, enough equipment and expertise. Compliance of public relating to the laws is not enough, because people need to be educated and be aware about laws and impacts of air pollution to human health.

Table 4 Principal system for control of Air pollution with a few detailed information

Principal Act	The relevant Ministries	Enforcement Authorities	Number of chapters and sections relating to air pollution control	Regulation relating to the legislation of Air pollution control	Number of chapters and sections
Municipality Act 1955	Interior Ministry	Municipality	1	-	3
Environmental Act 1973	The president of Iran	The DOE	-	-	14
Oil Act (1987)	The MOO	-	1	-	-
The second Development Plan of Economy, Social and Cultural of the country Act (1994)	The president of Iran	The DOE	1	Regulation relating to section 4(B) (1994)	-
				Regulation relating to section 4(B) (1998)	- 10
				Regulation relating to section 4(B) (1999) ¹⁾	- 4
Clean Air Act 1995	The president of Iran	The DOE	6 36	Clean Air regulation in accordance with section 35 (2000)	3 10
				Regulation relating to section 7 (1998) ²⁾	-
				Regulation relating to section 8 and 11 (1999) ³⁾	-
				Regulation relating to section 15 (2000) ⁴⁾	-
				Regulation relating to section 11 (2000) ⁵⁾	-
The third Development Plan of Economy, Social and Cultural of the country Act (2000)	The president of Iran	The DOE	1	Regulation relating to section 104 (2001)	- 17

Note:

- 1) The Prohibition of imports and production of buses and minibuses which do not meet the Iranian standard
- 2) Executive directive for emergency situation of Air Pollution
- 3) Emissions standard for the LDV and the LDT
- 4) Emission standard for factories and industrial workshops
- 5) Emission standard for motorbikes

Table 5 Ambient Air Quality Standards in Iran.

Air Pollutant	Duration for Evaluation	Air Quality Standard 1	Air Quality Standard 2
CO	Max Conc. 8 hours average	9ppm	9ppm
SO ₂	24 hours average	0.14ppm	0.1ppm
HC _(NMHC)	3 hours average, 6 a.m.-9 a.m.	0.24ppm	0.24ppm
(NO ₂)	annual average	0.05ppm	0.05ppm
SPM*	24 hours average	260µg/m ³	150µg/m ³

Note: Air Quality Standard 1 and 2 applied to the proper area according to the local

* Suspended Particulate Matter

Table 6 Emission standard for Light Duty Vehicles (LDV) and Light Duty Truck (LDT) (DOE 2000)

Reference (rw)*	Mass (Kg)	Carbon Monoxide (CO) (gr./test)	HC-NO _x (gr./test)
rw < 1020		58	19
1020 < rw £ 1250		67	20.5
1250 < rw £ 1470		76	22
1470 < rw £ 1700		84	23.5
1700 < rw £ 1930		93	25
1930 < rw £ 2150		101	26.5
2150 < rw		110	28

* Reference weight (rw) is defined as follows:

A automobile which is ready to drive without any load (objects, persons) with full fuel and necessary tool plus 100 Kg

All importers and domestic producers (the LDV and the LDT) of gasoline used must comply European standard (ECE-15.04) or equivalent (83.351/ECE) for producing or importing

Provision: if domestic car factories can not comply mentioned standard. They have a dead line until 1999 according to a plan, which will be confirmed by the MOO and the DOE to reach their productions to mentioned standard, otherwise production of mentioned vehicle would be forbidden in 2000

Table 7 Numbers of registered vehicles classified by car type and age

	Passenger Car	Van	Mini Bus	Bus	Mini Truck	Truck	Total
1967-1971	83970	25992	2743	5676	1823	13514	133721
1972-1976	225020	76109	5010	2920	1230	12768	323057
1977-1981	199269	52286	4643	2947	219	13758	273122
1982-1986	98979	33627	1450	1586	57	10880	146579
1987-1991	46487	13068	3893	852	50	6945	71295
1991	4375	----	3265	1330	150	5422	14542
1992	230398	15056	3786	1331	552	32704	283827
1993	73168	----	----	----	----	----	73168
1994	56877	----	----	----	----	----	56877

There is only 6 lines of electric buses in three axes in south of Tehran, which carry about 150000 passengers per day. Two hundred public buses use CNG fuel and about 30000 taxi use LPG fuel.

Table 8 shows the situation of Public Versus private transportation in the MOT

Table 8 Public Versus private transportation in the MOT

Public Transport			Private Transport		Number of passengers
Type of vehicles	Number	Type of fuel	Number	Type of fuel	
Bus	5500	Low sulphur gas-oil and CNG	700	Low sulphur gas-oil	4000000
Mini Bus	----	----	4500	"	2500000
Taxi	----	----	30000	LPG	2000000
Passenger Car	----	----	50000	Unleaded petrol	
Metro	----	electricity			630000

Some efforts of the local and national government in combating air pollution are as follow:

- Removing lead substance from petrol
- Reaching production of some types of vehicles to emission standard
- Establishing restricted area in centre of the city
- Installation of about 170 intelligent traffic signal on important cross roads

- Establishing, the TTTO, the TVTIB, the AQCC and TTCC
- Establishing a radio channel for traffic information and public awareness
- Changing fuel of buses and minibuses of public transport to low sulphur
- Changing fuel of all taxi from petrol to LPG
- Changing fuel of 200 buses to CNG fuel and by the end of 2003 adding 1200 new CNG fuel buses.
- Two lines of underground with length of 30 Km already in operation and one of 36 Km under construction.

