Chapter 6

Countermeasure for air pollution in the GTA

6. Countermeasure for air pollution in the GTA

6.1 Framework of countermeasure for air pollution in the GTA

6.1.1 Proposed framework for air pollution in the GTA

As reviewed and analyzed in the previous chapters, the present situation of air pollution in GTA is in severe conditions. About 71% of the pollution is being caused by vehicular emissions and about 29% by stationary sources including households. The status will become worse in the year 2010, when the yearly average concentration of CO, NOx, SO_2 and SPM in the ambient air will reach 26ppm, 0.3ppm, 0.2ppm and 200μg/m^3 respectively.

Therefore, improvement of environmental management systems of the government, a high-aged structure in vehicle fleets, energy saving among industries and individuals as well as technology development in industry are urgently required to promote in the Municipality and the Central government.

In addition to the above, economic policy measures addressing fuel price and foreign exchange rate system and import restrictions are to be analyzed in view of their decisive impacts to the air pollution conditions in the GTA, these causes, however, are beyond the scope of this Report, which only deals with organizational, institutional and technological measures for reduction of air pollution.

The measures for air pollution reduction in the GTA are classified into three categories; (1)establishment of environmental management systems in the central government and MOT, (2)measures targeting vehicular emission sources and (3)measures targeting stationary sources as shown in Fig 6.1.1-1.

Based on the results of analytical and simulation in the previous chapters, all the proposed measures were studied and evaluated and summarized in Table 6.1.1-1 concerning management systems, vehicles, stationary sources, commercial and households and public awareness which will lead to improvement based on the organizational and institutional and technological viewpoint.

Naturally, these countermeasures are not achieved only by MOT, almost all of which should be supported by the Central government.

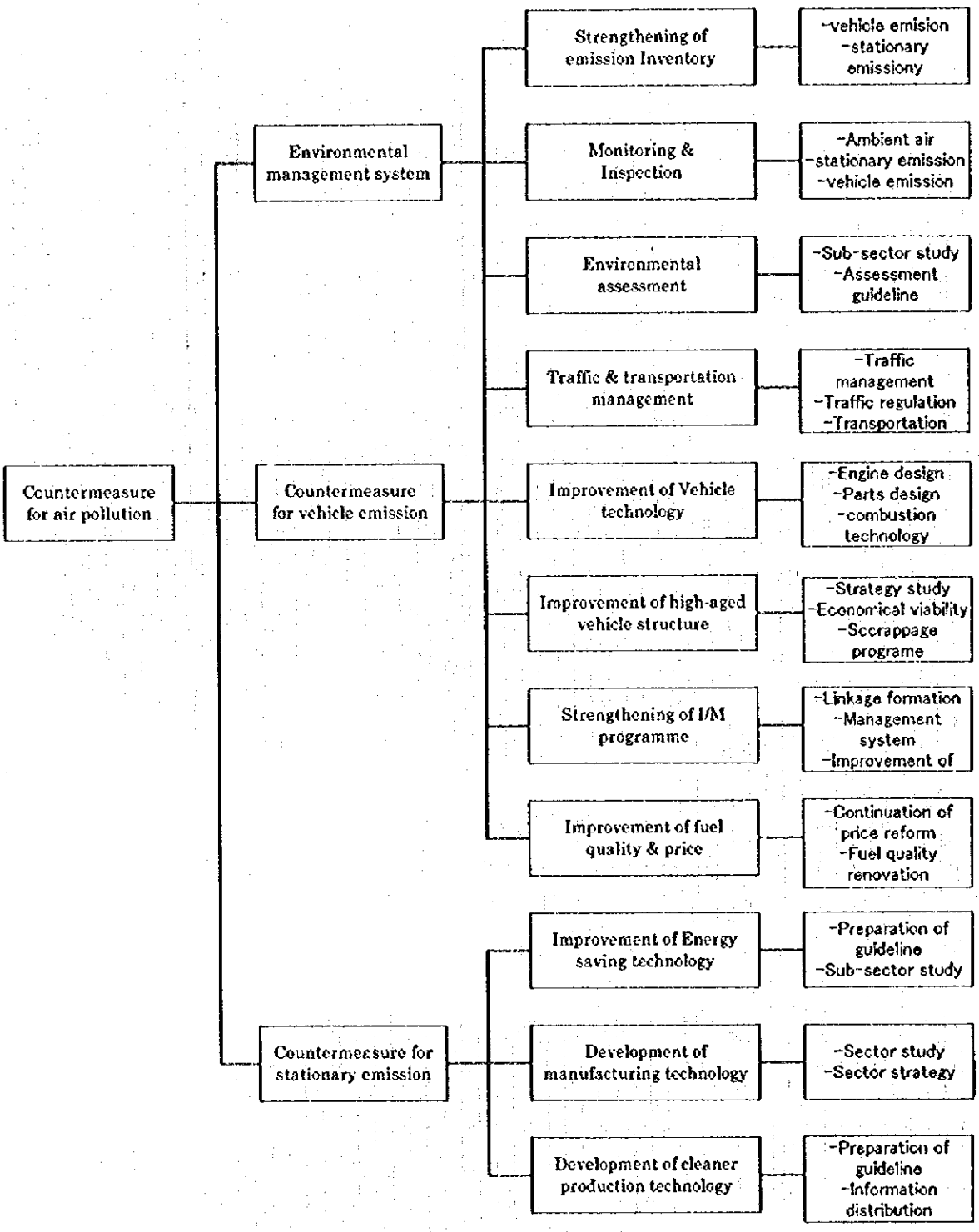


Fig. 6.1.1-1 Countermeasure for air pollution reduction in GTA

Table 6.1.1-1 List of Countermeasure for Air Pollution Control for Greater Tehran Area

No.	Countermeasure	Component of the countermeasure	
		Organizational and institutional measure (Org)	Technical measure for Improvement (Tech)
1	Policy & Management		
1-1.	Environmental management		
1-1-1.	Establishment of inventory system	All inventory data base is to be compiled for emissions sources for vehicle and stationary sector (Long and short term foreign expert shall be invited)	
1-1-2.	Environment assessment	Environment impact assessment is to be introduced prior to construction of facilities to cause environmental pollution	
1-1-3.	Ambient air monitoring system	All ambient air monitoring activities on any level are to be integrated to form database for policies making purposes (long and short term foreign expert shall be co-operated)	
1-1-4.	Man-power development	All measures to contribute to the man-power development including overseas technical cooperation is to be planned	
1-2.	Institutionalization		
1-2-1.	National environment center	Advisory service activities for environmental policy making including research and development in air pollution, waste water, industrial & municipal waste, food, forestry and biodiversities, underground water pollution is to be promoted and *	*national environment center is to be established
		Numbers of staff; ca. 200	
1-2-2.	Municipal environment research and promotion Center	Upgrading of AQCC; strengthening of assessment, monitoring, research, engineering and implementation plan. engineer and researcher; ca. 100	
1-2-3.	Expert certification system	Certification of 1) environment engineer, 2) inspection analyst, 3) combustion engineer, 4) monitoring analyst etc. shall be planned and promoted under the Central government	
1-2-4.	Re-organization of air pollution related activities in MOT	Present AQCC, TTTO, TCTTS, TTCC, TVTIB and ORSUITO etc. are to be reorganed to contribute an establishment of municipal environmental management system	

