CHAPTER 10 EIA FORMULATION

10.1 Preface

In Iran, the Environmental Impact Assessment Preparation Act (EIA law) and the Environmental Impact Assessment Guidelines were approved by the Environmental High Council (EHC) on 12 April 1994 and on 23 December 1997, respectively. Electric power development projects by MOE fall under the project categories of the EIA law. Namely, power plants having over than 100 MW generating capacity have to carry out EIA and DOE will decide whether the plants having less than 100MW generating capacity have to carry out EIA or not.

MOE has to prepare technical EIA guidelines at first. MOE and the JICA Study Team discussed a framework of the EIA for power plants, and both sides agreed that the JICA Study Team should formulate and propose the framework of technical guidelines of EIA on air pollution and water pollution due to operation of thermal power plants. The operation of the plants is the main issue for environmental consideration.

There is no data nor information available in Iran on other types of pollution than air and water due to power plant operations. Similar framework can be formulated later by the Iranian side when it is necessary.

The JICA Team's framework of EIA technical guidelines on air pollution and water pollution due to a thermal power plant operation (Operation) are elaborated in **Appendix** and **10-1 Appendix 10-2** respectively. Remarks on EIA and the Operation Monitoring are elaborated in **Appendix 10-3.**

Potential environmental impact sources and their impacts of steam power plants including coal fired are described in **Appendix 10-4** mainly cited from US EPA Publication (#68), for future use in Iran. Also, **Appendix 10-5** is prepared to describe briefly a prediction method of thermal effluent diffusion.

10.2 Outlines of Iranian EIA Process

Outlines and characteristics of the Iranian EIA process are as follows:

(1) Site Selection

Project site is determined before EIA as shown in **Fig. 10.2.1** (#88). Site selection is undertaken on the socio-economic and environmental basis. Therefore, site selection is not included in the EIA process.

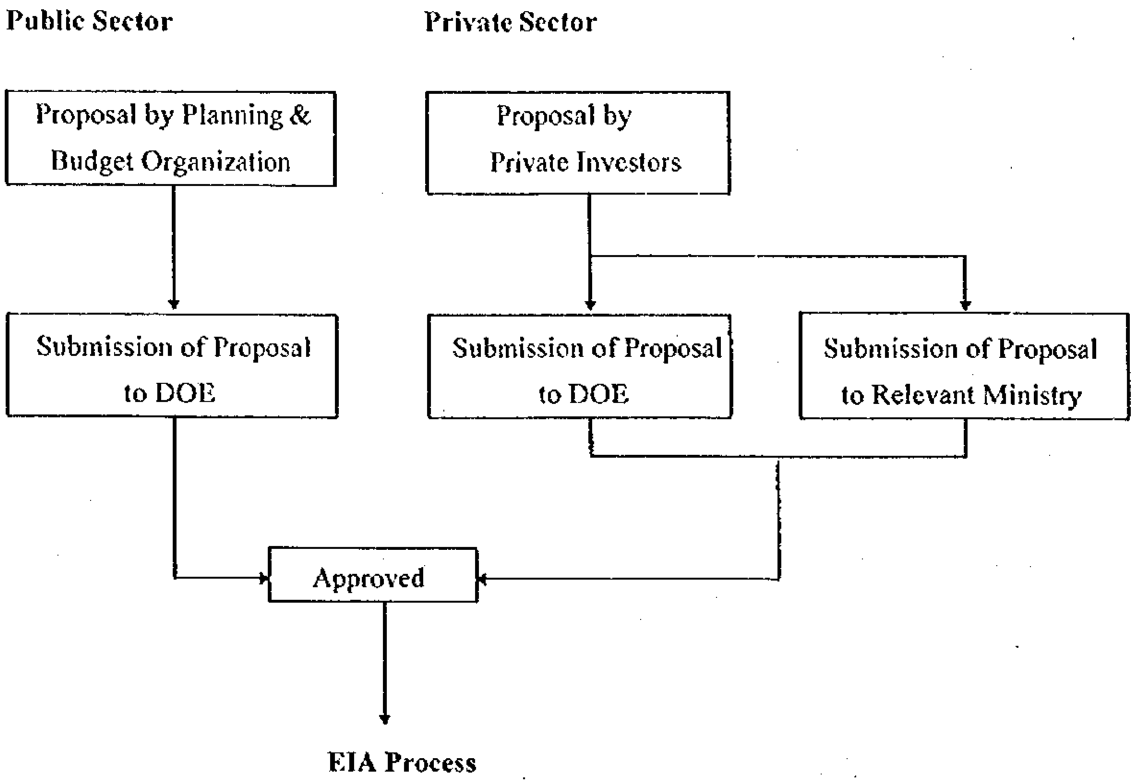


Fig. 10.2.1 Process of Site Selection

(2) EIA Process

EIA process consists of Preliminary EIA and Detailed EIA. Usually, most projects start from the Preliminary EIA, and then to the Detailed EIA as shown in **Fig. 10.2.2.** The EIA report (EIS) shall be presented to DOE.

(3) Classification of Impacts by Activity Timing

Environmental impacts will usually exerted in 3 stages of projects (project execution stage): (1) Construction stage, (2) Operation stage, and (3) After finishing life-time stage. This report concentrates on the operation stage.

(4) Preliminary EIA

In the Preliminary EIA, Project Initiator must predict potential environmental impacts by the proposed project based on a preliminary EIA matrix (a list showing relations between project activities and environmental factors), existing environmental data and basic project design. In the Preliminary EIA, no mitigating plan (measures) are considered in the basic project design.

The Project Initiator submits a Preliminary EIA report (EIS) to DOE for review by Review Panel.

If a certain environmental factor is predicted to be impacted from the project significantly or uncertainly, potential impacts should be assessed in more detail in the following Detailed EIA stage.

(5) Detailed EIA

After the Review Panel judged the Preliminary EIA report was insufficient, the Project Initiator must carry out a Detailed EIA. The Review Panel may advise on environmental data collection and methodology.

