### 7.3.3 Strengthening of activities of environmental impact assessment

As there are few activities for source inventory preparation and monitoring of ambient air pollutants at present, they should be stepped up for environmental impact assessment in the Municipality of Tehran. The process of environmental impact assessment (EIA) is outlined in Fig.7.3.3-1. The ambient pollutant concentration is considered to be a parameter expressing the extent of influence on human well-being and environment.

In general, environmental impact assessment (EIA) mainly consists of two steps. The first step is calculation of influence of emitted air pollutants to environment. The result is derived from a simulation model, of which base data are meteorological data, source inventory and topographical conditions. This is the main components of EIA procedure.

The second step is identifying the relationship among impacts of the calculated ambient concentration on human health, life circumstances and natural environment, taking account of the environmental standards. The environment standard should be determined as a desirable environmental concentration that would not influence human health, human life circumstances and natural environment. EIA checks whether the environmental standard will be met or not after the development plan has been implemented, by comparing the concentration calculated with a simulation model with the environmental standard. Should the standard not be met, the development plan should be reconsidered and redesigned; should it be met, the total amount of emitted pollutants would be determined, as a permissible emission level and the procedure of EIA would be completed. After the development plan is actually implemented, the environmental concentration in the targeted region should be checked through a continuous monitoring network.

An example of administrative procedures is shown in Fig.7.3.3-2.

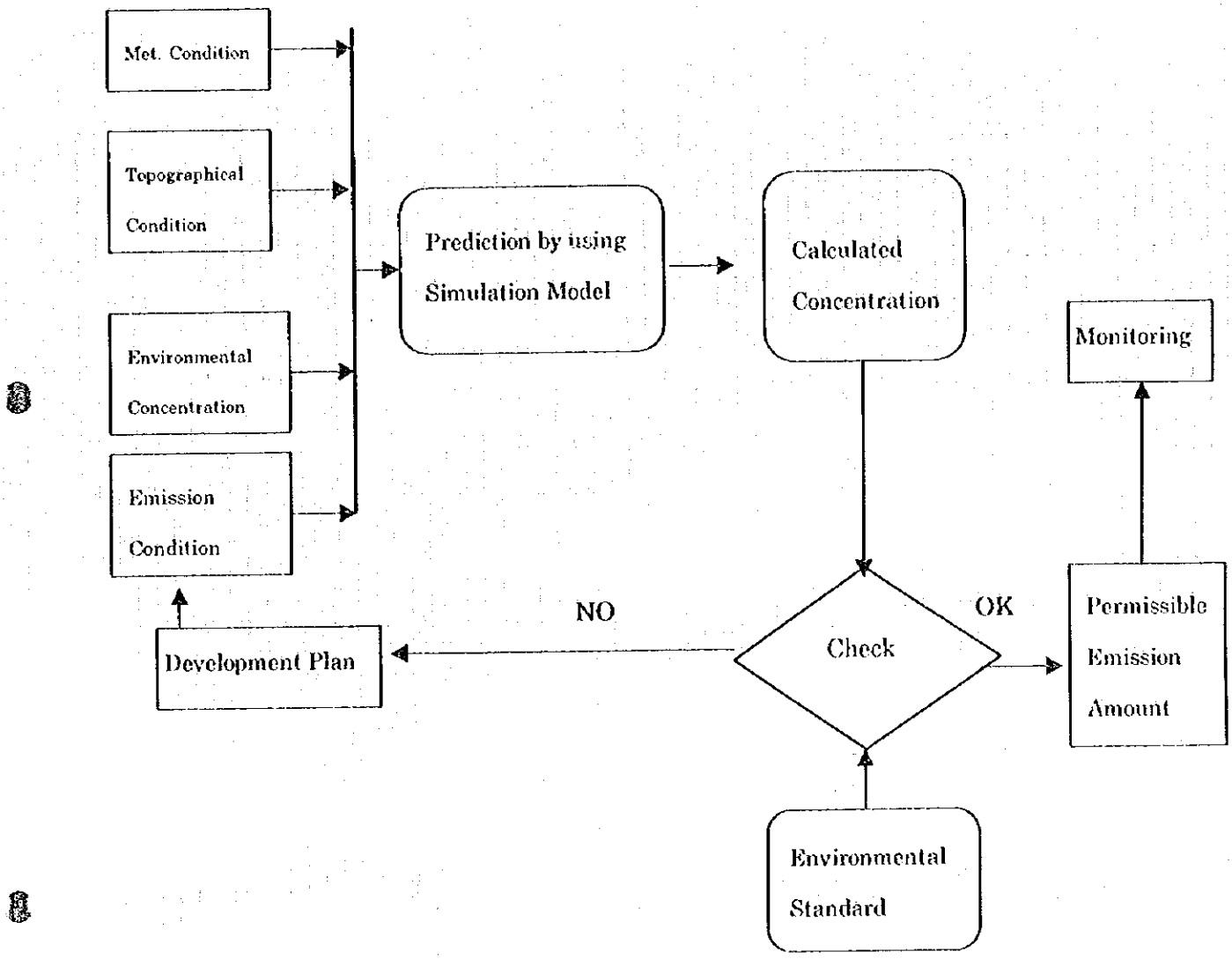



Fig. 7.3.3-1 Outline of flowchart of environmental impact assessment

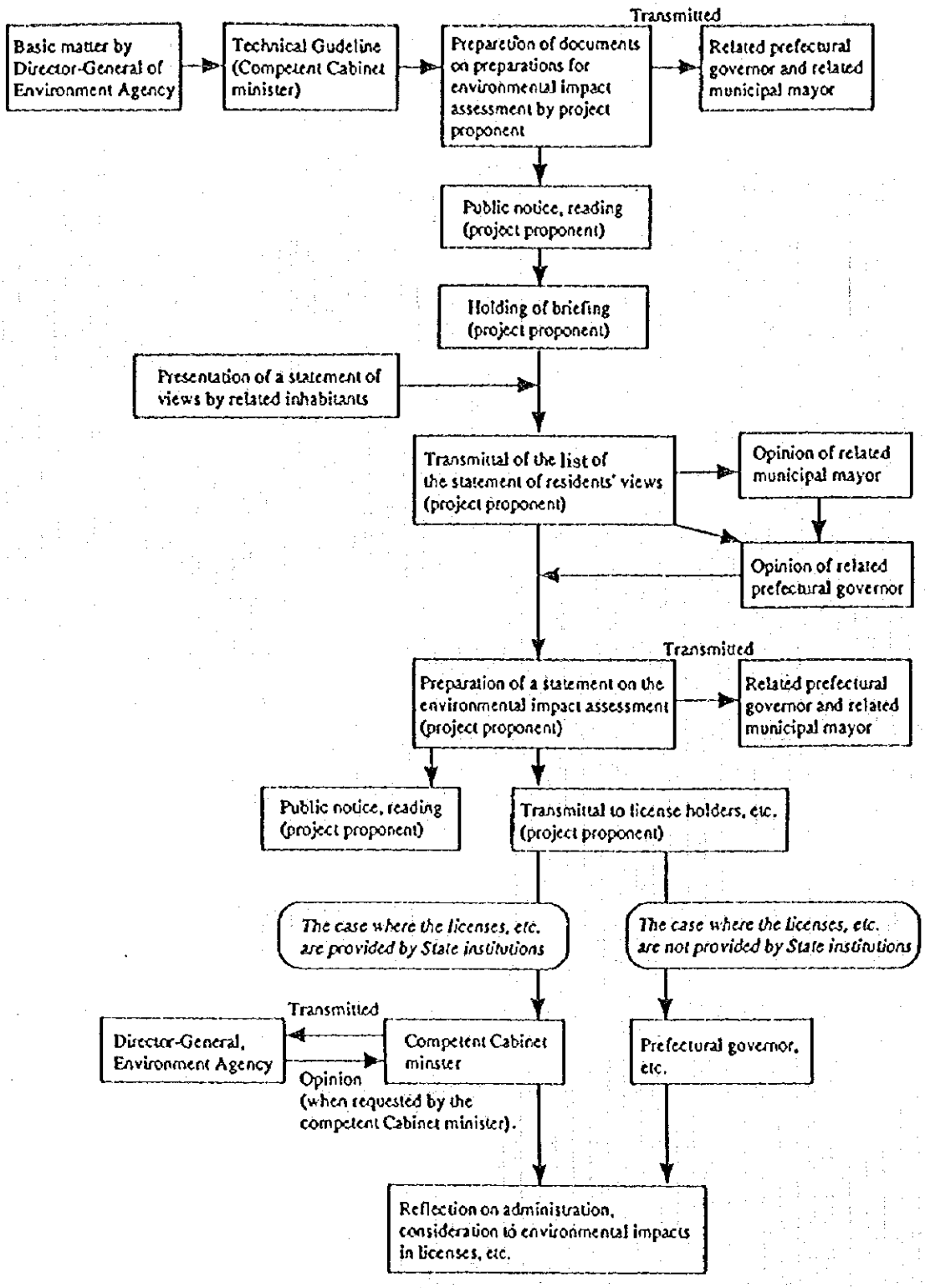



Fig 7.3.3-2 Flow example of procedures under main principles for implementation of Environmental Impact Assessment

## 7.4 Automobile emission control plan

Capter6 described concrete countermeasures targeting mobile emission source. In this section, the implementation plan of these measures will be discussed.

The implementation plan consists of three phases, each of which has been planned in reflection of the progress of reduction in automobile emission, improvement of technologies needed for the countermeasures and reforms of organizations and systems.

Corresponding to the 5year period from 1998 to 2002, phase1 is earmarked for planning and initial implementation of urgent measures. During phase2 covering the 5yaer period from 2003 to 2007, such measures that were planned during phase1 will be implemented; particularly such software reforms as organizational/institutional reforms will be focussed during this phase. Pase3 corresponds to the last 3yaers of the entire planning period from 2008 to 2010, when the progress of the measures taken in the previous phases will be reviewed and adjusted. In addition, the direction of measures to be taken after phase3 will be considered and implementation of large-scale measures will be started.

Such measures will not necessarily be implemented throughout all of these phases and some measures will be implemented during more than one phase. However, should initiation and termination of individual measures substantially deviate from the planned implementation schedule, the link among these measures would be adversely affected leading to confusion of the implementation schedule. Consequently, such deviations should be avoided to the extent possible.

### 7.4.1.Enhancement of public transportation systems

Reduction of contributions by mobile emission sources to the ambient air pollution needs reduction of automobile traffic volume. Measures to reduce automobile traffics in Tehran should include encouragement of maximum use and highest prioritization of public transportation means. Well-developed public transportation helps reduce

automobile traffics remarkably, even by 10-30% depending on situations of particular regions and cities.

In addition, in order to raise efficiency of use of public transportation means, construction and improvement of necessary facilities are essential at park-and-rides and transportation connecting points such as terminals.

MOT's means of public transportation consist of buses, mini-buses, trolley buses, taxis, railways and subways under construction. For improvement of such transportation systems, individual transportation means should be activated, their management bodies should be unified, and fare systems should be re-examined.