2	Monitoring		
2-1.	Ambient air monitoring system		
2-1-1.	Expansion of monitoring stations		1) New installation of 10 stations including ambient(7) and road side stations(3), 2) telemeter center (overseas technical cooperation and grant shall be utilized)
2-1-2.	Man-power development	Especially activities and specialist for 1) analytical instrument, 2) ambient monitoring instrument and 3) emission measurement instrument shall be strengthened in relation to the	
2-2.	Emission sources		
2-2-1.	Mobile I/M system		Linkages among certification/registration/inspection/maintenance activities shall be improved and strengthened (overseas technical cooperation and grant shall be utilized)
2-2-2.	Strengthening of inspection activities in the stationary emission sources		Inspection and monitoring activities in the emissions sources including 1) enforcement of installation of monitoring instrument
2-2-3.	Guideline for emission reduction amount	Shall be planned through 1) establishment of committee, 2) working group, 3) guide line, 4) dissemination and training (Short term foreign expert shall be received)	
2-2-4.	Improvement of regional inspection lab.		Inspection laboratories under the CRSU/TO shall be improved including central inspection lab and at least four district inspection laboratories (overseas technical cooperation and grant shall be utilized)
3	Vehicular sources		
3-1.	Urban Transport and Traffic measure		
3-1-1.	Enhancement of public transport system	Sub-way, bus, trolley bus and other mass transport system shall be expanded	
3-1-2.	Increasing parking area and facilities	Public and private parking facilities is to be expanded at measured junction	
3-1-3.	Modification of road structure	Junction and sideways etc. to contribute to the transportation and traffic efficiency are to be expanded	
3-2.	Traffic management system		
3-2-1.	Improvement of traffic control	Present restricted area, staggered, parking, bus operation and share system are to be totally improved	
3-2-2.	Improvement of traffic control system	Expansion of traffic signal and their control system be planned	
3-2-3.	Improvement of traffic efficiency	All measures for reduction of traffic stream shall be executed	
3-2-4.	Strengthening of vehicle inspection system		Inspection capacity is to be expanded including modification of contents of inspection item and procedure. (Overseas technical cooperation and grant shall be utilized)
3-2-5.	Strengthening of traffic regulation incd'g license	Present traffic regulation and driver license system are to be reformed	
3-2-6.	Incentive for low-emission vehicle	All measure to introduce low-emission vehicle shall be developed	
3-2-7.	Enforcement of emission standard	Stepwise enforcement of emission standard is to be planned and implemented	
3-2-8.	Scrappage program	Stepwise retirement program of high-aged vehicles is to be planned through elaboration of retirement master plan (Integrated overseas cooperation shall be promoted)	
3-2-9.	Improvement of maintenance shop		System renovation and improvement of maintenance facilities and man-power development (Overseas technical cooperation and grant shall be utilized)

3-2-10.	Establishment of I/M training course		Training center to contribute for man-power development of technicians for I/M system is be executed (Overseas technical cooperation and grant shall be utilized)
3-2-11.	Establishment of vehicle engineering center		Engineering center aiming improvement of in-use engine for emission reduction in engineering and repairment technology (Overseas technical cooperation and grant shall be utilized)
3-2-12.	Technical cooperation project		Promotion of receiving of overseas experts and training abroad including joint research etc. for all technical aspect is to be planned and executed
3-3.	Strengthening of vehicle technology		
3-3-1.	Improvement of car engine		Engine and peripherals design and manufacturing technology is to be developed through execution of plant renovation survey
3-3-2.	Improvement of main parts of car manufacture		Vehicle part manufacturing technology is to be developed (Overseas technical cooperation and grant shall be utilized)
3-3-3.	Introduction of catalytic converter		Catalytic oxidation converter is to be developed and mounted (Joint research project shall be promoted)
3-3-4.	Improvement of car maintenance system	Vehicle maintenance system is to be improved and strengthened in relation to the inspection system	
3-3-5.	man-power development of I/M system	All measure for development of man-power in I/M system are to be planned	
3-3-6.	Promotion of international cooperation	Receiving and dispatching of expert or joint research project are to be expanded	
3-4.	Improvement of fuel		
3-4-1.	Improvement of fuel quality		Higher octane rating and gasoline with lower volatility and up-grading of quality to international level
3-4-2.	Desulfurization of diesel oil		Covering whole consumption of diesel oil in GTA
3-4-3.	Discontinuation of leaded gasoline	Discontinuation of lead and necessary countermeasure	
3-4-4.	Construction of oxygenated fuel additive plant		New RFG manufacturing and distribution system of it
3-4-5.	Expansion of LPG/LNG vehicle	Conversion to LPG/LNG shall be expanded	
3-4-6	Fuel Price reform	Fuel price reform is to be expanded gradually to international level up to 2010	
3-5.	Promotion of public awareness		
3-5-1.	Promotion of public awareness activities	Public awareness activities is to be strengthened in central and Municipality level	
3-5-2.	Public campaign for emission reduction	Activities in central and Municipality level shall be strengthened including clean fuel purchase	
3-5-3.	Expansion of public transportation	Utilization of public transportation instead of passenger car shall be strongly campaigned	

4	Stationary source		
4-1.	Master planning and policy making		
4-1-1.	Investigation of present status of sub-sector		Investigation study for major polluted manufacturing sector are to be conducted (Overseas technical cooperation and grant shall be utilized)
4-1-2.	master planning and feasibility study		According to the above study, master plan for reduction of pollutants including guide line, are to be prepared with feasibility study (Overseas technical cooperation and grant shall be utilized)
4-2.	Action plan for execution		
4-2-1.	Motivation of energy saving	Energy saving project and implementation program shall be conducted under the government's support	
4-2-2.	Motivation for investment of emission reduction	Provision of miscellaneous assistance to investment projects	
4-3.	Dissemination of information on cleaner production technology.		Preparation of cleaner production technology and dissemination to the entrepreneur and introduction of training system (Overseas technical cooperation and grant shall be utilized)
4-4.	Improvement of combustion technology	Low cost measures for improvement of burner, and combustion control system etc.	
4-5.	Implementation of pollutant reduction measure		
4-5-1.	Construction of model plant for de-sulfurization of flue gas		Dissemination of information on emission reduction technology through construction of model plant (Overseas technical cooperation and grant shall be utilized)
4-5-2.	Construction of model combustion boiler		Dissemination of technology and information through construction of model boiler (Overseas technical cooperation and grant shall be utilized)
4-5-3.	Improvement of burner		Burner and control unit distribution project to medium scale industries (Overseas technical cooperation and grant shall be utilized)
5	Residential & Commercial		
5-1.	Standization of household heater		Improvement of heat efficiency including incomplete combustion
5-2.	Standardization of household cooking range		Popularly observed apparatus shall be inspected and be standardized
6	Environmental education and Public awareness		
6-1.	Strengthening of environmental public awareness		Environmental publicity including pollutant reduction campaign through media is to be made
6-2.	Motivation of cleaner fuel utilization	Benefit provision to pollution free fuel users	
6-3.	Expansion of media campaign		To be introduced for vehicle emission especially for retirement of high-aged vehicles and popularization of public transport media

6.2 Countermeasure for automobile emission

6.2.1 Overview

Figure 6.2.1-1 shows the essence of environmental problems caused by automobiles in the city of Tehran, and related countermeasures against them. A circle at the center of the page explains the following eight categories indicating situations related to automobiles in Tehran as follows.

- Road condition
- Geographical and meteorological condition
- Automobile fuel
- Economic activities
- Automobile technology
- Traffic infrastructure
- Automobile user

The outer circle describes sub-categorical situations of those described in the inner circle. Around the circle area described the present situations including measures being taken in Tehran corresponding to those in the circle. The squares painted red or green explain countermeasure needed to impose the amenities and environments. The countermeasures in red color are technical ones aiming at improvement of hardware such as an engine and gasoline, and those in green color are non-technical countermeasures depending on people's environmental awareness and PR activities, etc.

In the light of circumstances, a countermeasure against deterioration of traffic situations and city environments cannot catch up with rapid increase of traffic.