Additional environmental data should be collected necessarily in order to assess potential impacts in more detail by scientific methods on the environmental factors chosen in the Preliminary EIA. The data is used to know current environmental states, predict future environmental background and necessary parameters for estimation of environmental effects by the project. Also it is used to formulate more detailed EIA matrixes and more concrete activity conditions, than in the Preliminary stage. The newly formulated matrix and activity conditions are to predict contribution of the project to the environmental changes.

An overall effect on each environmental factor by both the background and the project can be predicted by superimposing the effect of the latter on that of the former. Methods for predicting future environmental effects and impacts should be scientific and desirably quantitative as much as possible.

The environmental impact by the predicted overall effect on each environmental factor is evaluated based on scientific criteria such as the environmental standards. If there are environmental factors on which their overall impacts are judged to be significant, suitable mitigation measures should be planned to satisfy the criteria. The measures include alternatives of the project design on facilities, fuel and facility layout, etc.

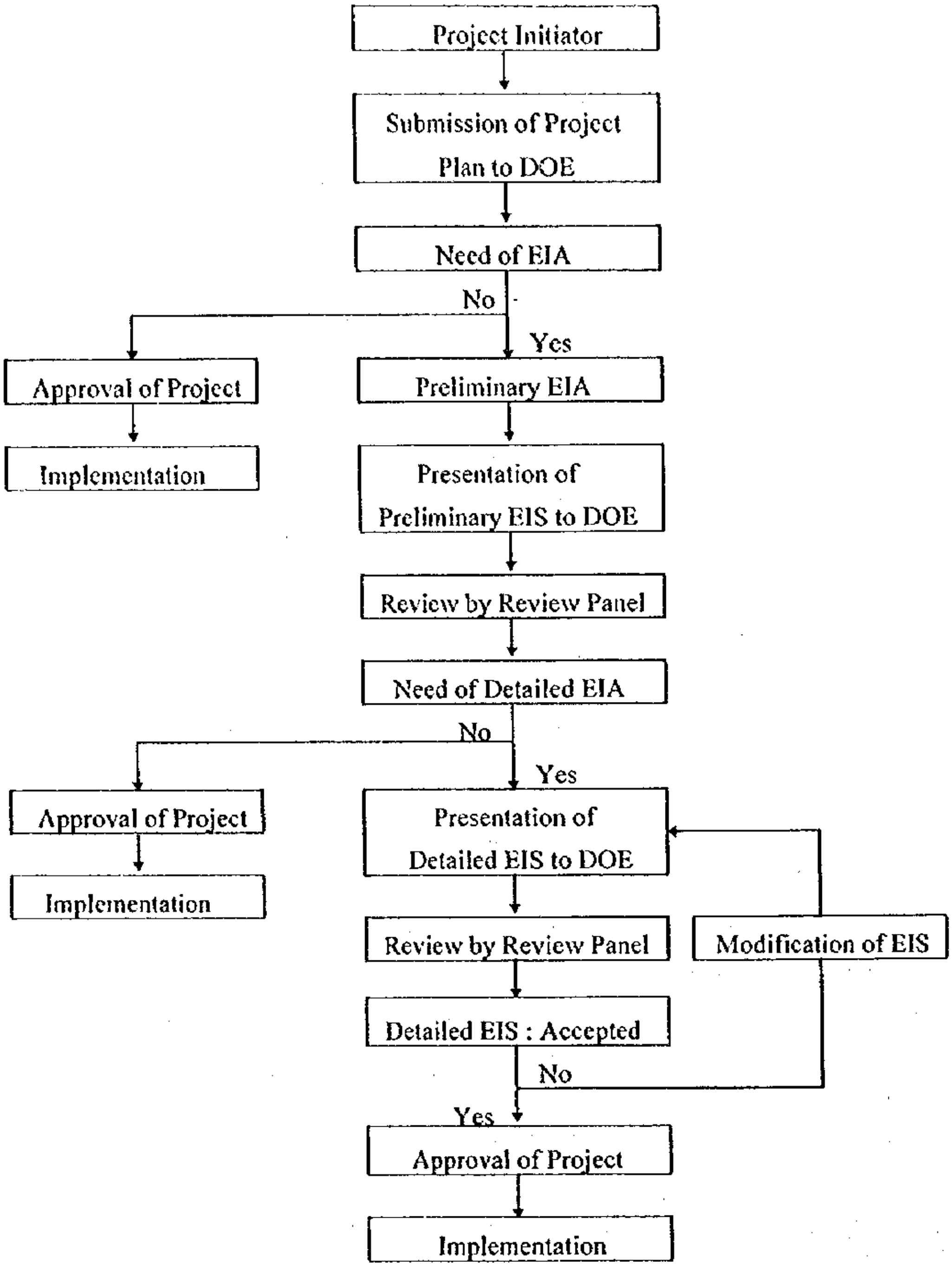


Fig. 10.2.2 Process of EIA in Iran

In case mitigation is required, its cost must be estimated, and a cost/benefit analysis will select the best feasible measure or judge profitability of the project.

In case suitable monitoring for environment and project activities is required, the Environment

Impact Assessor must formulate a monitoring plan. It is used to check validity of the Detailed EIA and execution of the mitigation measures.

(6) Detailed EIA Report

The Project Initiator must prepare a draft detailed EIA report (EIS) and with an executive summary for the project.

The draft detailed EIA report shall be submitted to DOE and reviewed by the Review Panel. The Review Panel will give comments on the draft EIS. The Project Initiator must modify EIA or EIS accordingly to the comments and finalize the detailed EIS. It should state impacts of all the environmental factors regardless of their significance. An executive summary must brief environmental impacts on all environmental factors whether they are significant or not.

(7) Implementation of Project

If the EIA reports reveal that the project has no potential significant impacts on environment, DOE will approve and permit implementation of the project.