Improvement of public transportation systems is an objective which should be pursued for ever. During the phase1 period, not only planning but functional improvement and expansion of buses, mini-buses and taxis operations should be carried out simultaneously so that necessary measures for improvement in the core components of the program will be completed in 10 years by the end of phase2. Desirably, provision and improvement of the trolley bus system (LRT) and subway networks should also be executed so that they will be partly operative during phase2 in consideration of their construction costs and construction periods. In phase2 and thereafter the mass public transportation systems such as LRT and subways that are able to meet requirements for incremental traffic demand should be improved and expanded on the basis of the review of the progress of the measures taken in the preceding phases.

Comprehensive improvement of urban transportation and urban environment should be made not only through the above-mentioned measures for promotion of use of public transportation but incorporating the following measures related to them:

1) Increasing parking areas and facilities

As one lane of each direction of roads in the central part of Tehran is used for parking, effective road spaces are substantially narrowed. A policy for providing more

parking facilities should be to obligate car owners and offices to have parking facilities and to strengthen laws and regulations including provision for enforced towing of illegally parked cars. Before the end of phase1, such legal frameworks should be established and propaganda among citizens should be started so that full enforcement will be ensured during phase3.

2) Modification of road structure

More efficient and smoother flow of road traffics requires improvement of intersections constituting bottlenecks of traffic flow and installation of traffic signals guiding traffics properly. TTTO, which is responsible for road planning, has already recommended ways and means for such measures for improvement to the Tehran Municipal authorities, specifying intersections and road structures to be rectified and improved. Consequently, such measures can be started during phase1.

Moreover, in concert with improvement of intersections and traffic signals, essential measures should include provision of a left turn lane, central separation zone (which could be converted into a bus lane or trolley bus lane in future) and reverse lane in view of their expected significant contribution to more efficient traffic.

Because plans of these measures should be flexible in response to changes in demand for transportation, the schedule in each phase should be constantly re-examined.

3) Improvement of traffic control

As one of means to discourage vehicle entry into the central part of Tehran, introduction of the road pricing system is expected to be effective. With proper pricing and speedy fare collection, the system is reportedly expected to reduce the targeted traffic by 5 to 10%.

In areas where air pollution is bad or roads are very congested, entry restrictions should be considered during specified hours in addition to the current restricted areas. By

the end of phase1, target roads should be chosen and the fare collecting system should be decided so that experimental operations will be started in phase2 and complete implementation will be started in phase3.

4) Improvement of traffic control center, signaling system and road information system

Expansion of the functions of a traffic control center, effective control of traffic signals based on information gathered with a traffic volume sensor and improvement of road information display devices will encourage car drivers to dispense with unnecessary trips leading to significant alleviation of urban congestion. The existing control center of TTCC is functioning satisfactorily, but it is expected to be more effective by incorporating a computerized wide-range cross-area signaling system and road information network system during phase2 and 3.

The costs to be borne by MOT for improvement of the public means of transportation discussed above and other proposed measures are approximately estimated as follows excluding the costs for land, labor/personnel and overheads. The costs for expansion of public transportation networks do not cover construction of subways.

| Measures | Cost [US$ 1,000] | Components |
|---|---|---|
| 1. Efficient use of public transportation | 60,000 | |
| Expansion and improvement of buses and mini-buses | 30,000 | _ Purchase of bus and mini-bus<br>_ Provision/improvement of bus stop, bus terminal<br>_ Provision/improvement of bus lanes<br>(expansion by 50 lanes is planned.) |
| Expansion & improvement of trolley bus | 20,000 | _ Purchase of trolley bus<br>_ Installation of wires<br>(expansion by 5 lines is planned.) |
| Expansion and improvement of park and ride | 8,000 | _ At several spots along trunk roads leading to the city<br>(Introduction of a road pricing system in future is taken into account.) |
| Establishment of public transportation management association | 2,000 | _ Unified system of fares for buses, mini-buses, trolley buses and subways<br>(to facilitate inter-system running and passenger's inter-system/transfer)<br>_ Planning of improvement of inter-system connecting points and other measures |
| 2. Increasing parking area and facilities | 12,100 | |
| Construction and improvement of parking facilities | 12,100 | _ Construction of parking facilities (including multi-storied and underground facilities)<br>_ Provision of parking maters and parking locks |
| 3. Modification of road structure | 60,500 | |
| Improvement of road structure | 24,200 | _ improvement of intersections and installation of traffic signals<br>(planned at 50 intersections) |
| Smoother and more efficient road traffic | 36,300 | _ Installation of left turn lanes and pedestrian's walks<br>_ Installation of a central separation zone<br>(in consideration of possible conversion into a bus lane or trolley bus lane in future.)<br>_ Installation of a reverse lane |
| 4. Improvement of traffic institutions | 12,100 | |
| Re-examination of designated traffic-restricted areas and improvement<br><br>Introduction of road use tax | 12,100 | _ Expansion of a restricted area<br>_ Introduction of a road pricing system<br>(including installation of a fare-collecting gate)<br>_ Introduction of a traffic zone system |
| 5. Improvement of traffic control system | 36,300 | |
| Upgrading of traffic control center | 36,300 | _ Setting up of additional centers<br>(for shared responsibility of inter-city areas and collection of detailed information)<br>_ Upgrading of the center<br>_ Systematic control of traffic signals with introduction of computers, and control of large displ |
| Total | 181,000 | |

7.4.2 Strengthening of inspection and maintenance capacity

Countermeasure No.2-2 Strengthening of I/M program

(1) Outline of countermeasure

Between 1998 and 2010, 50 vehicle inspection plants will be build with individual capacity of 50 vehicles per day and they will be managed and operated directly by the Municipal authority. In addition, among existing vehicle repairing shops(under private management and ownership) in Tehran, those judged to be good from such viewpoints as engineers' experiences, technical levels and equipment quality will be given a license to act as officially appointed agent who will inspect vehicles entrusted by the municipal authority. By 2010, 100 shops will be appointed and rent free of charge equipment needed for the inspection, particularly including the equipment to measure the concentration of pollution substances in the emission of idling vehicles. Management and engineers of these shops will be periodically educated in vehicle inspection techniques and necessity of environmental protection. This education will be provided at the "training course" proposed to be set up as countermeasure No.2-4. While the items to be inspected will be determined in consideration of the recommendations made in chapter 6, the inspection of the concentrations of exhaust gas should be made most rigorously so that a owner of vehicles discharging gas with pollutant concentrations above the standard to be determined in accordance with the measures recommended as countermeasure No. 2-3 will be obligated to change a carburetor and air filter useless tuning reduces the concentrations. The cost for changing parts should be borne by the vehicle owner.

(2)Major equipment and their costs

The costs of major equipment and materials to be needed for execution of these countermeasures are estimated as follows:

Total cost : US$ 16,000,000

Break down

Municipality-managed inspection shop

1) instruments to measure the concentrations of exhaust gas while idling

US$ 60,000

2) special tools for inspection and maintenance US$ 50,000

3) stocks of parts and others US$ 70,000

4) personal computers and peripherals US$ 185,000

5) office equipment and others US$ 25,000

US$ 290,000× 50 shops = US$ 14,500,000

Agent shops

1) instruments to measure the concentrations of exhaust gas while idling

US$ 15,000×100=1,500,000

US$ 14,500,000 + US$ 1,500,000 = US$ 16,000,000

(3)Personnel employment plan

Municipality-management inspection shops

| | |
|---|---|
| Manager | 50 persons (bachelor) |
| Chief engineer | 50 persons (bachelor) |
| Mechanical engineer | 50 persons (bachelor) |
| Chemical engineer | 50 persons (bachelor) |
| Technician | 750 persons (senior high school graduate) |

(4)Schedule and emission reducing effects

The schedule and estimated emission reducing effects of the proposed measure are listed below.

| | | | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1,998 | 1,999 | 2,000 | 2,001 | 2,002 | 2,003 | 2,004 | 2,005 | 2,006 | 2,007 | 2,008 | 2,009 | 2,010 |
| 12 Vehicle Inspection Program | Municipal shop | | | Start→ | 3 | 10 | 20 | 30 | 40 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | Agent shop | | | Start→ | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Taxi | Inspected vehicle | set | 0 | 202,500 | 459,000 | 594,000 | 729,000 | 864,000 | 999,000 | 999,000 | 999,000 | 999,000 | 999,000 | 999,000 | 999,000 |
| | Passenger car | CO reduction | ton/year | 0 | 121,500 | 275,400 | 356,400 | 437,400 | 259,200 | 299,700 | 299,700 | 299,700 | 299,700 | 299,700 | 299,700 | 299,700 |
| | | Sox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Nox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Cost | US$ | 0 | 1,620,000 | 2,780,000 | 2,900,000 | 2,900,000 | 2,900,000 | 2,900,000 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Reduction effectiveness | US$/ton | 0 | 13 | 10 | 8 | 7 | 11 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |

Countermeasure No. 2-3 Enforcement of emission standard

(1)Outline of countermeasure

The objective of this countermeasure is to set forth and enforce appropriate emission standards of Tehran in concert with tighter execution of vehicle inspection discussed as countermeasure NO.2-2, specifically, the proposal envisages formation of a "committee to study emission standards" participated by selected members representing the department and divisions concerned belonging to the Tehran Municipality as well as their local arms. The committee will be entrusted to determine emission standards appropriate for each phase and recommend them to the Municipality authorities for their decision and enforcement.

In order to regulate vehicle emissions developed countries conduct a chassis dynamo test for certification of a new model car and an exhaust gas pollutant concentration test for an official checkout of an in-used car.

Though the former test is difficult to be implemented in Tehran in the immediate future, introduction in the future is deemed essential for reduction of automobile emission. Consequently, even if it may not be implemented now, the committee is advised to set forth the emission standards anyway. Until certain preconditions are met and a full-fledged certification test is implemented, a sample test should be conducted instead, so that new car's pollutant emission during the standard mode runs will be monitored and accumulated in a database. The sample test will be made by sampling a certain percentage of new cars shipping by manufactures and the emission factors using the chassis dynamo test. Should 90% or more of sampled cars fail to clear the emission standards, the manufacturer would be imposed penalties including fines and/or suspension of manufacturing operations. In response to the progress of improvement of an engine and major parts, the emission standards should be lowered step by step, so that the certification test will be started in 2010 following the emission standards which will be comparable to those of developed countries. This measure targets only new cars.

For the measure targeting in-use cars, the regulated upper limit should be imposed on the pollutant concentrations while idling to be tested in the process of an official checkout. Should a tested car fail to clear the limit even with engine adjustments, the car owner would be required to replace a carburetor and an air filter at his/her cost. The regulated will be

decided by the committee as well and be lowered step by step by 2010.