3. CURENT AND FUTURE PLAN

The JICA studied about Air Pollution Control in Tehran, which was finalised in December 1997. The title of the study is “The study on an Integrated Master Plan for Air Pollution Control in the Greater Tehran”.

Also the AQCC, on behalf of the MOT and three Swedish firms SWECO, SMHI (the Swedish Meteorological and hydrological institute), and Motor Test Centre (MTC) in Joint Venture (JV) studied about Air quality in Tehran and title of the study is “Tehran Transport Emissions Reduction Project”. The main report of this study published in September 1997

In 2000, according to section 35 of Clean Air Act 1995, cabinet of Iran, with consideration of some important conclusions and suggestions which were found from those mentioned studies approved an integrated master plan of air pollution Control in Tehran. It consists of 3 chapters and 8 sections (DOE 2000), the summary of the master plan is shown in Table 9. Timetable for implementing this Action Plan is ten years, which commenced in 2000. To date, 3 years of the Action Plan has expired. Despite of duties of the Ministries and the Organisations relating to the Master Plan regulation, the result of implementing for the duration is not properly acceptable. For three years the result of implementing is 15 percent, which is fifty present behind scheduled programme.

Table 9 Tehran Master plan regulation for reduction of Air Pollution

Section	Type of Programme	Budget	Time Table	Responsible ministry or Organisation
1	To establish six Vehicle Technical inspection centres	1.65 million dollars	Early 2001	(the MOT)
2	To change gas -oil fuel for all public buses to gas fuel	The MOO must prepare necessary Budget	-	(the MOO)
3	To install enough numbers of parking meter in city centre	7.74 million dollars	-	The MOT
4	To install ITS Controls, especially in cross-roads	3 million dollars	By 2001	
5	One) Replacing the paykan's carburettor cars with the age of less than ten years with fixed Nozzle carburettor Two) Use of catalyst in gas fuel used in taxis and changing the fuel system to run only on LPG Three) To install catalyst for motorbikes	-	By 2005	The MOT
6	One) To provide at least 70% of unleaded petrol for consumption in Tehran and also to provide low sulphur gas -oil for public buses in Tehran Two) To present and implement an Executive programme consisting of time tables and necessary resources to prepare unleaded petrol and gasoline with acceptable standard	-	mid 2000	The MOO
7	Considering distribution of unleaded petrol all over the country, if the MOO prepare enough unleaded petrol and be able to distribute properly, then the MOI must comply ECER-83 standard for domestic the LDV production, also imported cars must comply to the mentioned standard	-	2002	The MOI
8	In order to continue study of other methods for Air Pollution and also to guarantee executing this regulation property, the committees that was appointed by the cabinet have to continue their duties. Also for public awareness and participation of people to contribute for carrying out this regulation, a committee under provision of the DOE and memberships of the MOT, the MOO, interior Ministry, the MOI, representatives of Radio and Television, Deputy police relating to Traffic Control must be established.			The DOE

There are some reasons for lack of unreasonable progress of the master plan for reduction of the air pollution, which are as follows:

1) Weakness in executing of legislation, regulations and standards.

A reason for ineffectiveness of the law is shortage of tools and equipment to carryout the law for example the TVTIB needs six centres to inspect motor vehicle but to date, all the centres are not completed. According to section 5 Clean Air Act 1995 any motor vehicle with no inspection sticker must be stopped by the traffic police unfortunately there is no appropriate co-operation and interaction between these two centres. Even if there is a good co-operation there will still be no satisfactory results because.

One) A high percentage of existing Motor vehicles are old and it is difficult to bring them to standard levels.

Two) Some of the car factories still produce cars with fuel emission below the acceptable standard

Therefore for proper practising of the law all the Ministries and the Organisation must carry out their duties, which legislation and regulations has determined

2) The related Ministries and Organisations are too busy to concentrate enough on the decisions regarding the air pollution.

3) For certain ministries (for example the MOI) reduction of Air pollution in Tehran may not be first priority and industrial development and increasing quantities of productions is more important than air pollution control.

4) Decision-making in the field of reduction of the air pollution without having enough specialised and scientific back-up

5) There is not enough contribution and interaction between ministries and organisations which are responsible in implementation of air pollution reduction plan

- 6) Lack of an efficient and specialised and well-equipped supervising body and system for supervising the performance of the ministries and organisations that are responsible for executing the solutions for reduction of the air pollution.