(8) Environmental Monitoring

The Project Initiator must implement the monitoring plan formulated by the Environmental Impact Assessor.

10.3 Framework of EIA Technical Guidelines on Air Pollution

The JICA Team's framework of EIA technical guidelines on air pollution due to a thermal power plant operation (Operation) is outlined as follows.

(1) Target Air Pollutants

The target air pollutants shall be a) Sulfur dioxide, b) Nitrogen dioxide, and c) Particulate matter.

(2) Target Area

The target area is, in principle, the surrounding area within 15 ~ 25km from the power station. The area shall be decided in consideration of the emission condition of the plant, meteorological condition and air pollution in the region.

(3) Data Collection

In order to know the actual current ambient air quality and to predict the future air quality in the area, the following data have to be collected. In principle, one year data are required on air qualities and meteorology.

a. Air qualities
b. Meteorology
c. Topography and sizes of buildings
d. Land uses
e. Stationary air pollutant sources
f. Traffic volume
g. Laws and regulations

(4) Current Environment

Current states of air pollutant sources, air qualities, meteorology, etc. in the area shall be realized from the data collected.

(5) Future Prediction

Emission rates and their impacts on air quality due to the Operation have to be predicted.

(a) Predicted time -- The predicted time is when the Operation is expected to be in normal.
(b) Prediction method -- Emissions can be estimated from fuel analyses, design figures, or published data and quality impacts can be predicted in principle using air dispersion equations.
(c) Predicted air quality -- By adding pollutant concentrations due to the Operation, the environmental concentrations shall be predicted.

(6) Impact Evaluation

Emission rates have to be evaluated in comparison with the emission standards, and changes of impacts in air quality have to be done with the air quality standards, or the like.

(7) Environmental Mitigation Measures

In case that the Operation is evaluated to give significant impacts on the environment, necessary measures against them have to be examined with evaluation of their effects.

(8) Examination of Impacts of Alternatives

Changes of emissions and impacts on air quality due to feasible alternatives for the Operation or the plant itself have to be predicted.

(9) Operation Monitoring

The Operation has to be monitored in order to confirm that the impacts of the Operation have been properly predicted and evaluated and that the power plant is operating as planned.

(a) Monitoring Items -- Air qualities, meteorology and air pollutant sources have to be monitored.

(b) Monitoring Time -- The Operation has to be monitored when the power plant is put into the normal operation (the predicted time).

(c) Examination of Monitored Results -- In case that the monitored results differ significantly from the predicted ones and that the Operation gives significant impacts on the environment, stricter mitigation measures must be applied.

10.4 Framework of EIA Technical Guidelines on Water Pollution

The JICA Team's framework of EIA technical guidelines on water pollution due to a thermal power plant operation (Operation) is outlined as follows.

(1) Target Water Pollutants

The target water pollutants shall be the items regulated by Waste Water Disposal Standards as briefly given below.

a. Items for living environmental protection: pH, BOD, COD, DO, etc.
b. Items for people's health protection: Cd, As, Hg, Cyanides, etc.
c. Other items: Water temperature, SS, N, P, etc.

(2) Target Area

The target area is public waters in the surrounding area of the power plant, within which the

Operation may give environmental impacts.

(3) Data Collection

In order to know the current environmental qualities of waters and to predict their future qualities in the area, the following data have to be collected.

a. Water qualities
b. Bottom sediment qualities
c. Hydrology
d. Meteorology
e. Water uses
f. Water pollutant sources
g. Laws and regulations

If field surveys are carried out, they must be for a suitable period to be able to estimate the water qualities, etc. in a whole one year.

(4) Current Environment

Current states of water pollutant sources, water qualities, hydrology, etc. in the area have to be realized from the data collected.

(5) Future Prediction

Pollutant emission rates and their impacts on water qualities, etc. due to the Operation have to be predicted.

(a) Predicted time -- The predicted time is when the Operation is expected to be in normal condition.
(b) Prediction method -- Emission rates can be estimated from design data, experiences and published data. Water dispersion equations are used in principle for prediction of impacts as needed.
(c) Predicted value -- Water qualities, etc. due to the Operation shall be predicted.

(6) Impact Evaluation

Emission rates have to be evaluated with the emission standards. Impacts of water qualities, etc. have to be evaluated in consideration of the water quality standards, etc.

(7) Environmental Mitigation Measures

If the Operation is evaluated to give significant impacts on the environment, necessary measures against them have to be planned with evaluation of their effects.

(8) Impact Examination of Alternatives

Changes of emission rates and their impacts on water qualities, etc. due to feasible alternatives for the Operation or the plant itself have to be predicted.

(9) Operation Monitoring

The Operation has to be monitored in order to confirm that the influences of the Operation have been properly predicted and evaluated and that the power plant is operating as planned.

(a) Monitoring items -- Water qualities, hydrology, etc. have to be monitored.
(b) Monitoring time -- The Operation has to be monitored when the power plant is put into the normal operation. (the predicted time).
(c) Examination of monitored results -- In case that the monitored results differ significantly from the predicted ones and that the Operation gives significant impacts on the environment, stricter environmental mitigation measures must be considered.

10.5 Remarks on Environmental Impact Assessment

The outlines of the remarks on EIA are as following.

10.5.1 EIA

(1) Survey, Prediction and Evaluation

a. Objectivity of methods
b. Data reliability
c. Quantitative approach

(2) Preparation of Environmental Impact Statement (EIS)

a. Consistent description
b. Simple and easy expression
c. As little use of technical jargons as possible
d. Clarification of grounds and reasons for selected or predetermined items.