We have two ways to approach a solution for problems of urban transportation: one is the approach to the supply side such as improvement of traffic facilities or an effective use of existing facilities, while and the other, the approach to the demand side such as an appeal to individuals' cooperation and people's traffic behavior. In addition to the above ways, we

examined issued on a car engine, car fuel, car maintenance, improvement of car inspection systems and a way to introduce a car scrappage program. These proposals are tabled in Figure 6.2.1-2.

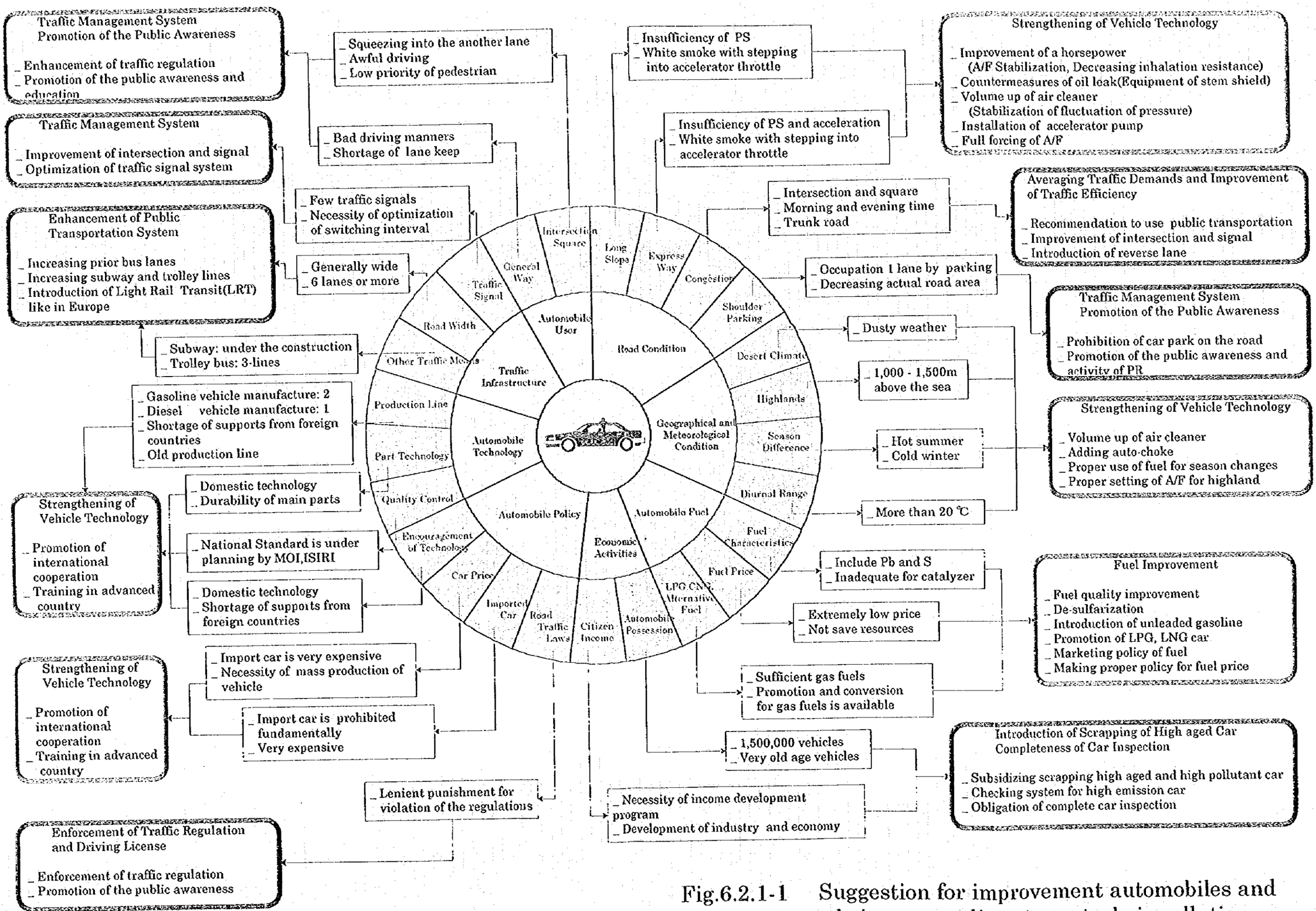


Fig.6.2.1-1 Suggestion for improvement automobiles and their surroundings to control air pollution

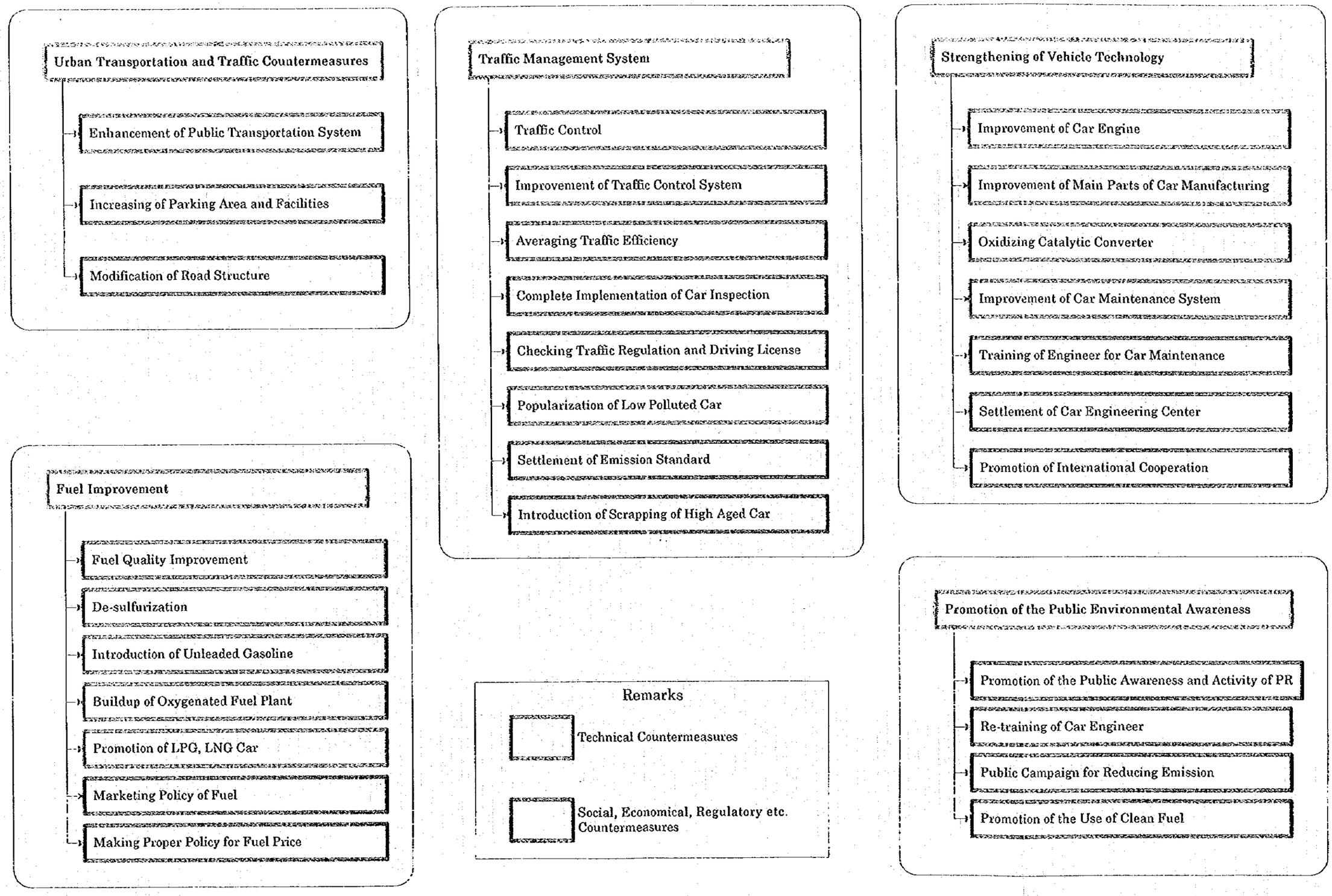


Fig. 6.2.1-2 Schematic proposals for improvement of automobiles, traffic system and social environment

6.2.2 Urban transportation and traffic countermeasures

(1) Enhancement of public transportation system

Districts 6,7,11 and 12 are the center parts of Tehran where government offices, business offices, buildings and markets are located. Citizens are commuting from mostly the suburbs to the center of the city districts are situated by means of different transportation. Almost all commuting vehicles are private cars, buses and taxis.