(2)Major equipment and their costs

Not applicable

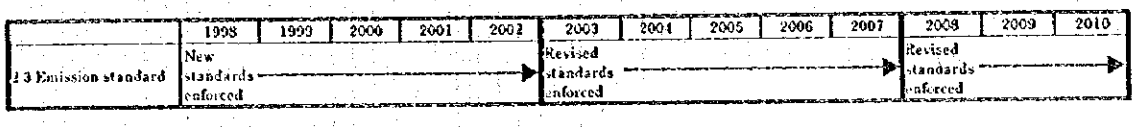
(3)Personnel employment plan

The committee will consists of the following members:

| | |
|---|---|
| Chairperson | 1 person, who is able to influence the politics and administration of the Municipality and is action-oriented, such as a deputy mayor. |
| AQCC representative | 1 person |
| TCTTS representative | 1 person |
| TTTO representative | 1 person |
| TTCC representative | 1 person |
| TIVTIB representative | 1 person |
| Programmer | 1 person |
| Statistician | 1 person |

(4)Schedule and emission reducing effects

Since establishing the emission standards by itself is not able to reduce pollutants, the emission reducing effects are considered identical with those of countermeasure No.2-2 listed above. The schedule is listed below.



Countermeasure No.2-4 Establishment of I/M training course

(1)Outline of countermeasure

Countermeasure No.2-3 is designed to provide hardware needed for automobile inspection, while countermeasure No. 2-4 is to establish the emission standards on which the inspection is to be based. This countermeasure aims to build a training center which will educate engineers who will be engaged in the inspection so that their technical level will be maintained at a satisfactory level and pollutant reduction efforts will be more effective. Equipped with measurement instruments and tools for car maintenance , the center will provide practical training for the purpose of pollutant emission both in the forms of practical exercises and lectures. The center will employ full-time staff consisting of mechanical and chemical engineers(university graduates or those with higher qualification), who will lecture or instruct practical experiences. Whenever necessary, outside lecturers will be invited.

The engineers employed by the Municipality-managed inspection plants and the agent shops will be required to attend training courses of the center regularly. Should they demonstrate poor performance or be absent from the course frequently, their qualification as inspecting engineer would be canceled. In addition to technical training, the center will provide lectures designed to enlighten trainee in needs for environmental protection(for example, impact of air pollution on human health).

(2)Major equipment and their cost

| | |
|---|---|
| Equipment | US$ 555,000 |
| Installation and adjustment | US$ 137,500 |

Breakdown

| | |
|---|---|
| -measurement instruments for vehicle emission(3 sets ) | US$ 200,000×3 sets = US$ 600,000 |
| -lift for vehicle maintenance | US$ 100,000 |
| -special tools for maintenance | US$ 100,000 |
| -parts for practices | US$ 100,000 |
| -personal computers and peripherals(including soft wares) | US$ 85,000 |

-office equipment and others US$ 70,000

Installation and adjustment

The following engineers will be sent by foreign makers for installation and adjustments:

| | |
|---|---|
| Measurement instruments for vehicle emission | 30 persons・day |
| Lift for vehicle maintenance | 60 persons・day |
| Computer | 15 persons・day |

105 persons・day × US$ 500 = US$ 2,500

To the above, the air fare in the amount of US$ 85,000 should be added.

US$ 52,500 + US$ 85,000= US$137,500

(3)Personnel employment plan

The center will employ the following full-time staff:

Director 1 person (a holder of degree in mechanical engineering or chemistry)

Manager 2 person (the principal and deputy)

Chief engineer

| | |
|---|---|
| Mechanical | 1 person (a degree holder) |
| Chemical | 1 person (a degree holder) |
| Electrical | 1 person (a degree holder) |

Lecturer

| | |
|---|---|
| Mechanical | 1 person (MS or BS) |
| Chemical | 1 person (MS or BS) |
| Electrical | 1 person (MS or BS) |
| Instrument | 1 person (BS) |
| Transportation | 1 person (MS or BS) |
| Programmer | 1 person (BS) |

(4)Schedule and emission reducing effects

The emission reducing effects of this measure alone cannot be estimated, but the impact will materialize through synergy with vehicle inspection. The schedule is listed below.

| | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.I/M training | Process | Start → | Completion | Start of operation | | | | | | | | | | → |

### 7.4.3 Institutional support for vehicle parts improvement

Countermeasure No.2-5 Establishment of vehicle engineering center

The investigation into emission sources of the ambient air pollution in Tehran reveals a great deal of contribution by vehicles to CO, and HC emission, In other words, the countermeasure must address vehicular sources. Being a research and study origination concerning transportation policies for vehicular pollution control, TCTTS and TTCC belonging to the Tehran Municipality recommended the mayor on ways to reduce transportation pollution and are engaged in practical jobs like traffic volume control, leading to considerable achievements. On the other hand, although improvement of automobile hardwares and fuels, more directly lead to reduced pollutant emission from vehicles, no facilities or organizations are engaged in comprehensive research and studies in automobile hardware in order to obtain technological and academic expertise. If the theme is right, such research is expected prove effective in a short period of time for reducing of ambient air pollution. Moreover, basic research and accumulated experimental data are essential for vehicular technological progress and reduction of the ambient air pollution in Tehran in the long run.

In consideration of such background, establishment of a vehicle engineering center is proposed.

The center's research divisions will consist of the followings, which will have the following equipment:

Chassis dynamo research division

The division will have an engine bench, experimental device for a chassis dynamo test and analytical device for the pollutant concentration of the exhaust gas in order to study the emission factors.

Engine combustion research division

The division will be engaged in development of a new model engine and improvement in the main part of existing engines in order to raise combustion efficiency.

Fuel research division

The division will be engaged in analysis of automobile fuels being distributed in Tehran, oxygenated fuels, conversion of gasoline into unleaded gasoline, combustion properties and

the like.

Peripheral components research division

The division will be engaged in R&D in major vehicle components such as a carburetor and catalytic converter.

Statistical and literature survey division

The division will collect and put in order literatures both in Iran and abroad, and build an information search system. It will also build a statistical database related to automobiles in Tehran.

(2)Major equipment and their costs

| | |
|---|---|
| Equipment | US$ 6,700,000 |
| Installation | US$ 250,000 |

Breakdown

Equipment

1.Chassis-dynamo meter (C/D)

(1) main equipment

- meters with several kinds (with different weights) of fly wheels
- vehicle fixing device

(2) peripheral equipment of C/D

- speedometer
- running distance meter
- engine revolution meter
- horse power meter
- torque meter
- thermometer (for gas and rooms)
- hygrometer
- flow-meter for absorbed air
- barometer
- others

(3) cooling blower (following vehicle speed)

- engine cooling blower
- tire cooling blower

Vehicle speed following type : The type which sends air in response to changes in vehicle speed.

(4) driver's aid

- mandatory mode (10.15 mode, 11 mode, LA-4 mode, FTP75 mode, etc.)
- optional modes (patterns) should be allowed to put in.

2. Analyzer

(1) direct gas analyzer

- THC analyzer : FID method
- CH4 analyzer : FID method
- NOx/NO analyzer : CLD method
- CO analyzer : NDIR method
- CO2 analyzer : NDIR method
- O2 analyzer : magnetic method

(2) dilluted gas analyzer

- THC analyzer : FID method
- CH4 analyzer : FID method
- NOx/NO analyzer : CLD method
- CO analyzer : NDIR method
- CO2 analyzer : NDIR method
- O2 analyzer : magnetic method

* The measurement items for direct gas anel dilluted gas may be identical, but their measurement ranges differ.

(3) sampling tube

- heated type (for a diesel oil car)
- for a room temperature type (for gasoline-burning car)

* The analyzer needs two types of sampling systems.

3. constant volume sampling device (CVS)

(1) sampling part

(2) controlling part (back)

(3) absorption blower

* The specifications depend on automobile types to be measured (engine size).

4. computer for controlling and processing of data

(1) control of different equipments (software)

(2) processing and graphic drawing of measured data (software)

* The required capacity of a computer depends on to what extent the data to be controlled and measured need to be processed and drawn. (Even a personal computer can meet the requirement to some extent.)

5. dillution tunnel : dillution wind tunnel

(1) dillution tunnel for measuring microswpic particles emitted by a diesel engine car or other cars (including an absorption blower)

* The specifications depend on automobile types to be measured (engine size)

(2) device for collection of microscopic particle matters (dust)

6. peripheral equipment

(1) tools for fixing and maintaining vehicles and for other purposes (including a jack and compressor)

(2) equipment for vehicle maintenance : timing light, engine revolution meter

(3) analysis of hydrocarbons, aldehydes and fuels : gaschromatography (GC), GCM, etc.

(4) black smoke measuring instrument for a diesel engine car : Boschmeter

(5) data recorder (for vehicle speed, engine rotation, etc.)

7. Others

equipment to manufacture dilluted air needed for CVS and a dillution tunnel as

well as air for absorption by an engine (If provided, these devices would upgrade the center.)

Installation

The following engineers will be sent by foreign manufactures for installation and adjustments;

| | |
|---|---|
| Analytical equipment | 90 person · day |
| Chassis dynamo | 180 person · day |
| Computer | 30 person · day |
| Electricity, air condition etc. | 30 person · day |

330 person · day × US$ 500 = US$ 165,000

In addition, the air line fare in the amount of US$ 85,000 will be added.

US$ 165,000 + US$ 85,000 = US$ 250,000

(3)Personnel employment plan

| | |
|---|---|
| Director | 1 person (a holder of degree in mechanical engineering or chemistry) |
| Manager | 2 persons (the principal and the deputy) |
| Research division chief | |
| -Chassis dynamo | mechanical 1 person (degree holder) |
| -Engine combustion | mechanical 1 person (degree holder) |
| -Fuel | chemical 1 person (degree holder) |
| -Peripheral device | mechanical 1 person (degree holder) |
| -Statistics / literature | mathematics 1 person (degree holder) |
| Researcher | |
| -Mechanical engineer | 5 persons (MS) |
| -Chemical engineer | 3 persons (MS) |
| -Electrical engineer | 2 persons (MS) |
| -Instrument | 1 person (BS) |
| -Transportation engineer | 1 person (BS) |
| -Programmer | 1 person (BS) |

(4)Schedule and emission reducing effects

The schedule is also listed below.

| | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J.S Establishment of vehicle engineering center | Process | Start → | | Start of construction | → | Completion | Start of operation | → | | | | | | → |

Countermeasure No. 2-6 Improvement of main parts of car manufacture

(1)Outline of countermeasure

Section 6.2.4 lists the parts of engines to be improved among those being most widely used in IRAN. Since nearly innumerable parts must be improved for the purpose of immediate reduction of the pollutant concentration to the level comparable to those in developed countries, simultaneous improvement of all of them would not be practical from the economic and technological viewpoints.

Because our study reveals that a carburetor and an air filter to be improved most urgently, the immediate measures should focus on these parts.

In order to produce in IRAN these parts with good quality, construction of a manufacturing plant would not be enough but improvement of quality management as well as education in it would be necessary, for a long period of time. In view of the importance and effectiveness of these plants for CO reducing measures, however, their entire requirements will be met by imports for the time being, provided that improvement should be attempted not only for these two parts but for other parts in a stepwise manner.