10.5.2 Operation Monitoring

(1) Preparation of Operation Monitoring Plan

a. Clarification of the Operation monitoring

(2) Execution of Operation Monitoring

a. Objective monitoring

b. Quantitative monitoring

(3) Preparation of Operation Monitoring Report

a. As little use of technical jargons as possible

b. Simple and easy expression

CHAPTER 11 RECOMMENDATIONS

11.1 Preface

This chapter sums up recommendations drawn from findings of the Study. Key elements of the findings are as follows:

a. Tabriz and Esfahan Plants will convert its fuel from fuel oil to natural gas in the future. There is no expansion plan of fuel oil firing plants at both plants.
b. Current air quality within 20 km around both plants is below the Iranian Standards of the maximum SO_2 and NO_2 concentrations, although meteorology is unfavorable for dispersion of the pollutants in both regions.
c. Ambient SPM in Esfahan is possibly above the Standard of the maximum daily average concentration. However, it contains particulates not only from the power plant.
d. Both plants are operating with less thermal efficiency of power generation than the ordinary ones.

It was also found that stack gases of both plants contained SO_2 and soot above the maximum permissible concentration of DOE's proposed emission standards. However, emissions of SO_2 and soot will be reduced to the levels far below the standards after natural gas is burnt for the power generation as having decided. Planning of SO_2 and soot removal units was eliminated from recommendations of the JICA Team. Refer to **Appendix 3-4** for SO_2, NOx, and soot removal processes with their initial investments and operational costs, when it is necessary to plan them to install in a power plant because of policy change, economic growth, or else.

Table 11.1.1 List of Recommendations

No.	Article	Titles of Recommendations	Types
1	11.2	Maintenance and Management of Power Plants	Direct
2	11.3	Improvement of Steam Turbine Efficiency	
3	11.4	Environmental Control Organization in MOE	
4	11.5	Plant Operator Training	
5	11.6	Stack Gas Monitoring	
6	11.7	Fuel oil Balance Study	Indirect
7	11.8	Regional SPM Monitoring and Source Identification	
8	11.9	Improvement of Simulation Models	

The recommendations proposed here can be divided into two types. The first type involves required actions having direct relations with people, equipment, plant units of the power plants, such as training, modification, addition or the like in the plants. The second one has indirect relations with the plants and involves other agencies together with MOE for materialization. Table 11.1.1 records titles of all recommendations in different types.

11.2 Maintenance and Management of Power Plants

1) Recommendation

Strict management of operation and maintenance should be implemented for the power plants in Iran.

2) Purpose

The purpose of this recommendation is to maintain and improve the power generating efficiency and to prevent the air pollution by means of the management of operation and maintenance.

3) Background

Stack gas monitoring data and information obtained in this Study have suggested that there are lack of strict application of management on operation and maintenance of the plants. Especially, it has not been established for energy saving (Heat management).

4) Various Measures

a. Keeping the degree of vacuum at condensers

Logged data of both power plants indicated that the degree of vacuum at condensers had varied widely. In comparison to the designed value, the degree of vacuum is lowered by 18.5mmHg (absolute operating pressure is 18.5 mmHg higher than the designed one) on the average in the case of Unit No.1 at Tabriz, and by 20.8mmHg on the average in the case of Unit No.4 at Esfahan, respectively. The lower degree of vacuum at the condenser than the designed value reduces power generating efficiency, because the turbine efficiency is affected greatly. Consequently, the degree should be kept strictly with the designed one, hopefully within ±3% by application of precise operation and proper maintenance management.

b. Controlling the stack gas temperature

Stack gas temperature monitored in this Study, is higher than the designed one, by 38 deg C at Tabriz Unit No.1, and by 21 deg C at Esfahan Unit No.4. The specified power generating efficiency can be obtained only if the unit is operated with keeping the designed stack gas temperature. It is determined by taking into consideration of the efficiency and the dew point of SO_3 (for corrosion control).

A certain degree of thermal energy is uselessly wasted from stacks to the atmosphere (with the exception of the unnecessary heat energy used for the diffusion of air pollutants). The abandoned quantity of heat causes the deterioration of power generating efficiency.

c. Controlling O_2 concentration in stack gas at an economizer exit

O_2 concentration in stack gas at the economizer exit can be controlled by adjusting the excess air ratio for fuel combustion in a boiler. This is the most effective measure in order to keep the boiler efficiency well by means of operation control.

By reducing the volume of stack gas by lowering O_2 concentration, the heat loss of stack gas is also cut down and the power generating efficiency turns out to be improved. At both Tabriz and Esfahan power plants, O_2 concentration has not been controlled strictly, because of the broken or not-calibrated O_2 meters at the economizer exits.

It is in pressing need of repair or replacement as well as calibration of the O_2 meters, and strict combustion management should be implemented.

For reference's sake, taking a power generating facility of 175MW burning fuel oil, the relation between generating output and O_2 concentration in stack gas at the economizer exit is as in **Fig.11.2.1** which is a compilation of operational results of one power company. While O_2 concentration in stack gas at the economizer exit is 3.3% under the rated output (175MW), it increases to 4 – 5% under the half output and then to 7 – 9% under the quarter output. It means that the lower generating output needs the more excess air and brings the more heat loss. From the viewpoint of power generating efficiency, it is desirable to maintain the rated operation as constantly as possible.

d. Grasping the performance of air heater

Stack gas was monitored at the air heater exit in this Study. As for Tabriz Unit No.1, at the beginning, O_2 concentration in stack gas was fairly high as 12 – 13%. The authenticity of measured data including such high value came into question, and reviews and discussions were gone over. A 3.5% data was reportedly obtained after necessary inspection and repair work of the air heater. As for Esfahan Units No. 3, 4 and 5, O_2 concentration in stack gas at the air heater exit is also high as 9 – 17%.

Generally O_2 concentration is in the range of 4 – 6 % for normal operation, and it can be said a great heat loss of stack gas is dissipated, as it stands. Though it can not be predicated without any reliable data of O_2 concentration in the stack gas at the economizer exit, the O_2 concentration of higher than 10% at normal operation is obviously extra-ordinary value. Since the data of this monitoring is reliable, it may be considered that the obtained high O_2 concentration arises from unexpected laminar flow (or channeling) which has been generated by leaked air into the air heater without being fully mixed with stack gas. Repeated O_2 measurements are necessary at various points (such as SPM and velocity measurements) to obtain the accurate average concentration.