There are more private cars than the public transportation vehicles. As people park their cars on streets or behind buildings due to the shortage of parking spaces, road parking makes streets narrow, worsens traffic jams and prolongs traveling time.

Furthermore, such parking prohibits the city's economic activities, and causes air and traffic pollution with increasing noise and congestion. For avoiding such a condition, it is necessary to expand the public transportation system as a matter of the first priority. As we have seen many successful examples in other countries. We would like to consider how Tehran can improve its public transportation.

1) Guidance to the public transportation

In order to activate the public transportation system, MOT needs convenient transportation facilities and services from the viewpoint of convenience of passengers. In the light of the situation of traffics in Tehran, the following countermeasures are recommended for MOT's consideration.

- Facilitating passengers' transfer to other means of transportation
- Centralization of management of the public transportation systems
- Establishing priority of public transportation system
- Appropriate investment for construction of public transportation systems

The means of public transportation in GTA are buses, mini buses, taxis, railroads, trolley busses, and subways which are now under construction. Using multiple means of transportation, a passenger usually rides several public carriers to transfer until one gets to the destination. Under such circumstances, enhancement of park-and-rides, bus stops and parking facilities as well as time adjustments for transfer are needed so that users can

transfer conveniently without cumbersome procedures. Because the public transportation mentioned above are run by different management, passengers must pay their fare each time when they transfer. In order to improve this managing system, MOT needs to unite the current administration and management so that opinions of different management will be harmonized and a way to distribute fare earnings will be decided.

The population of the inner Tehran area reached seven millions in 1994. In view of the traffic situation of Tehran, pursuing convenience and comfort by owning a car will significantly prevent the city from developing properly and functioning efficiently and, as a result, diminish the potential of the city. The availability and advancement of public transportation not only alleviates traffic jams and air pollution, but helps to save expenses for transports and thus increases the efficiency of energy consumption. In addition, it will help the whole country of Iran save natural resources and, as a result, prevent the Earth from becoming warm due to the greenhouse effect. The public transportation is an essential base of life for the aged, children and the disabled who have no means of transportation. In terms of the city planning of Tehran, development of public transportation is an important foothold that accelerates the advancement of the city.

From this point of view, it is clear that MOT needs to take the primary responsibility for improving the public transportation.

In general, it costs a great deal to manage public transportation. There are two revenue sources: one is a self-supporting accounting system whose principal income is fare revenues, and the other is a system with combined income from fares and subsidy from the government and municipality. Developed countries tend to choose the latter to secure funds for promoting the public interests.

There are several other ways for securing funds: for example, road pricing, parking fees and parking meters, penalty for violations of traffic regulations, fuel tax and fines against air pollution. In case of introducing the revenues should be used only for improvement and expansion of public transportation system. On the other hand, it is also important to make it known to everyone and to promote public awareness of their contribution to the air pollution control through using the public transportation system and raising funds supported by such tax and fine.

6.3 Countermeasure for stationary source

6.3.1 Long term target for air pollution control in GTA

Projection of long term emission quantities of air pollutants in GTA can be projected by the change of the following three (3) factors:

① Energy Growth factor : To be projected by average growth rate multiplied by energy conservation rate

② Emission factor : To be modified by installation of air pollution control equipment and combustion control technology

③ Fuel replacement factor : To be projected by change of fuels to natural gas

The concept of scenario for air pollution control is very briefly mentioned below.

- Do-Nothing: Energy conservation and pollution control measures are not positively conducted better than the current level, and pollution quantities in the future are estimated in proportion to the real economic growth rate in each economic sector, that is, by extrapolating the current trend.
- Common : Intermediate reduction of pollution between "Do-Nothing" and "Best" scenario.
- Best : Reduction scenario of pollution is fully implemented as scheduled.

The other major assumptions for the scenario are as follows.

- ☐ Target year : 2010 (Base year 1994)
- ☐ Average growth rate (1994-2010) : GNP 5.1%, Manufacturing 5.9%, etc.
- ☐ Power plants & Refinery in GTA : No capacity expansion is scheduled due to environmental reasons up to 2010.

(1) Target of energy conservation

The target of energy conservation is shown in Table 6.3.1-1.

Table 6.3.1-1 : Target of energy conservation

Sector	Base	Reduction target	
		Common	Best
Manufacturing			
31 Food	100	93.40%/IIP @2010	86.80%/IIP @2010
32 Textile	100	90.55%/IIP @2010	81.10%/IIP @2010
33 wood	100	91.75%/IIP @2010	83.50%/IIP @2010
34 Paper	100	81.45%/IIP @2010	62.90%/IIP @2010
35 Chemicals	100	75.75%/IIP @2010	51.50%/IIP @2010
36 Non-metal	100	89.30%/IIP @2010	78.60%/IIP @2010
37 Iron & steel	100	85.80%/IIP @2010	71.60%/IIP @2010
38 Machinery	100	95.25%/IIP @2010	90.50%/IIP @2010
39 Others	100	95.25%/IIP @2010	90.50%/IIP @2010
Household	100	125.15%/IHS @2020	150.30%/IHP @2020
Commercial	100	89.70%/ICS @2020	79.40%/ICP @2020
Power plants	100	97.50%/IIP @2020	95.00%/IIP @2020
Refinery	100	95.00%/IIP @2020	90.00%/IIP @2020

(Note) IIP:Index of Industrial Product, IHS:Index of Household Service
ICS:Index of Commercial Service

(2) Target of direct air pollution reduction

Regarding the stationary emission sources, the long term target for air pollution control in GTA is to clear the WHO quality standards in terms of SOx and NOx emission in 2010. In order to realize this objective, the following direct air pollution control is suggested:

- Fuel oil/solid fuel replacement with natural gas
- Installation of HDS and De-NOx facilities in a refinery
- Installation of De-NOx facilities in power plants

In the event that current emission factors (EF) of SOx and NOx could be reduced and fuel replacement with natural gas could be implemented according to the above measures as scheduled in Table 6.3.1-2 below in combination with energy conservation activities, SOx and NOx emission in GTA is expected to clear the WHO quality standards in the Best scenario in 2010.

Table 6.3.1-2 : Target of stationary air pollution control

(%)

Item	Base	Do-Nothing		Common		Best	
	1994	2005	2010	2005	2010	2005	2010
Fuel oil(FO) replacement with natural gas	100	100	100	80	75	75	70
Solid fuel(SF) replacement with natural gas	100	100	100	75	50	50	0
Change of EF by installation of HDS in Tehran refinery							
- Kerosene	100	100	100	100	100	100	100
- Gas oil	100	100	100	100	10	10	10
- Heavy oil	100	100	100	100	100	100	10
Change of EF by installation of De-NOx equipment & combustion control							
- Tehran refinery	100	100	100	95	90	90	50
- Power plants	100	100	100	95	90	90	50
- Industries	100	100	100	98	97	96	95
Change of EF by De-NOx by combustion control							
- Household/commercial	100	100	100	99.5	99	99	98

(Note) EF : Emission factor (Scenario/sheet4)

The figures in the cells of Common & Best cases indicates fuel oil & solid fuel ratios or change of EF to the corresponding figures of Do-Nothing cases

(3) Case study for reduction of pollutant

Based on the assumptions described above, emission amounts of SOx and NOx from stationary emission source are projected as follows.