(2)Major equipment and their costs

Equipment US$ 4,000,000

Breakdown

- carburetor (fixed ventury type) US$ 60/piece
- air filter US$ 20/piece

These 2 parts will be imported (50,000 pieces for each part)

US$ 60 x 50,000 + US$ 20 x 50,000 = US$ 4,000,000

(3)Personnel employment plan

A project team will be formed for improvement of spare parts. The team will discuss various issues concerning import and domestic production of auto parts, and consist of the following members:

project manager — 1 person (ph D in mechanical engineering)

technical adviser

- mechanical — 1 person (ph D)
- chemical — 1 person (ph D)
- Iran KHODRO executive — 2 persons (1 engineer, 1 non-engineer)
- Technical staff mechanical engineer — 2 persons (MS)
- chemical engineer — 2 persons (MS)
- Iran KHODRO engineer — 3 persons (BS)

(4)Schedule and emission reducing effects

| | | | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 6 Improvement of main parts of car manufacture | Taxi | Inspected vehicles | sets | 0 | 0 | 5,000 | 5,000 | 5,000 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 10,000 | 10,000 | 10,000 |
| | | CO reduction | ton/year | 0 | 0 | 4,000 | 4,000 | 4,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 8,000 | 8,000 | 8,000 |
| | | Sox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Nox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Cost | US$ | 0 | 0 | 400,000 | 400,000 | 400,000 | 600,000 | 600,000 | 600,000 | 600,000 | 600,000 | 800,000 | 800,000 | 800,000 |
| | | Reduction effectiveness | US$/ton | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Passenge car | Inspected vehicles | sets | 0 | 0 | 5,000 | 5,000 | 5,000 | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 | 10,000 | 10,000 | 10,000 |
| | | CO reduction | ton/year | 0 | 0 | 4,000 | 4,000 | 4,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 8,000 | 8,000 | 8,000 |
| | | Sox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Nox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Cost | US$ | 0 | 0 | 400,000 | 400,000 | 400,000 | 600,000 | 600,000 | 600,000 | 600,000 | 600,000 | 800,000 | 800,000 | 800,000 |
| | | Reduction effectiveness | US$/ton | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Countermeasure No. 2-7 Introduction of catalytic converter

(1)Outline of countermeasure

Effectiveness of the 3 element catalyst for reduction of NOx, HC and CO is wellknown. However, because Pb and SOx contained in gasoline react with the catalytic device and impair its cleaning function, desulfurization and lead elimination of gasoline are the crucial preconditions for use of this catalyst. Moreover, since unleaded gasoline causes balb seat recession and impedes running of a car if an engine with specifications matching unleaded gasoline is used, supplying cars with engine specifications designed for use of unleaded gasoline is essential. In other words, introduction of the 3 element catalyst, use of unleaded gasoline, desulfurization of gasoline and introduction of cars with specifications matching unleaded gasoline should be targeted in close coodination in the context of planning and implementation with long term perspectives. Furthermore, in order for the 3 element catalyst to clean the 3 ingredients simultaneously, the oxygen content of the mixed gas must be maintained at the optimum level, namely, the theoretical air-fuel ratio, because deviation of the air-fuel ratio from this status will drastically reduce the cleaning ability of the catalyst. While several methods have been developed for maintaining the air-fuel ratio at the theoretical level none of them is easily applicable in Iran in view of the technological level of the country. In any case, maintaining the optimum air-fuel ratio coupled with lead removal and desulfurization of gasoline is a crucial prerequisite for introduction of the catalyst.

Like countermeasure No. 2-6, domestic manufacturing of the 3 element catalyst is a final goal but is difficult to be achieved in a short period of time. Consequently, the requirements will be met by imports for the time being.

(2)Major equipments/materials and their costs

| | |
|---|---|
| Equipment | US$ 60/piece |

Breakdown

| | |
|---|---|
| 3 element catalyst | US$ 125/piece × 100,000 pieces = US$ 12,500,000 |

## (3)Schedule and emission reducing effects

| | | | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-7 Introduction of catalytic converter | Taxi Passenger car | Attached vehicle | set | 0 | 0 | 0 | 0 | 0 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 20,000 | 20,000 |
| | | CO reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 | 36,000 | 36,000 |
| | | Sox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Nox reduction | ton/year | 0 | 0 | 0 | 0 | 0 | 120 | 120 | 120 | 120 | 120 | 120 | 240 | 240 |
| | | Cost | US$ | 0 | 0 | 0 | 0 | 0 | 1,250,000 | 1,250,000 | 1,250,000 | 1,250,000 | 1,250,000 | 1,250,000 | 2,500,000 | 2,500,000 |
| | | Reduction effectiveness | US$/ton | 0 | 0 | 0 | 0 | 0 | 69.44 | 69.44 | 69.44 | 69.44 | 69.44 | 69.44 | 69.44 | 69.44 |

### 7.4.4 Fuel quality improvement

1) Diesel oil desulfurization

According to MOO's data on fuel properties, the sulfur content of Iranian diesel oil is 1.0wt% Max, which is considerably larger than the corresponding ratio in most other countries. Sulfur in diesel oil increases CO, HC and NOx emission of exhaust gas and causes emission of particulate matters. Moreover, it hurts EGR devices and impairs the functions of catalyst for oxidization. Consequently, in sulfur content of diesel oil must be kept as low as possible, at highest between 0.05 and 0.1wt%, which is considered the current world standard.

Desulfurization needs a hydro-desulfurization plant (HDS), whose construction and operation start-up will need a period until the end of phase2.

2) Introduction of oxygenated fuel and proper pricing of fuel

Oxygenated fuels including MTBE-containing fuel facilities complete combustion of CO and HC, significantly reducing their emission. While in Iran, some quantity of MTBE-added unleaded gasoline is already being marketed and NIOC is building the Bandar-Imam petrochemical plant and the Khark Island plant, oxygenated gasoline should be more widely sold within phase2. Because the price difference between oxygenated gasoline and regular gasoline influences propagation of the former, policy measures are needed to set proper fuel prices.

More extensive use of oxygenated unleaded gasoline enables car makers to produce more cars equipped with oxidization catalyst and three-element catalysts, hopefully leading to further reduction of automobile emission.

While national government organizations like MOO and NIOC are responsible for improvement of automobile fuels and MOT is not in a position to be involved directly, MOT is recommended to take decisive steps attempting to strongly influence the national government and auto makers in view of expected substantial impact of

use of oxygenated fuel on reduction of ambient air pollution.

The costs for construction of a desulfurization and MTBE plants are approximately estimated bellow.

| Measures | | Costs [US$ 1,000] | Components |
|---|---|---|---|
| 1. | Desulfurization & low-sulfurization of auto fuels | 38,200 | |
| | License and basic engineering | 3,200 | |
| | EPC | 35,000 | Engineering procurement and construction |
| 2. | Construction of oxygenated fuel plant | 121,000 | Bandar-Imam petrochemical plant and Khark island plant |
| Total | | 159,200 | |

7.4.5 Scrappage program

Countermeasure No.2-10

(1)Concept

As discussed previously, while measures relating to the traffic management system which are effective being effective for reduction of the vehicle emission should be promoted, implementation of individual projects would not be efficient, without being linked to each other, because, for example, vehicle inspection without maintenance follow-up would be meaningless; investment cost per unit quantity of emission to be reduced by a simple scrappage program, e.g. US$8000/ton-CO reduced, would be more expensive compared than complete maintenance of in-use vehicles, e.g. US$10/ton-CO reduced; and replacement of high aged vehicles with medium aged vehicles should be combined with the scrappage program.

Fig. 6.2.3-5 shows indicative project components, which include followings;

- Improvement of a periodical vehicle driving certification system
- Improvement and complete execution of vehicle inspection linked with compulsory vehicle maintenance regarding penalty payment for failure of maintenance
- Improvement and strengthening of maintenance activities
- Opening of banking accounts for procurement of lower emission vehicle including new vehicles for taxi and/or vehicle owners
- Establishment of an In-use Vehicle Sales Center intimately linked with actual scrappage and disposal of vehicles of high-aged cars
- Promotion of practical research and development in rehabilitation technology for in-use vehicle
- Establishment of an environmentally and economically beneficial system for the "Low emission vehicle propagation project".

Key considerations for the projects are as follows;

a. Methodology for giving incentives to vehicle owner

A model in which some benefits will be granted to the owner who are intending to get a more ecological vehicle, e.g. from 20 year aged car to 15 or 10 in the form of payments for the vehicle or in the form of coupon for gasoline and the like.

b. Manufacturing of new vehicles

The required number of new vehicles should be procured through an international tender inviting, among others, joint ventures of Iranian auto manufacturers possibly under the supervision of an international organization

c. In-use Vehicle Sales Center

At present, in-use vehicles, are traded in free markets without any national or Municipal authorization. In view of the present high CO/HC concentration in the ambient air, however, some kind of in-use car sales center should be established and supervised until CO pollution has been satisfactorily reduced.

And these shall be controlled by the Vehicle Inspection Bureau.

d. Necessities of establishment of new municipal organization and increase in man-power

Though there are already a considerable number of man-powers and departments under the DTT of MOT, investment an organization dealing with new car procurement and research in in-use vehicle technology needs to be established in a stepwise manner.

According to a preliminarily calculation, benefits of CO reduction are expected to be huge and in about around ten years the project will nearly solve the CO issues.

(2)Scrappage program

During this period, about 30,000 units of high aged cars, mainly passenger cars and mini trucks, will be scrapped. The planned scrappage will be implemented in 3 stages : in the first stage, 5,000 units will be scrapped on an experimental basis; in the second stage, 10,000 units, and in the third stage 15,000 units.

Scrapped will be mainly those car which are not able to clear the CO emission factor (120g/km) even with maintenance, replacement of a carburettor and tuning up with medium aged cars.

For financial support of car owners, they will be progressively required to open a bank account so that such incentives as arrangement of low interest loan, subsidy of maintenance experts, and supply of fuel will be provided corresponding to car owners

amounts of savings and the emission factor.

A low price car manufacturing will be undertaken through an intersectional tender by a joint venture to be formed by Iranian makers and foreign makers, so that two thirds of manufacturing costs of new cars will be recovered.

More specifically, an "in-use car center" will be established and sell cars at "designated retire prices" specified on the basis of the emission factor in accordance with classification.

Replacing 30,000 unit cars with the emission factor at 120g/km with cars with a 75 g/km emission factor and replacing cars with a 75 g/km with those with a 50 g/km emission factor will reduce 19.2 ton of emission.

A new car will be priced at US$ 5,000 per unit, two thirds of which will be recovered. An approximate total cost is estimated at US$ 40,000,000.

### 7.4.6 Public awareness

Countermeasure No. 2-11 Promotion of public awareness

(1) Outline of countermeasures

A public aware committee will be established in MOT consisting of representatives of AQCC, TTCC, TCTTS, TTTO, the national television organization and press. Each organization will choose one representative who dose not have to serve the committee on a full-time basis. The committee will employ full-time staff consisting 3 non-engineers and 3 engineers in electronics and environmental science.

In an initial period, the committee will meet at least once a week to discuss such subjects as restrained use of individuals car, automobile maintenance, ways to ensure compliance of traffic rules, more use of public transportation, public education in environmental protection issues, and planning /implementation of public relation activities through television networks, press and schools.