From now on, it is necessary to endeavor to improve the efficiency by means of a regular monitoring of stack gas. For this end, the targeted O_2 concentration and stack gas temperature at the air heater exit, and methods for precise operation and proper maintenance should be determined with taking into consideration the performance of the air heaters, by knowing the air leakage which can be calculated from the measured data of O_2 concentration in stack gas at both air heater inlet (i.e. the economizer exit) and exit.

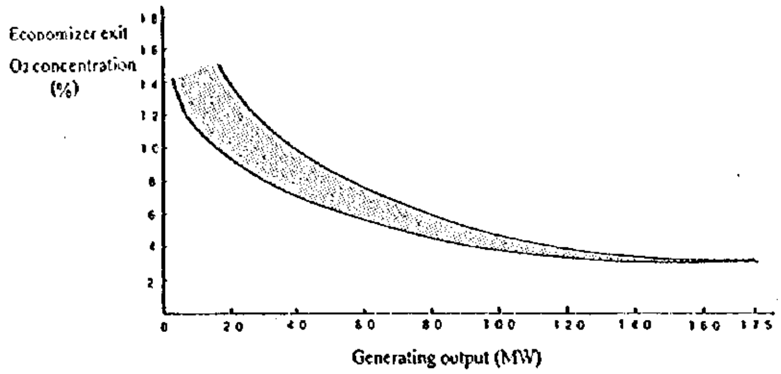


Figure 11.2.1 Generating Capacity vs. O_2 in Stack Gas at Economizer Exit
(Source: one Japanese Power Company)

e. Accuracy of Operational Instruments

Measuring instruments and gauges installed at power plants are indispensable for operators in order to operate the power plants efficiently and precisely. Judging from field work around the plants and the logged data of both Tabriz and Esfahan plants, there is a strong possibility that the indicated values of the instrument in the central control rooms as well as at field are defective or unreliable.

Even though any measures based on these unreliable indication are taken, it always involves high risk to err in judgment. It is in pressing need of repair or replacement as well as calibration of monitoring instruments and gauges, and accordingly precise operation control should be implemented with accurate data.

As described above, operational measures which lead to precise operation and proper maintenance of facilities, can be taken immediately because there is no call for any new substantial investment. A great benefit can be expected in return. All staff engaged in power generation should understand their responsibility that they are obligated to endeavor to maintain and improve the power generating efficiency by implementing precise operation control and proper maintenance.

Regarding maintenance and management of general power generating units, references are given in Appendix 11-2.

11.3 Improvement of Steam Turbine Efficiency

1) Recommendation

In order to improve the overall power generating efficiency of the power plants in Iran, appropriate measures to keep and improve the turbine efficiency should be implemented.

2) Purpose

The purpose is to improve the power generating efficiency raising up a few percent by means of measures of improving the turbine efficiency which mainly affects the power generating efficiency.

3) Background

The current power generating efficiency of Tabriz Plant is low as 33 – 34%. As abnormal vibration was found on turbine at Unit No. 2 after the scheduled inspection, operation of the Unit was shut down and inspection and adjustment were carried out. Hearing from a supervisor at the time also revealed the deterioration of turbine efficiency. In addition to taking the precise operational measures described above in **Article 11.2**, it is necessary to improve the turbine efficiency which is the most influential factor on power generating efficiency.

4) Measures to improve the efficiency

The steam turbine of Tabriz power plant is a shaft of tandem compound, which is composed of a high pressure (HP) turbine with 8 stages, an intermediate pressure (IP) turbine with 5 stages and 2 low pressure turbines with 20 stages.

In order to improve the turbine efficiency, it is effective to take appropriate measures especially for HP and IP turbines. Power generating efficiency should be improved by replacement of diaphragm packing (labyrinth packing) and shaft packing with new ones to reduce the circulating steam leakage area of HP and IP turbines, and of worn out rotating blades (rotors) of HP turbine with new one. Estimated costs of the measures to improve the turbine efficiency are shown in **Table 11.3.1.**

Table 11.3.1 Costs for Turbine Efficiency Improvement

Replacement	Materials and Equipment		Supervising	Field Work	Delivery
Packings	Shaft & Diaphragm	400,000	200,000	60 days	6 months
Rotors	for HP	4,200,000	200,000	60 days	one year
Total		US$ 5,000,000		80 - 100 days	

Note: Expenses for local people and equipment transportation are excluded.

If the thermal efficiency is improved by 3% by these measures including maintenance and management ones, costs from fuel saving will be as follows:

Efficiency Improvement 33.5 to 36.5%

Fuel oil Consumption 65 tons/hour

Annual Utilization 61.4%

Fuel oil Price US$ 78/ton

Fuel oil Saving = (65 - 65 x 33.5/36.5) x 24 x 365 x 0.614 ≒ 30,000 tons/year

30,000 x 78 = US$ 2,340,000

11.4 Environmental Control Organization in MOE

1) Recommendation

MOE should expand its Environmental Department with more activities and also establish an environmental control organization in its each power plant.

2) Purpose

To find solutions to various environmental issues related with power plants, to deal with a social concern and local requests, to increase the efficiency of power generation, to prepare EIA for new power plants, etc.

3) Background

There are 6 experts in Environmental Department in the organization of Deputy of Energy Affairs (ED-MOE) and there is no specific organization in each power plant (Tabriz and Esfahan) to deal with environmental issues locally.

Demands are locally, nationally, and internationally becoming strong for pollution mitigation nowadays to be carried out by the power generation sector as one of the dominating pollutant emission sources. Apparently the current organization in MOE does not have enough resources to deal with these demands.

Especially, it is important for the plants to keep good relation with local people, in order to continue and expand power generation there in accordance with the economic and social development of the country.