1) Emission quantities of pollutants in each scenario

Table 6.3.1-3(1)~(2) and Fig 6.3.1-1 show the emission quantities of pollutants in each scenario explained above.

Table 6.3.1-3(1) : Stationary emission quantities of pollutants in each scenario (t/y)

Year	SOx			NOx		
	Do-Nothing	Common	Best	Do-Nothing	Common	Best
1994	253,981	253,981	253,981	95,571	95,571	95,571
2005	413,303	308,227	217,134	150,202	128,698	109,879
2010	524,585	266,237	83,902	188,220	146,396	109,304

Table 6.3.1-3(2) : Stationary emission quantities of pollutants in each scenario (%)

(%)

Year	SOx			NOx		
	Do-Nothing	Common	Best	Do-Nothing	Common	Best
1994	100	100	100	100	100	100
2005	163	121	85	157	135	115
2010	207	113	33	197	153	114

2) Outcome of projection

As shown in Table 6.3.1-3(1)~(2) and Fig 6.3.1-1, if compared to the emission amount in 1994, the Do-Nothing scenario indicates that the emission amounts both of SOx and NOx will be almost 1.5 times in 2005 and 2 times in 2010, while the Best scenario will lead to 70% reduction of SOx and slightly increasing level of NOx emissions in 2010. It is believed that the Common scenario may be the most likely scenario among 3 cases, which induces almost 1.1 times increase in SOx and 1.5 times increase in NOx in 2010 compared with in 1994.

Chapter 7

Recommended master plan and implementation schedule

7. Recommended Master Plan and Implementation Schedule

7.1 Medium and long term master plan for air pollution control in the GTA

7.1.1 Master plan

As discussed in the previous chapter, it is understood that ambient air quality in the year 2010 respecting CO, HC, SOx, NOx and SPM will far beyond the level of the WHO standard and that strategic execution of countermeasures in the fields of air pollution control management, vehicular sources and stationary sources is the key.

Therefore, a medium and long term master plan targeting the year 2010 will be presented below.

(1) Basic principles for a master plan

1) The socio-economic development plan was based on the SFYDP reflecting the sectoral statistical data for 1994 as well as those for 1997 for some important cases.
2) A master plan for the air pollution reduction in GTA should be elaborated covering the cross-sectoral issues on the national level, which are beyond the matter of MOT. These countermeasures are also reviewed and presented in this report.
3) Neither the emission data in GTA nor the data measured and observed during the Study for elaboration of the countermeasures are not enough.
   One of the important countermeasures should target an establishment of the air pollution management system aiming the accumulation of data base for policy making for air pollution reduction.
4) However, urgent and feasible countermeasures for air pollution emitted from vehicular and stationary sources have been presented for execution in consideration of present severe condition of the GTA.

5) The WHO standards for ambient air quality has been adopted for the target air quality in the 2010.

(2) A medium and long term master plan

An indicative medium and long term master plan is presented in the Fig.7.1.1-1, whose outlines are explained below;

1) MOT is requested to prepare within the financial year 1997/98, 'a master plan for air pollution reduction in the GTA' based on the outcomes of the IBRD's TERP project and JICA Study including formation of working group for elaboration and detailed planning of the urgent sub-projects as listed below.

- Establishment of an inventory system
- Expansion of monitoring stations in GTA
- Enhancement of public transport
- Expansion of the I/M program
- Rehabilitation of automobile industries
- Renovation of in-use vehicle including mobile parts
- Improvement of the quality of vehicle fuel
- Study in the economy and expected environmental load of passenger car
- Plan of trial projects on the TDM in GTA
- Detailed scrapping program on high aged vehicles
- Sub-sector studies in manufacturing industries
- Introduction of advanced combustion and energy saving technologies
- Introduction of cleaner production technologies
- Preparation of air pollution prevention guidelines for manufacturing industries
- Promotion of joint projects with foreign countries