JICA studies relating to air pollution reduction has been carried out since September 2002 and will be finalised in January 2005. The title of the study is “the study on strengthening and improving Air Quality management in the Greater Tehran Area ”

An objective of the study is to formulate an effective management action plan (Management Action Plan) for developing the environmental management system with reference to the principal of ISO 14001.

The management Action plan will be formulated taking in to account the following points.

- The Management Action Plan will consist of continuous activities for achieving an environmental target by respective stakeholders related to air quality improvement.
- The present Action Plan will be examined carefully and some parts of the present Action Plan will be incorporated in the Management Action Plan (PADECO Co, 2002)

4. CONCLUSION

Considering this paper it is clear that lots of efforts has been made to reduce air pollution by national government and the MOT. Some of the efforts mentioned previously are passing laws, regulations, standards, establishing some relating organisations and companies, studies by helping international agencies, approval of master plan and implementing of some parts of the master plan. However the result of implementing of master plan are not completely satisfying according to the programme.

It seems that following weakness may exist

- Lack of a powerful managing system that enforce related authorities to implement their duties according to the action plan
- Shortage of budget to substitute new cars instead of existing old cars which emit pollution every day
- First priority of the MOI is quantity and quality development of industry and reaching their productions to emission standard is second priority
- The DOE do not have enough expertise in dealing with inspections of industries and Type Approval, Conformity of Production of vehicles
- Deficit of close interaction between related authorities which must implement their duties relating to the action plan
- There are not a suitable and wide spread programme for public awareness and education on impacts of air pollution to their health
- There is no approval programme to participate Tehran citizen, NGO, Universities and Enterprises for reduction of air pollution

If above weaknesses are removed then the action plan of Tehran is suitable for other big cities in Iran such as Esfahan City.

If the management of the MOT decide to carry out parts of the action plan, which is their duty, there may be two scenarios as follows:

1) By own resources

It is necessary to put the action plan in first priority and it will take a long time to complete all of the related projects (directly and indirectly) (i.e. completion of 8 lines of underground, changing the fuel source of public buses and minibuses to CNG fuel, completion of Intelligent Traffic Signal (ITS), creating many parking spaces in the centre of city and construction of all inspection maintenance system. The total budget of the MOT in each year is about 750 million dollars, which is not sufficient for these purposes.

2) By other resources

It is suggested that the MOT with participation of domestic private sectors, international investment sectors, and international loan, may carry out their projects in reasonable time.

Public and government awareness relating to the matter and some interaction, co-operation between related Ministries and Organisations are two important lessons which were learned from a successful experience. Lack of powerful management, shortage of enough equipment expertise and budget, financial impacts of executing the standards (Inspection maintenance) to the people, which have own cars are failures in implementing the action plan.

Author suggests following topic contribution between the MOT and Kitakyushu Initiative Network

- 1- Retrofitting existing Paykan's cars carburettor
- 2- Reduction in existing motor cycle emission
- 3- Development of CNG fuel vehicle (the LDV and LDT)
- 4- Technical co-operation in vehicle emission standard promotion
- 5- Inspection and maintenance programme management.

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The following acronyms are used in this paper

Acronyms		Definition
$\mu\text{g}/\text{m}^3$	=	Micro-gram per cubic meter
AQCC	=	Air Quality Control Company
CO	=	Carbon Monoxide
CNG	=	Compressed Natural Gas
DOE	=	Department of Environment
GTA	=	Great Tehran Area
$\text{HC}_{(\text{NMHC})}$	=	Hydro Carbon
ITS	=	Intelligent Traffic Signals
JICA	=	Japan international Co-operation Agency
JV	=	Joint Venture
LDV	=	Light Duty Vehicles
LDT	=	Light Duty Truck
LNG	=	Liquid Natural Gas
LPG	=	Liquid Petroleum Gas
MOI	=	Ministry of Industrial
MOO	=	Ministry of Oil
MOT	=	Municipality of Tehran
MTC	=	Motor Test Centre
NO	=	Nitrogen Monoxide
NO_2	=	Nitrogen Dioxide
NO_x	=	Nitrogen Oxides
O_3	=	Ozone
PM-10	=	Particulate matter less than 10 μm of particle size
PPB	=	Part Per Billion
PPM	=	Parts Per Million, normally used as "PPM"
RSUITOC	=	Relocation and Systemising of Urban Industrial and Trade Occupation Company
Rw	=	A automobile which is ready to drive without any load (objects, persons) with full of fuel and necessary tool plus 100 Kg
SO_2	=	Sulphur Dioxide
SPM	=	Suspended Particulate Matter
SMHI	=	the Swedish Meteorological and hydrological institute
TPD	=	Tehran Provincial Directorate
TVTIB	=	Tehran Vehicle Technical Inspection Bureau
TTCC	=	Tehran Traffic Control Company
TTTO	=	Tehran Traffic and Transportation Organisation
WHO	=	World Health Organisation