4) Suggested Organization

As a central organization in Tehran, ED-MOE should have groups to handle following tasks in relation with the power generation.

① Planning and studying various environmental issues and countermeasures,

② Managing and auditing environmental information and data, publishing the data, budgeting required funds and planning to improve human resource capabilities,

③ Contacting other authorities for reporting, obtaining permission,

④ Dealing regulations and so on with technologies, and doing research and development for technologies, and

⑤ Assessing environmental impacts on air, waters and others.

ED-MOE should be able to mobilize required experts in other departments of the Ministry in order to prosecute a complex project such as an EIA Study. ED-MOE should be able to manage the project even if a part of the tasks are carried out in the different departments.

Each power plant should have an independent organization under the general manager of the plant with the following capabilities:

① Monitoring and analyzing emissions, environmental qualities, and energy efficiencies,

② Reporting the above data to the general manager who should consequently report it to ED-MOE and to local municipality, periodically, and

③ Suggesting operational changes to the general manager, if it is necessary to keep operation clean.

11.5 Plant Operator Training

1) Recommendation

MOE should train its power plant engineers and operators to give pollution control minds and technologies.

2) Purpose

To give engineers and operators (who manage, maintain, and operate power plants) understanding of pollution causes and their countermeasures

3) Background

MOE is training its power plant operators in its school at Tabriz. The main purpose of the plant operation is undoubtedly to generate power as demanded. Therefore, the courses of the school are concentrated in equipment operation and maintenance with safety in minds. There is no practical course on the pollution issue.

Substantial amounts of pollutants can be reduced by controlling operational parameters or maintaining equipment. For example, looking at a color of smoke, operators can adjust air fuel ratio for reduction of soot emission. Or, cleaning tips of burners can also reduce soot emission.

Esfahan Power Plant reported its specific energy consumption was 2433 kcal/kwh in 1995 (#30). It was equal to 35.3 % of the fuel efficiency which seems to be less than the efficiency commonly realized. Another JICA Study in Iran "Comprehensive Energy Studies" (#83) in March 1994 suggested that the power plant efficiency seemed to be less than expected. It was evidenced during this Study that a well maintained Ljungstrom gas-gas heat exchanger was able to increase the fuel efficiency by a few percent to not-maintained one. Higher fuel efficiency means less fuel consumption and hence less emissions of SO_2 and soot.

It is imperative for operators and even engineers to be trained for pollution control and energy saving.

4) Curriculum Involved

Deputy of Energy Affairs, MOE, published a book of 337 pages titled "Energy & Environment" in Farsi. This book is probably the first textbook of the training course. Following are courses to be taught.

① What is pollution?
② MOE's efforts to reduce pollution
③ Kinds and magnitudes of pollution caused by power generation
④ Countermeasures to reduce pollution
⑤ Reduction of pollution by operational controls

5) Organization and Facility

Current management and some of teaching staff of the Tabriz School can be utilized. Additional teaching staff for pollution shall be mobilized from Environmental Department of MOE, DOE, Universities, or else temporally until availability of permanent staff.

As there is no suitable pilot facilities for teaching in emphasizing pollution control and energy saving, one unit of 368 MW unit in Tabriz Power Plant may be used for the training with a complete set of monitoring and operational instrument installed. **Table 11.5.1** gives required investment for monitoring instrument including spare and consumable parts for one year.

Table 11.5.1 Required Initial Investment for Stack Gas Monitoring

Instrument	Monitoring Principle	Required	Initial Investment
SO_2 Analyzer	Infrared-absorbing	one set	US$18,000
CO Analyzer	Infrared-absorbing	one set	18,000
NOx and O_2 Analyzers	Chemi-luminescence and Zirconia O_2 ion conductivity	one set	28,000
Humidity Meter	$CaCl_2$ absorption	one set	9,500
Thermometer	Thermocouple	one set	1,000
Gas Flow Meter	Pitot tube	one set	4,000
Soot Analyzer	Dynamic pressure balance	one set	18,000
Total			US$96,500

Local currency portion for construction has to be added for modification of the existing equipment and installation of analyzers.

11.6 Stack Gas Monitoring

1) Recommendation

Each power plant should monitor its stack gases periodically.

2) Purpose

The amount of pollutants generated depends on the operating conditions of the boiler (such as operation capacity, fuel-air ratio and combustion temperature), properties of fuel, etc. Therefore, it is necessary to measure repeatedly the amount of these pollutants generated with related operating conditions and to compile these data. The purposes of the stack gas monitoring system can be divided as follows.

① To obtain quantitative data which provides reliable basis to publicize and to assess the impact of pollutants on air pollution,

② To be used for combustion control and management,

③ To determine target sources for emission controls, if there are many sources, and

④ To afford data for selection of an appropriate exhaust emission control device, and to help evaluation of the benefit after such control measure is applied.

3) Background

A power plant is one of major polluters of air quality in a region of its location. The plant is responsible to control its own emissions not to deteriorate ambient air qualities.

The Standards for Exhaust Gas from Factories and Industrial Working Place drafted by DOE (#90) will be authorized and enacted as an effective law near future, with or without changes of the drafted sentences. Specified in the draft are intensities of SO_2, CO, NOx, SPM and Smoke in exhaust gases from power plants. Power plants will be obliged to show whether amounts of emissions are conforming to the standards or not, after the authorization of the Standards.

Except CO and smoke monitoring, one set of the equipment which the JICA Team used in the Study is available to MOE now. Also there are people capable to operate and maintain the equipment in ED-MOE and in the Tabriz and Esfahan plants.

As there is no scientifically proven data of pollutant emissions and no standards of local nor national, plant operation does not aim to reduce the emissions currently. Also lack of data make it difficult to install an effective emission control device in an appropriate plant, even if there is a necessity.