(2) Major equipment and their costs

| | | |
|---|---|---|
| Equipment | | US$ 173,000 |
| Installation | | US$ 37,500 |
| Breakdown | | |
| Camera for program production | 3 sets | US$ 50,000 |
| VTR for editing | 1 set | US$ 15,000 |
| Editor | 1 set | US$ 10,000 |
| Color monitor | 1set | US$ 7,000 |
| Projector | 1set | US$ 10,000 |
| Desktop computer | 2 sets | US$ 9,000 |
| Scanner, graphic display and other peripheral equipment | | US$ 20,000 |
| Color printer | 2 sets | US$ 7,000 |
| High speed copier, color copier | 1set each | US$ 25,000 |
| Other office equipment | | US$ 20,000 |

Installation

Engineers will be sent by foreign makers as follows for installation and adjustments:

AV 10 person · day

Computer 5 person · day

15 persons · day × US$ 500 = US$ 7,500

To the above the airline fare in the amount of US$ 30,000 will be added.

US$ 7,500 + US$ 30,000 = US$ 37,500

## 7.5 Emission reduction plan of stationary source

In Iran, although the industrial sectors are supervised by MOO, MOI, MOE and DOE which is responsible for environmental legislation, evidently, environmental control technologies like cleaner production, energy conservation and monitoring system are behind world trend.

Since the revolution in 1979 and the war thereafter, the national policies on investment by foreigners, import and foreign exchange systems have discouraging effects on industrial vitality. Such policies are also regarded as driving force to shift the Iranian economy from the manufacturing sector to service sector. Accordingly, it is believed concerning countermeasures toward stationary sources that implementation of environmental control measures by means of investment is not always appropriate, but improvement of production process with quality control is also indispensable priority tasks to be pursued concurrently with improvement of environmental management systems including monitoring activities as well as research study in energy conservation and cleaner production in collaboration with foreign countries.

Practical emission reduction plan of stationary sources is discussed in this section concerning :

① Inspection activities on emission of pollutants
② Energy conservation measures
③ Pollution control technologies
④ Fuel replacement with low sulfur fuels.

The summary of the proposed emission reduction plan is shown in Table 7.5-1, and the major items in the table are explained below.

### 7.5.1 Monitoring activities on emission of pollutants

Monitoring activities are indispensable to environmental management and inspection because they provide scientific rationale for enforcing polluters to reduce emissions in accordance with regulations.

Table 7.5 -1 : Proposed emission reduction plan of stationary emission sources

| | Subject | Description | Schedule |
|---|---|---|---|
| 1 | Monitoring activities on emission of pollutants | | |
| 1.1 | Expansion of measurement & analysis | Improvement of inspection laboratories | 1998-2000 |
| 1.2 | Survey for industrial subsectors | Data collection & accumulation | 1998-2000 |
| 1.3 | Establishment of guidelines | Based on above survey & data | 1999-2001 |
| 1.4 | Study for emmision control | Legislation under above guideline | 2000-2001 |
| | | | |
| 2 | Energy conservation measures | | |
| 2.1 | Establishment of guidelines with targets | Based on survey of item 1 | 1999-2001 |
| 2.2 | Installation of model boiler | Demonstration & investigation for energy conservation & pollution control technologies | 2000-2001 |
| 2.3 | Promotion of combustion technologies & improvement of heat efficiency | Accumulation of technologies & demonstration by display | 1999-2002 |
| | | | |
| 3 | Pollution control technologies | | |
| 3.1 | Improvement of combustion technologies | | |
| 3.1.1 | - Study for cleaner production technologies | Data collection from foreign countries | 1998-2000 |
| 3.1.2 | - Installation of de-NOx facilities | Application of SCR, CM (LNB, TSC, FGR, OSC) | 2001-2004 |
| 3.2 | Reduction of sulfur content of fuels | | |
| 3.2.1 | - Study for de-sulfur & de-SOx technologies | Data collection from foreign countries | 1998-2000 |
| 3.2.2 | - Installation of de-sulfur plants | Application of HDS process | 2001-2010 |
| 4 | Fuel replacement with natural gas | Expansion of natural gas supply grids | 1998-2004 |
| 5 | Others | | |
| 5.1 | Introduction of ISO-14000 | Under leadership of AQCC | 2000-2002 |
| 5.2 | Study for financial inentives | Tax reduction, subsidy, low interest loan | 2002-2005 |

(Repo2C-E.xls)

In order to accelerate the activities of ORSUITO for monitoring emission of air pollutants through its operational units in GTA as well as to give its rulings more scientific rationale, ORSUITO should have the measuring equipment in the following steps:

① First step : Expansion of central laboratory

The central laboratory of ORSUITO should be expanded as shown in Table 7.5.1-1 below as the minimum requirements. Those measuring equipment have to be fully utilized by the staffs of ORSUITO through training how to handle them. The unit price of each equipment is illustrated in Table 7.5.1-2.

Table 7.5.1-1 : Price of measuring equipment to be supplied to ORSUITO (1994 basis)

| Equipment | Set | Unit price (million Rs) | Total price (million Rs) |
|---|---|---|---|
| Hand operation set | 2 | 236,250 | 472,500 |
| Automatic operation set | 2 | 432,500 | 865,000 |
| Atomic absorption meter | 1 | 300,000 | 300,000 |
| Fume hood | 1 | 95,000 | 95,000 |
| (Total) | | | 1,732,500 |

(Note) See Table 7.5.1-2 for details (Analysis1)

②Second step : Expansion of laboratories located at southern 4 districts

In order to promote measuring activities of energy intensive areas like 4 southern districts, the laboratories need to be expanded similar as the central laboratories do. In the light of the monitoring activities, the following matters should be discussed.

- Subsector-wise features of air pollution
- Guidelines for air pollution control
- Establishment of emission regulations

Table 7.5.1-2 : Price of measuring equipment for emission of air pollutants from factories

| Hand operation | | | Automatic operation | | |
|---|---|---|---|---|---|
| Item | Equipment | Unit price (¥1000) | Item | Equipment | Unit price (¥1000) |
| Velocity | Pitot tube | 100 | Velocity | Pitot tube | 100 |
| | Pitot tube | 100 | | Pitot tube | 100 |
| | Mano meter | 150 | | Mano meter | 150 |
| | Thermo couple | 100 | | Thermo couple | 100 |
| CO2,O2,CO | Orsat | 150 | CO2,O2,CO | Orsat | 150 |
| Moisture | Mini pump | 150 | Moisture | Mini pump | 150 |
| | Gas meter | 100 | | Gas meter | 100 |
| | U-tube | 100 | | U-tube | 100 |
| | Sampling tube | 150 | | Sampling tube | 150 |
| | Balance | 200 | | Balance | 200 |
| Dust | Pump unit | 1,000 | Dust | Sampling unit | 3,600 |
| | Sampling tube | 100 | NOx, SOx | Nox analyzer | 1,800 |
| | Nozzel | 100 | | Sox analyzer | 1,800 |
| | Hose | 100 | | O2 analyzer | 1,500 |
| NOx | Sampling set | 500 | | Pump unit | 1,100 |
| | Vacuum pump | 100 | | Pump unit | 1,500 |
| SOx | Sampling set | 200 | | Recorder | 650 |
| Laboratory | UV-VIS meter | 2,000 | Laboratory | Dry oven | 300 |
| | Dry oven | 300 | | Electric furnace | 500 |
| | Electric furnace | 500 | | Balance | 250 |
| | Balance | 250 | | Water distillatio | 1,500 |
| | Water distillatio | 1,500 | | Glassware | 500 |
| | Glassware | 500 | | Others | 1,000 |
| | Others | 1,000 | | | |
| | (Total) | 9,450 | | (Total) | 17,300 |

(Note)

If metal analysis in flue gas is to be conducted, the following equipment is needed.

| | |
|---|---|
| Atomic absorption meter | 12,000 |
| Fume hood | 3,800 |
| (Subtotal) | 15,800 |

(Note) FOB Japan

7.5.2 Energy conservation measures

The target of energy conservation activities is described in details as shown in section 6.3.1, and for the sake of confirmation, Table 6.3.1-1 in section 6.3.1 is reproduced in Table 7.5.2-1 below. Energy conservation is one of key factors for air pollution control, since air pollutants will decrease almost in proportion to energy conservation ratios and also operation cost of factories will decrease reflecting the reduction of energy consumption.

Table 7.5.2-1 : Target of energy conservation

| Sector | Base | Reduction target | |
|---|---|---|---|
| | | Common | Best |
| Manufacturing | | | |
| 31 Food | 100 | 93.40%/IP @2010 | 86.80%/IP @2010 |
| 32 Textile | 100 | 90.55%/IP @2010 | 81.10%/IP @2010 |
| 33 wood | 100 | 91.75%/IP @2010 | 83.50%/IP @2010 |
| 34 Paper | 100 | 81.45%/IP @2010 | 62.90%/IP @2010 |
| 35 Chemicals | 100 | 75.75%/IP @2010 | 51.50%/IP @2010 |
| 36 Non-metal | 100 | 89.30%/IP @2010 | 78.60%/IP @2010 |
| 37 Iron & steel | 100 | 85.80%/IP @2010 | 71.60%/IP @2010 |
| 38 Machinery | 100 | 95.25%/IP @2010 | 90.50%/IP @2010 |
| 39 Others | 100 | 95.25%/IP @2010 | 90.50%/IP @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%/IP @2020 | 95.00%/IP @2020 |
| Refinery | 100 | 95.00%/IP @2020 | 90.00%/IP @2020 |
| (Note) IP:Index of Industrial Product, IHS:Index of Household Service ICS:Index of Commercial Service | | | |

For the purpose of energy conservations, the following matters should be discussed.

- Guidelines to achieve the energy conservation targets
- Installation of a model boiler for research and dissemination of energy conservation
- Dissemination of combustion technologies with manuals and display shops

### 7.5.3 Pollution control technologies

For introducing cleaner production technologies, selection of energy intensive industrial subsectors and such critical equipment as boilers and furnaces should be made, to which cleaner technologies should be applied with priority. Then implementation procedures should be planned as illustrated below.

(1) Improvement of combustion technologies

As described in section 6.3.2(2), combustion technologies should be improved with the following procedures mainly in relation to NOx reduction, since SOx emission has only remote relation with combustion technologies for stationary emission sources.

The projection of NOx reduction could be estimated by changing NOx emission factors as shown in Table 6.3.1-5(2).

1) Energy conversion sector

This sector burns a huge amount of fuels per unit facility, generating a large amount of SOx and NOx as well as other types of pollutants.

The energy conversion sector share is estimated to have 19% of the total emission of SOx and 18% of NOx in GTA in 1994.

Therefore, it would have a strong impact on overall environment if pollutants were fully eliminated in this sector. Hence, this report plans that de-NOx facilities will be fully installed at the power plants in terms of improvement of combustion technologies while de-sulfur facilities of HDS will be installed at refineries like Tehran Refinery for SOx reduction. The investment cost of the de-NOx facilities and the reduction amount of NOx are as shown in Tables 7.5.3-1,-2 below.