Fig. 7.1.1-1(1) Master Plan for Air Pollution Control for Municipality of Tehran

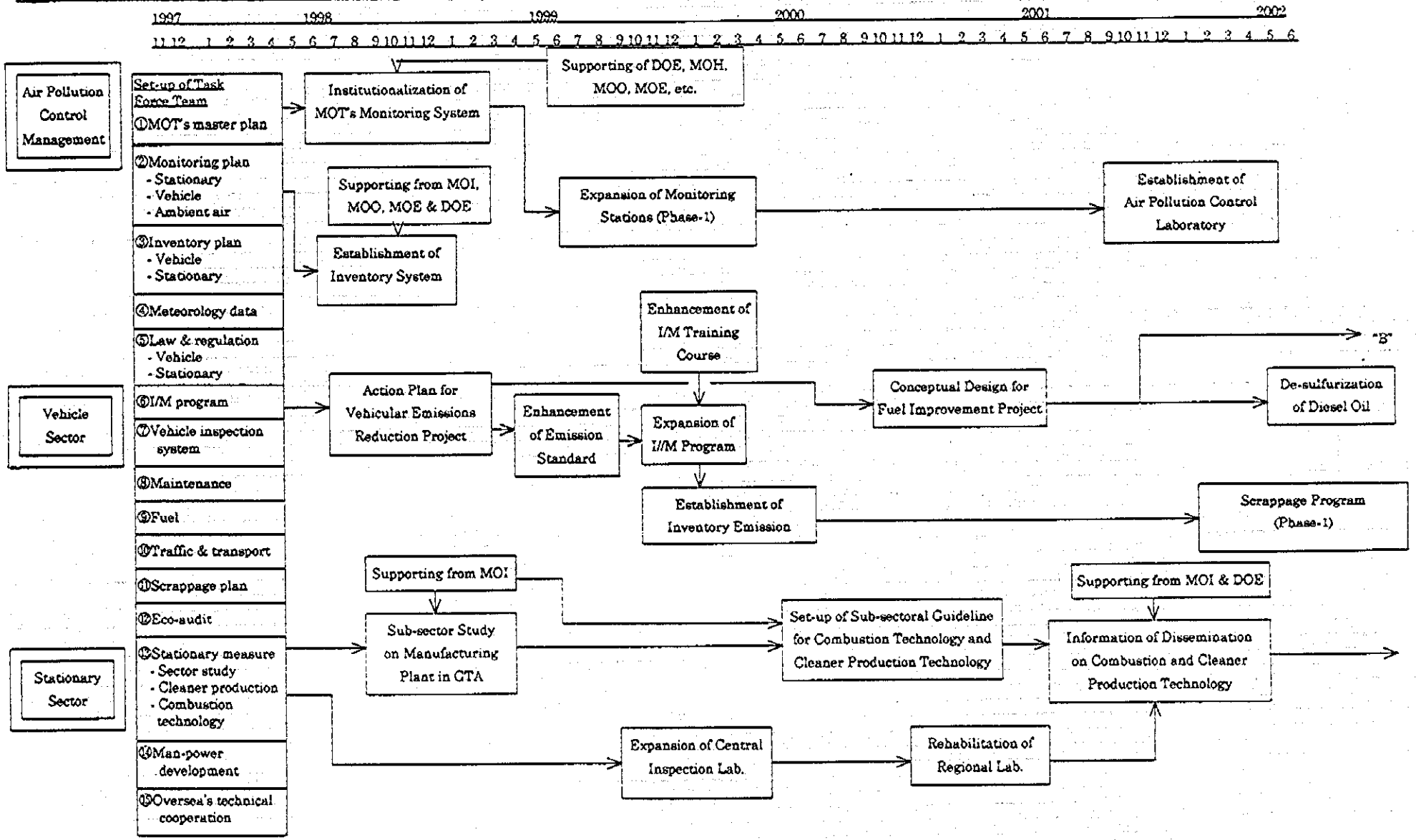


Fig. 7.1.1-1(2) Master Plan for Air Pollution Control for Municipality of Tehran

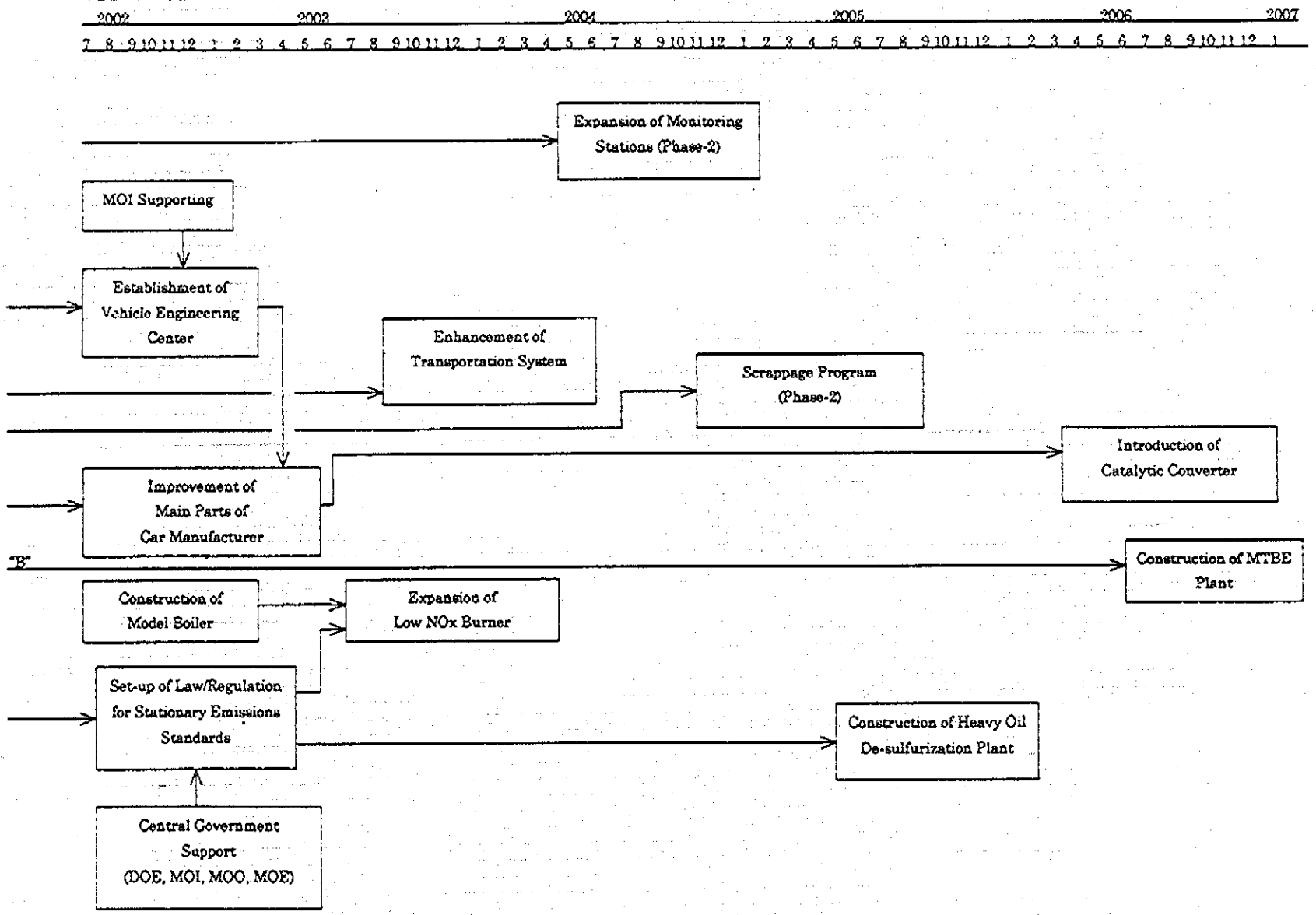
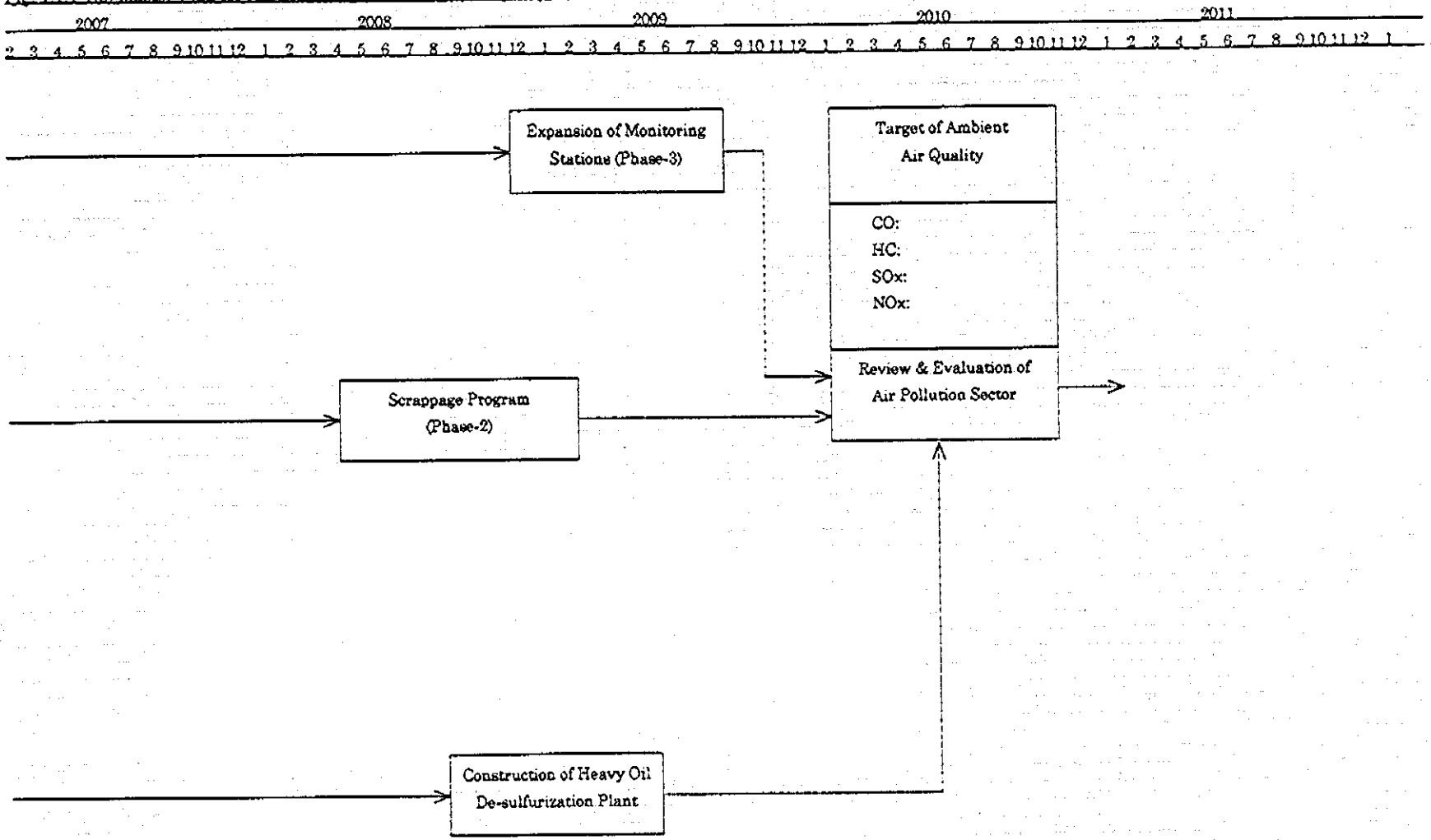