4) Tasks

① Monitoring

- Frequency: Three times/year (Winter, Summer, and Spring or Fall). Monitor at each average generation period of midnight, early morning, daytime, and evening, also at every time after changing the kind of fuel and after alteration of operational conditions boilers.
- Items to be measured: as listed in the DOE's drafted Standards and additionally amounts of O_2, flow velocity, gas temperature, and water contents to obtain pollutant emission rates.

The monitoring items, methods, initial investment costs of one equipment set are listed in **Table 11.5.1** as reference. Each method shall be in accordance with those in the Standards, although not written in the DOE's draft yet.

② Maintenance of Monitoring Equipment

As the JICA Team stressed repeatedly, maintenance of monitoring equipment governs the accuracy of the monitored data and decides durability life of the equipment.

Each monitoring equipment shall be maintained and checked by the operators of the equipment after use, or before use when it has not been used for more than one week after maintenance and check. The maintenance and check shall be carried out accordingly to the manufacturer's manual.

The equipment is needed overhauling maintenance and sometimes repair work of damaged parts. As it is impossible for the operators to carry out these tasks in the routine maintenance, these tasks should be entrusted to a technical expert of the analyzer manufacturer or its agents. Therefore, it is recommendable to purchase monitoring equipment from those who have representative offices in Iran.

③ Data Compilation

Monitored data shall be compiled as required by regulations or else. It is recommended that the accumulated monitor data of more than 3 years be kept for future use, because they are valuable for check of the past data, for comparison with the current data after installation of control measurements, or else.

11.7 Fuel oil Balance Study

1) Recommendation

MOE should ask a competent authority to organize a committee of a study on residual fuel oil balance, composing of related governmental authorities.

2) Purpose

The committee has to find out feasible ways of disposition and consumption, most economically and without damaging environment, of fuel oil presumably remaining un-used by conversion of fuel to natural gas in the power sector.

3) Background

MOE has adopted a general policy that all power plant using residual fuel oil should convert it to natural gas as fuel for power generation in the future. It had already decided to apply the policy on Tabriz and Esfahan Power Plants (Minutes of Meeting: Sept. 27, 1998). From the standpoint of environmental preservation, natural gas is far better than the fuel oil, because of far less emission of SO_2 and soot. However, it leaves excess fuel oil un-used in the country.

The power industry consumed residual fuel oil of 7,038,000 m^3 in 1997 (#98), showing about 5% of annual average growth from 5,786,000 m^3 in 1993 (#24). It has been consuming around 30 % of the fuel oil produced in the Iranian oil refineries (**Appendix 11-2**). The Tabriz Power Plant, at its full capacity, consumes probably more than 60% of the fuel oil produced by the Tabriz Oil Refinery. Also it is similar at Esfahan with Tabriz, if the fuel oil is consumed both at Esfahan and Montezari Power Plants (**Appendix 11-2**). Those amounts of fuel oil will be surplus in the refineries, after the power plants convert it to natural gas. The refineries can have three choices or combination of them to get rid of the stock of the surplus fuel oil: 1) sell it as it is, 2) decompose it and reduce its sulfur contents, or 3) reduce its production.

If the surplus fuel oil is sold as it is to consumers in Iran, SO_2 and soot will be emitted and cause pollution there. Possibility of export of the surplus fuel oil is questionable in favorable price and demand in the future. The transportation of viscous oil to other new consumers will need additional investment in piping and lorries.

It is less economical to reduce sulfur in fuel oil at refineries than to remove SO_2 at power plants. Rough estimation indicates (**Appendix 11-2**) that Iran has to spend twice more initial investment if sulfur in fuel oil is to be removed at the refineries. Sulfur reduction at the refinery may be preferable for production of low sulfur fuel oil to small consumers in polluted and populated area. Small consumers usually can not afford to install and operate SO_2 removal plants in their territories.

The last choice is to reduce production of fuel oil at the refineries without installation of any desulfurization unit. This is the most difficult one, because it means reduction of crude oil processing capacity and reduction of refined oil products such as gasoline in the refinery.

4) Tasks Involved

① To list up possible users of fuel oil with their location, seasonal consumption amounts, height and diameter of their stacks, and other pollution sources within 20km area, land utilization, weather conditions and others,

② To estimate possible consumed amount of fuel oil without deteriorating environment by preliminary EIA studies,

③ To find an economical way of sulfur removal: SO_2 removal from stack gas after combustion of fuel oil or direct sulfur removal from fuel oil in the refineries, by assuming certain capacity (for example at 368 MW),

④ To foresee future trends of fuel oil export market,

⑤ To foresee future trends of oil products,

⑥ To formulate recommendation on continuation or change of the natural gas conversion policy, and to recommend conversion schedule of the power sector to decision makers, and

⑦ To recommend to decision makers a stage-wise conversion scheme of refineries' processing flows with capacities in meeting with the power sector's schedule.

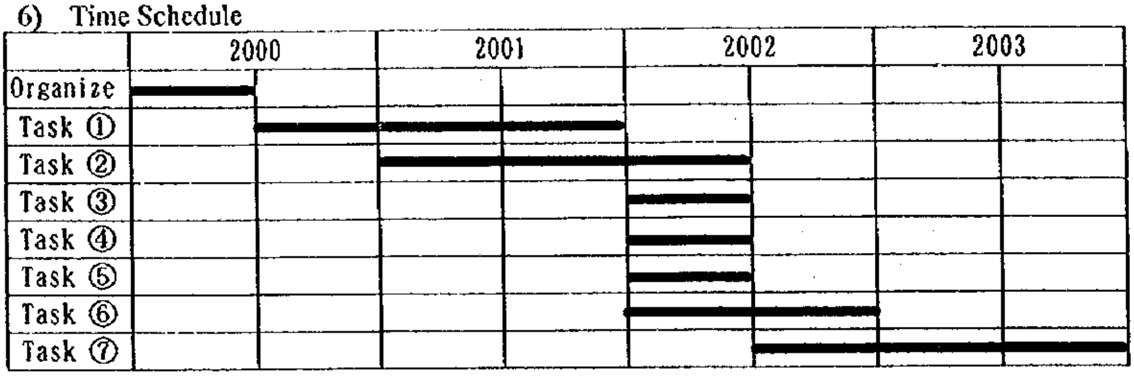
All the tasks given above should be accomplished in consideration for that the recommended items would be carried out from the year of 2005 and completed in 2015.