Table 7.5.3-1 : Investment cost of de-NOx facilities at power plants (1994 basis)

| Plant | Type | Capacity(Mw) | Total cost(million Rs) |
|---|---|---|---|
| Besat | SCR | 391 | 41, 550 |
| Ray | SCR | 1, 243 | 132, 075 |
| Firouz | LNB+TSC+FGR | 75 | 5, 675 |
| | (Total) | | 179, 300 |

(Analysis)

Table 7.5.3-2 : Reduction amount of NOx at power plants (1994 basis)

(ton/year)

| Plant | Emission before implementation | Emission after implementatioin | Reduction amount (Balance) |
|---|---|---|---|
| Besat | 5,022 | 1,004 | 4,018 |
| Ray | 6,013 | 1,203 | 4,810 |
| Firouz | 713 | 428 | 285 |
| (Total) | 11,748 | 2,635 | 9,113 |

(Analysis)

2) Manufacturing sector

This sector shares 64% of the total emission of SOx and 42% of that of NOx in GTA in 1994, although the per unit consumption of fuels is much less than the energy conversion sector. However, this sector has a large potential in innovating technologies of energy conservation, improving fuel combustion and cleaner production as described in section 6.3.2, especially in the subsectors of iron & steel, nonmetal products and chemicals.

Since there are many steam boilers and heating furnaces in many kind industrial units in GTA, even if their scales are not always big, installation of combustion modification (CM) equipment such as low NOx burners (LNB) to these boilers and furnaces are very effective in reduction of NOx emission.

a) Small packaged steam boiler with low NOx emission burners

For reference in replacing numerous steam boilers of small capacities currently used with low NOx emission type boilers following the experience in Tokyo in the small and medium size industries and commercial sectors, the unit prices of boilers are collected from suppliers in Japan as shown in Table 7.5.3-3.

Table 7.5.3-3 : Price of small packaged boilers with low NOx emission burners

(1994 basis)

| Boiler type | Fuel | Steam (kg/h) | Nox reduction method | Unit price (million Rs) |
|---|---|---|---|---|
| Once through | Natural gas | 5,000 | LNB | 520 |
| Once through | Natural gas | 2,000 | LNB | 275 |
| Once through | Natural gas | 1,000 | LNB | 175 |
| Once through | Natural gas | 500 | LNB | 85 |

b) Installation of low NOx emission burners (LNB) to furnaces

Since there are numerous furnaces in the industrial sector, especially in the subsector of chemicals, non-metals and iron & steel, a large amount of NOx reduction can be expected by installation of low NOx burners (LNB) to these furnaces. There are some other types of NOx reduction systems for combustion modification (CM) systems other than LNB, although LNB is the most popular as described in section 6.3.2(2). Table 7.5.3-4 illustrates investment costs and reduction effects of these CM system.

Table 7.5.3-4 : Investment cost and reduction effects of CM system (1994 basis)

| | Type | Pollutant for reduction | Reduction ratio (%) | Investment cost (Rs/m3/hr) |
|---|---|---|---|---|
| 1 | LNB+TSC+FGR | NOx | <50 | 16,425 |
| 2 | LNB+FGR | NOx | | 12,275 |
| 3 | TSC+FGR | NOx | | 11,875 |
| 4 | LNB+TSC | NOx | <40 | 12,000 |
| 5 | TSC | NOx | <30 | 7,300 |
| 6 | LNB | NOx | <30 | 3,225 |
| 7 | OSC | NOx | <20 | 650 |

(Analysis)

3) Commercial/household sector

This sector shares 14% of the total emission of SOx and 11% of that of NOx in GTA in 1994, but per unit consumption of fuels is negligibly small compared to the other sectors. However, there are many types of fuel combustion equipment such as a

household heater, cooking range and water heater. In this sector, reduction of NOx emission is expected through prolonged combustion time in the heating process (low temperature combustion), although total NOx reduction may not be in a large amount, since the NOx emission factors in this sector are relatively small. Under the circumstance, environmental control in this sector is to be focused on the public awareness.

(2) Installation of de-sulfur plants at refinery

1) Process selection

The most popular process of HDS (Hydrodesulfurization) can be applied for heavy oil, gas oil and kerosene at any refinery like Tehran Refinery as shown in Table 7.5.3-5. These direct oil desulfurization units at a refinery are the most fundamental and effective measures to kill the origin of SOx generation in place of flue gas desulfurization (FGD) process . Table 7.5.3-5,-6 below shows the investment costs and reduction amounts of SOx with the HDS process.

Table 7.5.3-5 :Investment cost of HDS plants at refinery (1994 basis)

| Fuel | Process | Capacity(b/d) | Total cost(million Rs) |
|---|---|---|---|
| Heavy oil | HDS | 79,021 | 900,000 |
| Gas oil | HDS | 52,520 | 185,975 |
| Kerosene | HDS | 35,651 | 132,625 |
| | | (Total) | 1,218,600 |

(Analysis)

Table 7.5.3-6 :Reduction amount of SOx by HDS plants at refinery (1994) (ton/year)

| Plant | Emission before implementation | Emission after implementatioin | Reduction amount (Balance) |
|---|---|---|---|
| Heavy oil | 261,402 | 26,140 | 235,262 |
| Gas oil | 41,940 | 4,194 | 37,746 |
| Kerosene | 6,620 | 662 | 5,958 |
| (Total) | 309,962 | 30,996 | 278,966 |

(Analysis)

2) Outline of HDS process for heavy oil

Process features including design conditions, ISBL/OSBL facilities are almost the same as the case of diesel oil desulfurization plant as described in section 6.2.5(2) except the following items.

- Plant capacity : 80,000 BSD
- Construction cost : US$ 300,000,000

7.5.4 Fuel replacement with low sulfur fuels

Fuel replacement with low sulfur fuels, especially with natural gas is the most facilitated and effective process for reduction of SOx as well as NOx emission in GTA. Since the investment cost to be required for construction of a natural gas supply grid in GTA taking into account the increased demand in future is currently not available, the feasibility study for this undertaking is worthwhile for the purpose of national environmental control and economic distribution of natural resources in Iran.

The effect of reduction of SOx and NOx through fuel replacement with natural gas as well as fuel substitution from solid/fuel oil to low sulfur oil in GTA is illustrated in Table 7.5.4-1 below.

Table 7.5.4-1 : Reduction amount of SOx & NOx by fuel replacement with low sulfur fuels (1994 basis)

(ton/year)

| Fuel conversion | Emission before implementation | | Emission after implementatioin | | Reduction amount (Balance) | |
|---|---|---|---|---|---|---|
| | SOx | NOx | SOx | NOx | SOx | NOx |
| Solid fuel/fuel oil to natural gas | 252,714 | 63,104 | 371 | 30,673 | 252,343 | 32,431 |
| Solid fuel/fuel oil to low sulfur fuel oil* | 252,714 | 63,104 | 29,596 | 58,273 | 223,118 | 4,831 |

(Note) * Solid fuel is converted to low sulfur heavy oil (Analysis)

## 7.6 Institutionalization and human resource development

### 7.6.1 Responsibilities of the central government

The major problem in the current system is lack of close collaboration between that the central government and the local governments. These administrative bodies should cooperate with each others playing their individual roles. The national government should be responsible for nationwide environmental issues, while each local body for the practical measures. The basic roles of the national government are, firstly, to formulate comprehensive environmental policies: for example, low-sulfurization of gas oil and heavy oil and encouragement of installation of de-sulfurization units and, secondly, to determine an environmental standard and, based on this, specify an emission standard. The environmental standard is determined from the viewpoint of protecting human health while the emission standard must be practical and be tightened the standard step by step. In addition, activities for sensitizing the general public to the importance of observing the rules are needed.

Thirdly, the central government should make a nationwide plan for improving environment in cooperation with local governments. In addition, the central government should play an important role in promoting studies and education about the preservation and improvement of environment, and sensitizing the public to these necessities. The data relating to environment should be obtained at public expense and therefore should be made available to the general public as a rule. Such a system of sharing data is crucial.

### 7.6.2 Responsibilities of the local government (Municipality of Tehran)

The major role of the local government is to implement the measures according to the basic environmental policy defined by the central government. Actuality, however, the basic plans concerning air pollution are also made by MOT (See the four declarations including "Clean City 80" and "Congestion Free City 80"). Both basic ideas and concrete measures have been incorporated in the plans. The goals of the countermeasure plans should be precisely determined by impact assessment so that air pollution will be eliminated in neither too excess nor too little emission reduction. The emission reduction should be decided to satisfy environmental standard but should not be excess. The role of the local government includes the implementation of measures, consisting measuring pollution, analysis and recording statistics, evaluating the environmental impact, carrying out countermeasures based on the evaluation, promoting public awareness of environmental issues.

The most practical goals to cope with air pollution on a short-term bias are as follows:

a) Completion of a highway which is now under construction.
b) Further promotion of the subway and bus systems
c) Expansion of the restricted area and hours for vehicles entry
d) Improvement of the car inspection system and parts such as carburetors
e) Urgent introduction of oxygenated gasoline (MTBE)( This is not directly responsibility of MOT; however it is effective to improve CO pollution.)

The most practical measures on a mid-term and long-term basis are as follows:

a) Establishment of an inspection system and enhancement of public awareness of observing rules
b) Improvement of car inspection workshops and inspection techniques
c) Further promotion of the relocation of industrial factories

The general guidelines for improving environment are detailed in the Green City 80 Plan and others.

### 7.6.3 Introduction of new institutions

It is desired that the national government organizations which are in charge of environmental issues, should supply their information to the public. In view of the public nature of the measured data, an annual data book should be published.

The Municipality of Tehran (MOT), the local government, should reconsider the division of responsibility among its branch organizations including AQCC and TCTTS, so that they can carry out a comprehensive research to cope with air pollution. An institution with integrated responsibility dealing with traffic and environment should therefore be established so that the main subjects to be dealt with will be as follows:

a) Study on traffic flow
b) Study on vehicle technology
c) Study on measures to be taken for environmental protection

The study on environmental issues is of an academic nature and the existing divisions cannot cover all the necessary issues. The mayor may therefore have to hire a consultant or an organization in order to receive the technical advice. The required number of stuff should be more than dozens of people covering main environmental subjects and interdisciplinary fields.

Another urgent task is to improve the inspection centers (PVTIB). The current inspection system needs urgent improvement from the viewpoint of efficiency . The construction of inspection workshops should be promoted to ensure inspection of all vehicles. There are currently 1.3 million vehicles in Tehran, while there are 80 inspection facilities, each of which can inspect only one vehicle at a time. If it is assumed that an inspection workshop is open eight hours per day and the time spent for inspection of a vehicle is one hour, all the workshops in the city can cover only about 250,000 sets of vehicles per year. This means that the current number of workshops is short of the capacity for inspecting all cars in a year with a factor six. The key to improving efficiency is to expand the operation capacity so that more than one vehicle can be inspected at a time and to improve technology so that on-the-spot repairing can

be done. The required number of workshops is at least more than double of the present number 80 and the checking method should be improved from the viewpoint of efficiency.