Fig. 7.1.1-1(2) Master Plan for Air Pollution Control for Municipality of Tehran



2) There are 13 years until the year 2010. In consideration of the present availability of related data base and extents of analysis in Tehran, it is recommended to divide these periods to three phases: the five year first phase from 1998 to 2002, the five year second phase from 2003 to 2007 and the three year third phase from 2008 to 2010. For each phase, the following measures would be taken:

(1) Execution of urgent sub-projects

(2) Establishment of management systems and organizations for air pollution control in GTA

(3) Detailed clarification of air pollution mechanism through establishment of a monitoring and inspection system including improvement of an inventory system

(4) Preparation of a detailed implementation plan for large scale countermeasure projects to be executed in phase 2

(5) Implementation of all measures for renovation of mobile manufacturing industries in Iran

(6) Execution of a sub-sector study followed by preparation of a master plan and guidelines for the sub-sectors in the manufacturing industries

During the second phase;

(1) Implementation of large scale countermeasure projects planned in phase1

(2) Modernization of automobile industries

(3) Modernization of manufacturing industries in MOT

After phase2, almost all major pollution issues would be overcome as far as CO, HC and SOx are concerned.

During the third phase;

Evaluation of the implemented projects and execution of countermeasure for NOx reduction would be carried out in line with the environmentally advanced countries' present situations.

3) During the phase1, any projects requiring a large amount of investment will not be executed. They need in-depth analysis of the present situation of the issues as well as basic and detailed project planning including cost estimation. Therefore, during the phase 1, urgent projects including establishment of an inventory system, expansion of monitoring stations and strengthening of central inspection lab. In ORSUITO, enhancement of the I/M program and scrappage program phase 1 will be implemented.

4) During the phase 2, second phase expansion of monitoring stations for air pollution management and improvement of public transportation systems, improvement of mobile parts, establishment of a vehicle engineering center aiming supporting functions for in-use vehicles, introduction of a catalytic converter and the second phase scrappage program will be implemented . Particularly, for the stationary sector, introduction of combustion technology and cleaner production technology, information dissemination of low NOx burners etc. combined with construction of a model boiler aiming at information dissemination of needs for energy saving will be implemented.

5) During phase 3, third phase expansion of monitoring stations for air pollution management, the third phase scrappage program and start-up of operation and distribution of MTBE in vehicular sector and start-up of a hydro-desulfurization plant will be executed.

The countermeasures during the above three phases are expected to contribute to reduction of the targeted pollutants to the level of the WHO standards of CO,

SOx, NOx and SPM, i.e. 2.5ppm, 17～26ppb, 38ppb and60～ 90 $\mu g/m^3$ respectively.

(3) Cost estimation of sub-projects in the master plan

Table 7.1.1-1 is a summary table for the recommended sub-projects in the master plan showing their periods of start-up after the planning and construction, the estimated cost required, expected reduction amounts of CO, SOx and NOx and the cost required per unit reduction weight (ton) of the targeted pollutant.

Table 7.1.1-1 Summary of countermeasure for air pollution control for Greater Tehran Area

No.	Countermeasure	Implemetation period 1/	Project cost (US$1000)	xpected amount of pollutants to be reduced(ton)			
				CO	SOx	NOx	Cost(US$/ton) 2/
1	Air pollution control management						
1-1.	Establishment of inventory system	1998	283		12699.3	4774.9	59.27
1-2.	Ambient air monitoring system	1999	522				
1-3.	Municipal environment research and promotion Center (establishment)	2003	24,630		5079.72	2864.94	
1-4.	Expansion of monitoring stations	1999, 2003, 2007	2,750		2539.86	1909.96	
2	Vehicular sources						
2-1.	Enhancement of public transport system	2003	231,150	124,021	1,251	5,942	1863.8
2-2.	Strengthening of I/M programme	1998	25,300	165,000			153.33
2-3.	Enforcement of emission standard	1998	354	41,340	500		8.56
2-4.	Establishment of I/M training course	2000	1050	82,680			12.7
2-5.	Establishment of vehicle engineering center	2001	8,520	110,000	500	10,000	77.45
2-6.	Improvement of main parts of car manufacture	2000	5,560	220,000			25.27
2-7.	Introduction of catalytic converter	2005	148,780	110,000		30,000	1352.55
2-8.	Desulfurization of diesel oil	1999	44780		6,000		7463.33
2-9.	Construction of MTBE plant	2007	139,980	145,000			965.38
2-10.	Implementation of scrappage programme	1999, 2004, 2008	53,560	152,000			352.37
2-11.	Promotion of public awareness	1998	400	24804.12			
3	Stationary source						
3.1	Improvement of regional inspection lab.	1999, 2003	990		10159.4	3819.92	97.45
3-2.	Investigation and preparation of master plan on manufacturing sub-sector in GTA	1998	1,310		25398.6	11459.8	51.58
	1) Sub-sectoral study 2) Measure for saving of energy 3) Introduction of cleaner production technology 4) Nox reduction measure		114 1820 190 310				
3-3.	Construction of de-sulfur plant	2005	976,490		153,000		6382.29
3-4	Fuel conversion to natural gas	2005	3,140		200,000	40,000	16

Remarks: 1/ Operation start-up
2/ Per ton of targeted pollutants

7.2 Implementation schedule

Based on the consideration of the strategies for reduction of air pollution in GTA, most urgent and efficient projects were selected for MOT's implementation and their costs on a basis of the order of magnitude are summarized in Table 7.2-1.

As in the similar category of the master plan, they are divided into three categories, (1) management improvement and strengthening of institutionalization, (2) vehicular emission reduction, (3) stationary emission reduction.

For improvement of management system and strengthening of institutionalization, policy and action plan need to be formulated for reduction of air pollution by the central government and MOT including preparation of a concrete implementation plan and subsectoral guidelines to promote the air pollution reduction project. Firstly, MOT is recommended to prepare such project concepts which should be discussed and authorized by DOE and SCE, to be followed by implementation of each component.

For the vehicular emission reduction, a scrappage program should be studied in details and be promoted because of their complicate nature and its cross sectoral linkages. Their each component should be independently renovated technically in accordance with the recommendation of this report.

CO and HC pollution is expected to be easily reduced but it takes long time because their causes are clear but inputs for reduction are huge.

Therefore, stationary emission reduction should be a next difficult issue as in other developing countries. Therefore, countermeasure for the stationary

emission should be started in view of the present technological situation in Iran's industrial sector.

The public awareness is most important because air pollution reduction in GTA could not be successful without raising public consciousness in order to rectify the current public feeling about the present subsidized price system of fuel, inferiority of public transportation in social recognition, previous government's recommended automobile ownership per family, and high price system of new vehicles.
Therefore, public campaigns concerning air pollution situation and health damages should be urgently promoted.

Though total cost required for the project implementation amounts US$ 295million, overseas technical cooperation both bilateral and multilateral in the form of grant, loan, of short or long term experts, joint research, and dispatching of Iranian expert to foreign countries would cover at least critical equipment and local currency needs.