## 7.7 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 7.7.-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 issues 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 7.7-1 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 | Desulfunzation 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 con : 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.

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# Appendix

[Appendix]

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# Appendix 2.2.3
# Clean Air Act (a plan for the Control of Air Pollution)

In the Name of God

**A Plan for the Control of Air Pollution**

**Section One: General**

**Article 1:** In order to implement the 50th Article of the Constitutional Law of the Islamic Republic of Iran, and to cleanse and safeguard the air from pollution , all organizations and institutions, and public and private are persens required to follow the regulations and policies specified in this law.

**Article 2:** Actions which cause air pollution are forbidden. By air pollution, it is meant the creation and spread of one or more pollutants of solid, liquid, gaseous, light and non-light radiating nature, that when released into the air in certain quantities and for certain time periods, change the quality of the air, making it injurious for humans, other animals, plants, and buildings.

**Article 3:** The sources of air pollution that fall under the regulations of this law can be classified into three groups:

A - Motor vehicles
B - Factories, workshops, and power plants
C - Business, domestic, and miscellaneous sources

**Section 2: Motor Vehicles**

**Article 4:** The use of motor vehicles which emit smoke and other pollutants into the air, above the permitted levels, is forbidden. The permitted level of motor vehicle emissions is determined by the EPO, with the help of the Ministry of Heavy Industry, and approved by the Supreme Council on Environmental Protection Affairs.

**Article 5:** All motor vehicles in use must possess a special license indicating compliance with the permitted levels of air polluting emissions. Owners of motor vehicles are bound, each year, to have their vehicles inspected at the EPO's verification center (established by the Municipality), and to receive a license indicating compliance with the permitted levels of pollution. Those vehicles that do not possess this license will not be allowed to drive on the roads.

**Note 1:** The cost of the inspection of motor vehicles will be collected from the aforementioned vehicle owner, according to rates set by the Ministry of Interior and the EPO, and approved by the Supreme Council on Environmental Protection Affairs.

**Note 2:** The date for the implementation of this Article and its Notes will be at most one year after approval of this law. The EPO and the Municipality, as well as other related organiaztions, are charged with gathering in the aforementioned time interval, the necessary contingencies for the implementation of this article.

**Article 6:** The Municipalities, the Police Force of the Islamic Republic of Iran, the Ministries and related agencies, are hereby obliged to design and organize the traffic of motor vehicles and the urban transport system, generally, in such a manner as to reduce air pollution, as well as meet the need's of daily urban travel.

**Note 3:** The regulations of this article, which include restrictions on the time and location of urban travel, and recommendations for greater use of public transport, will be passed by the Ministry of Interior (Municipalities), the Police Force of the Islamic Republic of Iran and EPO, and if necessary, together with the related agencies, and in a form approved by the Board of Ministers.

**Article 7:** In emergency situations, when, due to specific atmospheric conditions, air pollution in cities reaches levels deemed dangerous for human and environmental health (as determined by the Ministry of Health and Medical Education), the EPO will, with the help of the Ministry of Interior (Municipalities and Police Force of the Islamic Republic of Iran) place temporary prohibitions and restrictions related to the use of polluting sources, and immediately inform the public of these actions, through the media. With the end of the emergency situation and reduction of air pollution, the EPO will remove these restrictions, and inform the public of the change.

**Article 8:** The production and import of motor vehicles, as well as engines and other parts related to motor ignition, such as carborators and filters, must comply with the standards of the EPO.

**Article 9:** The Ministry of Heavy Industry is charged with regulating the policies and production plans of units and companies whose function is to produce motor vehicles so that 1) these units do not produce vehicles with engines and parts that are not up to standard, 2) priority is given to the production of vehicles for public transport, and 3) vehicles are produced that are able to use natural gas as well as gasoline.

**Article 10:** Registration of all motor vehicles requires compliance with the standards of Article 8 of this law.

**Article 11:** The standards set in Article 8 and 9 of this law, will be prepared by the EPO with the cooperation of the Ministry of Heavy Industry, the Ministry of Oil, and related research institutions, and approved by the Supreme Council on Environmental Protection Affairs.

**Section 3: Factoris, Workshops, and Power Plants**

**Article 12:** Establishing new factories and workshops, and changing the location and/or production line of existing factions and workshops, requires compliance with the regulations and criteria of the EPO.

**Article 13:** Ministries of Industry and (Heavy Industry) Mines and Metals, Agriculture and Jahad-e-Sazandegi, will, at the time of issuing a permit for the establishment of new factories and workshops, forward a copy to the EPO. The owners of the mentioned permit muat comply with Article 12 of this law. The issue of an operation permit requines location approval from the EPO.

**Note 1:** Construction of power plants, refineries, petrochemical factories, defense industry factories, airports, and loading terminals requires compliance with the regulations and standards of the EPO in regards to their location.

**Note 2:** Regulations and standards of Article 12 and 13 will be preparel by the EPO, with the cooperation of ministries mentioned in this article, and will be approved by the Board of Ministries.

**Note 3:** The EPO is charged with publicizing environmental regulations and standards, through related ministries, to the owners of the permits.

**Article 14:** Activities of new factories and workshops that do not comply with the regulations and standards set in Article 12, as well as activities and operations of factories, workshops, and power plants which produce sources of air pollution above the permitted levels, are forbidden.

**Article 15:** The EPO will identify those factories, workshops, and power plants whose pollution is higher than the permitted levels set in the environmental standards, and will communicate this finding, along with the determination of

the type and measure of the pollution, to their owners and other resposible parties. The owners will then be given until a specified time, as determined by the EPO with the help and cooperation of related organizations, to take action in relation to the elimination of the pollution, which may or may not require temporary closure of their work and activities.

Note 1: Where the owners or managers of polluting factories and workshops produce plausible explanations at to why they can not reduce their pollution within the specifed time, the EPO can, for one time only, grant an extension to the time period.

Note 2: The EPO is charged with determining, for every region, clean air standards as well as standrds for polluting emissions produced by the factories and workshops of that region, with attention to the quality of the air and ecological conditions of the region, and to submit these standards to applicants and owners of factories and workshops. The permitted levels (environmental health standards) under this Article will be determined by the EPO and approved by the Supreme Council on Envoronmental Protection Affairs.

Article 16: In instances where the owners or other responsible parties of polluting factories, workshops, and power plants do not modify their activities so as to reduce pollution within the allocated period, and with the request of the EPO and the order of the local judge, their activities will be curbed.
The above mentioned factories, workshops, and power plants may resume their work only after permission is issued by the EPO and/or through a court order.

Note: Where owners and other responsible parties of polluting factories, workshops, and power plants, after receiving the EPO's notice, have not by themselves altered or halted their activities, or, after closure of their factories or

workshops, they resume work without permission from the EPO or a court order, they will be penalized according to this law. Managers of government factories, workshops, and powerplants who ignore the EPO's notice, will have their cases reviewed by special disciplinary committee.

**Article 17:** In an emergency situation or under special atmospheric conditions, the head of the EPO has the power to request the temporary closure of factories and workshops, whose activities pose an immediate danger, until the end of the emergency period. If the EPO meets with a refusal, it can obtain a court order to support its action.

**Article 18:** In cases where a reduction or elimination of pollution resulting from the activities of factories and/or workshops is not possible, and/or their activities pose a danger to the wellbeing of residents in their area, the EPO, with the help of other related ministries and governmental organizations, will determine a plan for the transfer of the mentioned factories and workshops to more appropriate locations. Accordingly, after approval from the Board of Ministries, such a plan can be implemented.

**Article 19:** Factories, power plants, complexes, townships and other production units, must allocate at least 10% of their area to greenery and tree planting. Only through the establishment of such green space, as specified in this article, may these industries continue their operation. Industrial ministries are charged with monitoring compliance with this Article.

**Article 20:** Factories, workshops, power plants, and brick and lime burning furnaces are required to use fuels and combustion systems that reduce the level of air pollution.

Note: The Ministry of Oil is charged with placing as a priority, the distrubtion of gas to industrial units such as factories, workshops, and brick furnaces, located adjascent to large cities.

Article 21: The regulations of this Section and those related to the prohibition of industrial units in the vicinity of cities, will be determined by the EPO, with the cooperation of related ministries, and approved by the Board of Ministries.

Section 4: Business, Domestic, and Miscellaneous Sources

Article 22: The spread of any type of air polluting material, above the permitted level, from business, domestic, and miscellaneous sources, into the open air, is forbidden. The type and amount of pollution comming from business, domestic, and miscellaneous sources, and the permitted levels under this Article, will be determined by the EPO and approved by the Supreme Council on Environmental Protection Affairs.

Article 23: Sources of pollution, such as public baths, bakeries, hotels, and restaurants, should, in their plans for controlling the spread of smoke, soot, and other pollutants, adopt the use of cleaner fuels, such as natural gas, that cause less air pollution. The Minitry of Oil should put as a priority, the supply of natural gas to businesses and public services.

Article 24: In order to prevent environmental pollution, hospitals, clinics, and health centers will be bound, after a date established by the EPO, to use standardized incinerators, and to use such equipment in the proper, recognized manner, as determined by the EPO. Those hospitals, clinics and health centers that are unable to use such standardized equipment, will have their waste collected in a speedy manner by an EPO appointed organization, after submitting the proper fee.

Article 25: The burning and storage of city and household waste and any type of refuse, in public areas, is forbidden.

Article 26: The Ministry of Housing and Urban Development, and the Ministry of Interior are charged with creating a seperate section within their planning documents, for the study of environmental problems. Such plans, which include those for the creation of green areas, road and transportation networks, housing regulations, etc., must comply with the EPO's standards, regulations, and requirements.

Artticle 27: Regulations pertaining to the implemntation of Article 26 of this law will be determined by the Minitry of Housing and Urban Development, the Minitry of Interior, and the EPO, and approved by the Board of Ministries.

Article 28: The creation of any type of noise pollution above the permitted levels, is forbidden. The regulations for the control of noise pollution will be determined by the EPO and approved by the Board of Ministries.

**Section 5: Punishments**

Article 29: Individuals who use motor vehicles that pollute above the permitted levels, and those who ignore the regulations of Article 7 of this law, will be sentanced a fine of 5000 to 100,000 Rials, depending on the number of cylinders, the volume of the engine, and the level of pollution of the car, as well as the repitition of the offense. This fine will be in accordance with the regulations set by the EPO and the Ministry of Interior, and approved by the Board of Ministries. In the meantime, the polluting motor vehicle will be banned from travel and use.

Article 30: Owners and responsible parties of polluting factories and workshops which act against Articles 14, 16, and 17 of this law, will be sentanced , for their first

offense, a fine of 500,000 to one million Rials. If repeated, they will be sentanced to imprsonment from two to six months and fined 700,000 to two million Rials.

Note 1: Owners and responsible parties of these polluting factories and workshops will, in addition to the aforementioned sentances, be required to pay compensation to the EPO as well as the general public, in accordance with a court order.

Article 31: Individuals who prevent EPO inspectors from taking samples for the determination of pollution levels, or who give false information to these inspectors, will , in accordance to the graity of the case, be fined 500,000 to five million Rials. If such an offense is repeated, they will be sentanced to imprisonment of one to three months and fined once again.

Note : Should inspectors of the EPO themselves participate with such individuals in providing false information, they will be prosecuted by a special disciplinary committee and receive the maximum sentance, as specified above.

Article 32: Owners of businesses and other public buildings who act against Article 25 of this law in the creation of air pollution will be sentanced a fine of 100,000 to 500,000 Rials, and on repitition, 300,000 to two million Rials.

Article 33: Individuals responsible for air and noise pollution due to miscellaneous and residential sources, will be sentanced a fine of 30,000 to 300,000 Rials, and on repitition, 100,000 to one million Rials.

**Section 6 : Miscellaneous Regulations**

Article 34: The Radio and Television Organization of the Islamic Republic of Iran is charged with arranging, with the help of the EPO, programing appropriate

for the education of the public on the regulations and laws pertaining to the protection of the environment.

**Article 35:** The revenue generated from the fines specified in this law will be transferred to the government treasury account. Furthermore, every year, 50% of the revenue and a maximum of one billion Rials will be allocated to the EPO for the implementation of this law, and 20% and a maximum of 400 million Rials will be issued to the Police Force.

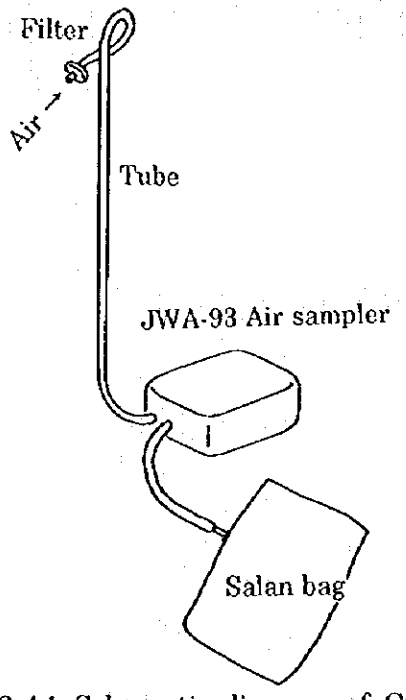
**Article 36:** The regulations pertaining to this law will be prepared by the EPO (and in some cases, with the cooperation of other relevant organizations) within three months after approval of this law.

**Article 37:** The President and the Chair of the EPO are responsible for the execution of this law, and must report every six months on the status of its implementaton to the relevant subcommitte of the Parliament of the Islamic Republic of Iran.

**Article 38:** From the time of the announcement of this law, all other laws contrary to it and related to the control of air pollution, will be cancelled.

Appendix 3.4.2-A Explanation of CO measurement

(1) Schematic diagram of CO sampling (2) Pictures of CO sampling



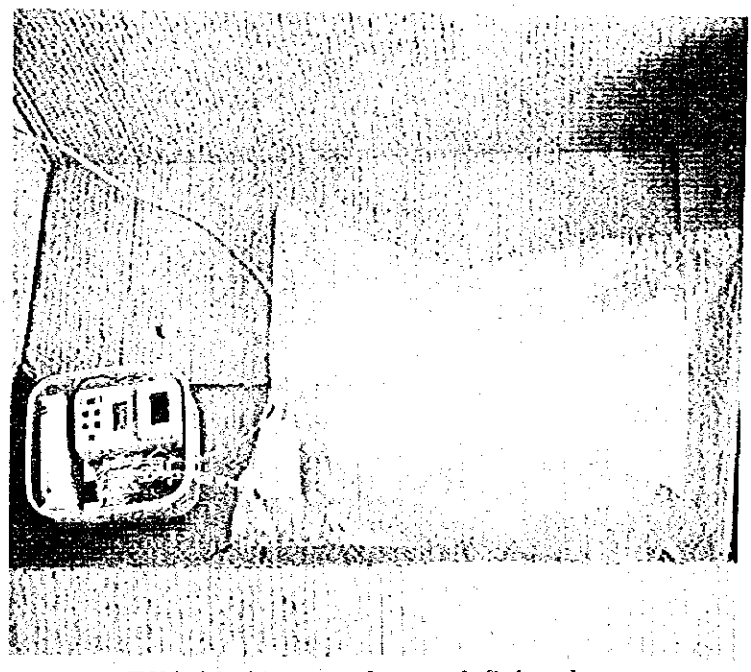
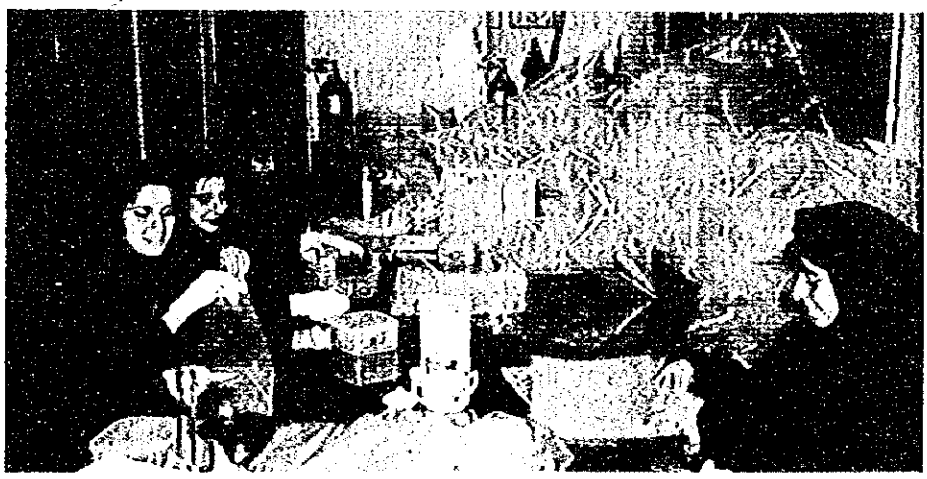
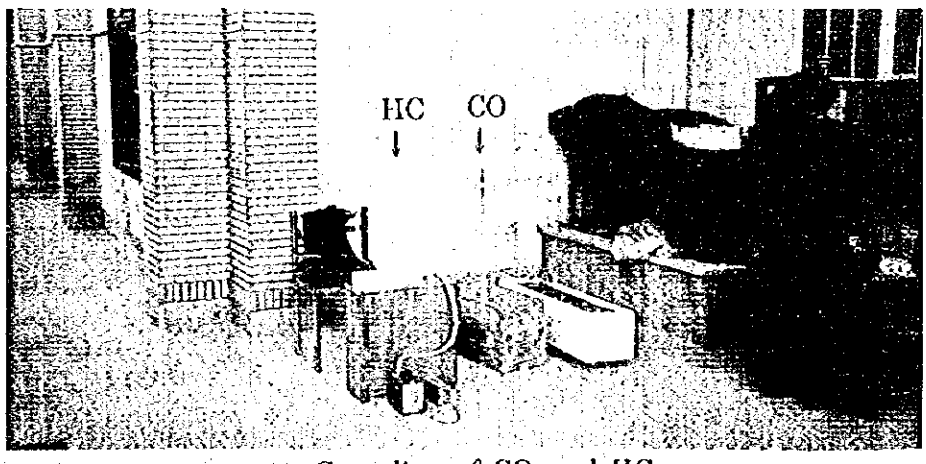



Fig. 3.4.2-A1 Schematic diagram of CO sampling JWA-93 Air sampler and Salan bag

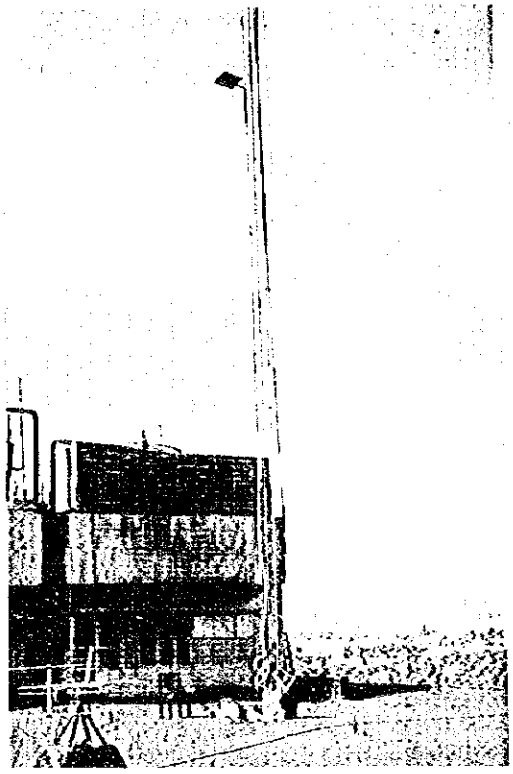


Preparation of the bags




Sampling of CO and HC

(2) Picture of CO sampling



(3) Picture of CO and HC analysis

MOT government office building
(vertical sampling of CO)

Analysis of CO and HC

Appendix 3.4.2-B Explanation of HC measurement

(1) Schematic diagram of HC sampling

The indirect sampling system consists of an airtight plastic container with a Tedolar bag, a pump and a connection tube. The container has one inlet valve and one outlet valve. The outlet valve is connected to the air pump with a silicone tube, while the inlet valve is connected to a Tedolar bag in the container. At first, both valves are turned to open and the pump is switched on simultaneously. The pump reduces the pressure inside of the container by pulling out the air. The ambient air is pulled into a Tedolar bag through only the inlet valve. After sampling, the pump is switched off and both valves are turned to close.

The indirect sampling system is designed originally for sampling of odor. The system was introduced to the measurement of HC, because HC is not stable compared to CO, and will be adsorbed or destroyed easily in the sampling tube and pump of the usual sampling device such as for CO sampling which has a sampling bag behind the pump.

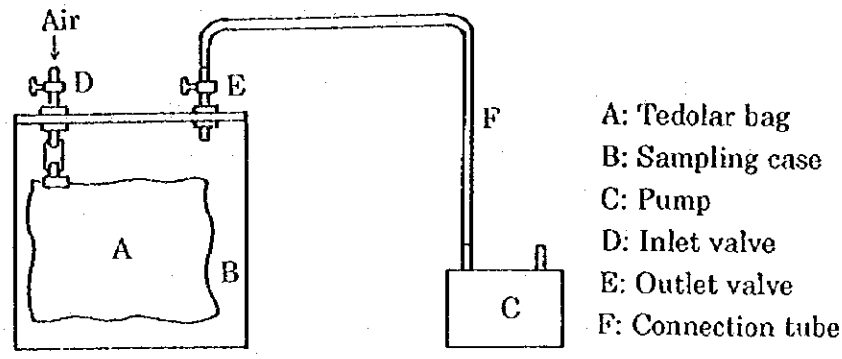



Fig. 3.4.2-B1 Schematic diagram of Indirect sampling system

(2) Pictures of HC sampling