Table 7.2-1 Implementation Schedule

No.	Project	Priority	Phase 1						Phase 2					Phase 3		
			'97	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10
1	Air pollution control management															
1.1	Establishment of inventory system	A														
1.2	Ambient air monitoring system	A														
1.3	Municipal environment research and promotion center	A														
1.4	Expansion of monitoring stations	A														
2	Vehicular sources															
2.1	Enhancement of public transport system	A														
2.2	Strengthening of I/M program	A														
2.3	Enforcement of emission standard															
2.4	Establishment of I/M training course															
2.5	Establishment of vehicle engineering center	B														
2.6	Improvement of main parts of car manufacture															
2.7	Introduction of catalytic converter	A														
2.8	Desulfurization of diesel oil	B														
2.9	Introduction of MTBE	B														
2.10	Scrappage program	B														
2.11	Promotion of public awareness	A														
3	Stationary sources															
3.1	Improvement of regional inspection Lab.	A														
3.2	Investigation and preparation of master plan on manufacturing sub-sector in GTA	A														
3.2.1	Sub-sector study	A														
3.2.2	Promotion of energy saving	A														
3.2.3	Introduction of cleaner production technology	B														
3.2.4	Promotion of NOx reduction project	B														
3.3	Construction of de-sulfur plant	B														
3.4	Fuel conversion to natural gas	B														
	Review/Evaluation of the master plan															

Remarks: : Basic design, : Detail study and/or cons : Implementation

Priority : A : No alternative, B : Alternative be considered

Chapter 8

Conclusion and evaluation of project

8. Conclusion and evaluation of project

8.1 Concluding Remarks

8.1.1 Present status of air pollution in Tehran

Because the concentrations of SO_2, CO, SPM and HC are quite high in the central part of Tehran, as mentioned in Chapter 4, the reduction strategies are urgently necessary. The CO concentration exceeds 10 ppm at Bazar in August, and at Fatami from July to November. While the SO_2 concentration is in general higher in winter, it sometimes exceeds 100 ppb. The SPM (PM10) is the highest in September exceeding 0.16 mg/m^3, and the NO_2 concentration is 25-70 ppb. Urgent reduction in the CO concentration is firstly needed and then efforts to decrease SO_2, SPM, HC as well as NO_2 are necessary.

From the viewpoint of diffusion potential, Tehran's potential is similar to Tokyo for small and middle scale stacks and surface sources. Tehran's diffusion potential is much better than Mexico City, Jakarta which are notorious cities for air pollution. If the emission amount of Tehran were to be the same with that of Tokyo, air pollution would also be on approximately the same level with Tokyo. Namely, the average concentrations of CO and SO_2 in Tokyo are less than 1 ppm and 0.01 ppm respectively.

Also, the CO concentration could be simulated fairly well with a diffusion simulation model. The estimated and measured concentration distributions agree well with each other.

8.1.2 Emission from automobile and industry

The basic master plan of reduction of emission is shown in chapters 6 and 7. As described in former chapters, air pollution in Tehran is characterized by the fact that the CO emission from automobile is the highest. Besides high altitude (1300m) and steep slope roadways, there are many structurally defective cars (too small air filters or small engines) and high aged cars. In order to improve the condition, both

strengthening of regulation and technological improvement are necessary. Especially, complete implementation of Inspection/ Maintenance and combined car scrappage program are needed so that CO emission can be reduced.

As described in Chapter 4, the CO concentration was estimated for the case of complete implication of I/M and a car scrappage program under some conditions, where the CO concentration would be smaller than 10 ppm in an annual average. This result is fairly satisfactory as the immediate target of CO reduction.

As emission of SO_2 from factories and commercial and domestic sectors is relatively large, countermeasures for these sources are necessary. A most obvious measure would be switching of fuel to LPG and LNG. Desulfurization of heavy oil and making low-sulfur heavy oil would also be effective. For a large factory, construction of a de-sulfurization unit from combusted air would be effective but would cost more.

The SOx concentration is estimated with a diffusion simulation for some cases, demonstrating that efforts to decrease emissions are necessary.

8.1.3 Countermeasures for air pollution

As shown in the proposed master plan in chapters 6 and 7, countermeasures for air pollution should be carried out comprehensively covering technology, institutions, social matters as well as people' environmental awareness. Choice should be decided in the light of their feasibility including economical and technical reasons.

(1) Countermeasures for automobile emission

Practically important countermeasures are as follows.

① Improvement of automobile technology

Technology development in Iran relating to manufacturing of automobiles is behind a developed country. Improvement in basic planning, quality control,

producing technology and other matters is necessary. Environmental technology, basic design of car engines, main parts, catalysts for cleaning up exhaust gas should be developed. For these purposes, it is effective to accept technology transfer from developed countries. Also, exchange of engineers between developed countries is necessary.

② Improvement of automotive fuel

Introduction of oxygenated gasoline, such as MTBE-added gasoline, is needed, because CO pollution by CO is must be most urgently reduced. In view of high altitudes and steep slope roadways, reformation of regulations enforcing use of oxygenated gasoline should be considered. Also, mixing plant oil ester with diesel oil is effective for reducing black smoke. After taking such countermeasure for CO emission, non-leaded gasoline and a three element catalytic converter should be introduced. Furthermore, fuel prices should be rationalized as soon as possible if economical situations allow. Also, efforts to propagate a LPG/CNG car should be continued.

③ Reformation of regulation relating to automobiles

At first, the I/M system should be implemented with complete coverage and should be combined with a car scrappage program of a high aged car. Introduction of a license system for a car maintenance engineer may be necessary to give incentives to more skilled engineers. Furthermore, in view of the present chaotic traffic conditions, re-education may be needed for a driver seeking to renew his/her license.

④ Institutional improvement for automobiles

The public transportation system should be fully utilized. For promoting use of the public transportation system, improvement of service is necessary. For example, a common ticket system may be considered to simplify passengers change of lines.

Also, for discouraging roadside car parking abundant availability of parking places is desired. Amendment of regulations may be necessary so that a car owner will be obligated to have a parking place. A centralized traffic control system with computerized control signals should be established.

Enforcement of a car-limited area and implementation of a park and ride system should be made.

⑤ Reform of present institution

If TVTIB is to carry out the I/M system, the capability of TVTIB should be enhanced. A comprehensive traffic environmental research institute would be necessary under MOT. Drastic amendment of existing organizations may be necessary.

⑥ Promotion of people's environmental awareness

PR activities should be continued and stepped up.

(2) Countermeasures for stationary sources

Countermeasures for factory emission should include ① Amendment of regulation and relocation of factories, ② Comprehensive planning for fuel supply, and ③ installation of de-sulfurization facilities. Also, countermeasures for commercial and domestic sectors should include switching of fuel to LPG/LNG.

1) Factory

① Amendment of regulation and relocation of factories

The emission standard should be established in the form of a quantity standard as distinct from a concentration standard. Also, a routine or non-routine on site inspection should be done. Regulations should be amended stipulating penalty for violation. Desirably a licensed pollution control engineer and manager should be appointed at each factory.

Also, more factories should be relocated to an industrial complex

continuously.

② Comprehensive planning for fuel supply

In order to reduce SOx pollution, switching of fuel to LPG and LNG should be promoted, and production of low sulfur heavy oil should be increased, and in a smaller factory, low sulfur oil should be used.

③ Installation of de-sulfurization facilities

A large factory should be equipped with a de-sulfurization cleaner extracting SOx from exhaust gas.

2) Commercial and domestic sectors

More LPG/LNG should be used as automobile fuel replacing gasoline. Also, for domestic combustion equipment should also be improved. Public awareness for health effect of room air pollution should be promoted.

8.2 Evaluation of the Project and Technology transfer

The present project has obtained successful results. The most important point of the project is that the technology transfer to AQCC should be successful. Through this project, impact assessment techniques including diffusion simulation, methods of a field survey, meteorological measurements, analyzing methods have been transferred to the Iranian counterpart, AQCC. In future, AQCC is expected to carry out impact assessment in relation to air pollution by itself.