Therefore, demands, conversion schedule, etc. should be foreseen in the tasks until 2015.

5) Organizations Involved

Committee Member: Plan and Budget Organization, Ministry of Oil, Ministry of Industry, Ministry of Mines and Metals, DOE and MOE.

6) Time Schedule



11.8 SPM Monitoring and Source Identification

1) Recommendation

MOE should ask DOE-Esfahan to organize a project to monitor SPM in the Esfahan region. Also the project should identify each contribution of major sources to the airborne SPM.

2) Purpose

The main purpose is to find out whether SPM exceeds Iranian National SPM standards or not in the region. If it does, the project should point out major sources as the priority targets of SPM reduction.

3) Background

The Study found that monthly average airborne SPM concentration in Esfahan was over than 100 μ g/m^3 during June to October: the peak at 157 μ g/m^3 in August. The Iranian SPM standard has two standards: one for the 24 hours average (260 μ g/m^3) and the other for the annual average (75 μ g/m^3). More than once a year these standards should not be exceeded. However, the 24 hours average seemed to be exceeded in Esfahan.

The instrument used in the Study was a low volume sampler which was able to collect SPM samples at least for two weeks. Although it is able to collect samples for shorter period, it is not recommendable to use for the 24 hours average samples, because of smallness of collected sample amounts.

4) Tasks

① SPM monitoring in summer by an automated continuous analyzer

Carry out SPM monitoring at around 10 places in the Esfahan region from June to October continuously for one month at each places, in order to confirm the 24 hour average data. And prepare for the succeeding tasks as soon as violence of the

National standard is confirmed. Especially order necessary equipment for the task ③ in advance.

② SPM emission inventory

List up SPM emission sources in the region and to estimate roughly emission amounts from these artificial stationary and mobile sources. The amounts may be estimated with referring to published data such as Reference #62. Select about 10 large emission sources. Also select about 10 large natural sources of SPM generation, such as agricultural fields, unpaved roads, playgrounds, deserts, sea or lakes, etc., by local perception and understandings.

③ Sample collection

Collect samples from the sources selected in the task ② in summer. Also collect SPM samples from environmental air at five places for 3 summer months.

④ Elemental analyses of SPM samples

Analyze around 20 to 40 organic and inorganic chemical elements in samples. Numbers and kinds of elements are decided by kinds of samples from experience.

⑤ Calculation of source contributions

Calculate a contribution rate of each source to airborne SPM with the CMB (Chemical Mass Balance) method given in **Appendix 11-3.**

5) Required Resources

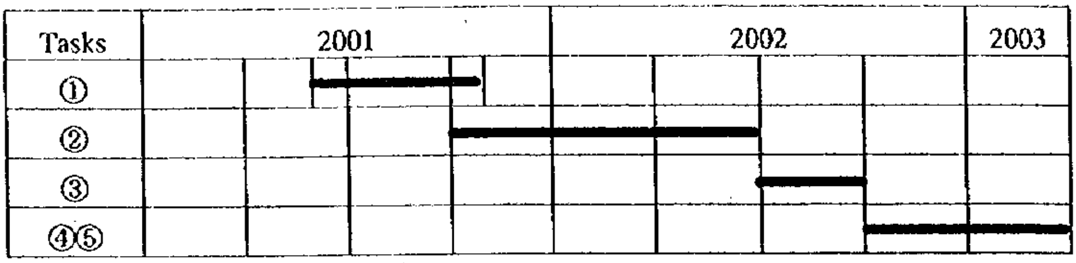
The following table indicates required equipment and investments for the tasks, except costs of transportation, custom clearances, and also personal wages, etc.

Task	Equipment or Remarks		Investment US$
①	Automated continuous SPM analyzer -2 units		60,000
②			--
③	Flue gas soot samplers	2 sets	15,000
	Mobile source soot samplers	2 units	10,000
	Low volume samplers	5 units	25,000
④⑤	Subcontracts		400,000
Total			US$510,000

Outside resources should be mobilized for chemical analyses and CMB calculation.

6) Schedule

Task schedules are given in the table below, with assumptions of a) required equipment for the task ① can be ordered during 2000 to meet the next summer monitoring, and b) the ones for the Task ③ can be ordered as soon as confirmation of the violation to the standard during the task ①.



11.9 Improvement of Simulation Model

1) Recommendation

MOE should ask DOE to improve regional simulation models of the target regions in cooperation with related authorities by inputting more accurate regional data.

2) Purpose

The purpose is to establish more accurate simulation model and investigate the pollution mechanisms in the target regions. Environmental protection master plans for the regions can be made and adequate countermeasures can be implemented with the established model. After this model improvement study, capability of DOE and other authorities will be ready to meet necessity of other regions for the simulation study.

3) Background

In this JICA Study, various emission sources were included as much as possible to improve accuracy of the two regional simulation models, although the range and accuracy of information and data on sources other than the power plants were insufficient. Those emission sources are factories, establishments, vehicles and so on which affect air qualities in the region. Administratively, power plants and MOE are responsible for emissions from their own power plants, and DOE is responsible for qualities of the regional total environment. Improvement of the models by collection and addition of accurate data is necessary for planning to control regional air pollution.

4) Tasks

The study team for this model improvement study should refer to the previous JICA project carried out for the Greater Tehran Area (#81), as for model of conducting following tasks.

A) Collection of Emission Source Data

① The Other Large Factories except the Power Plants;

Certain questionnaire form will be distributed to investigate types and number of facilities, operational patterns, annual fuel consumption, fuel specifications, pollutant emissions, pollution control measures etc. and compile them into emission source database. The large factories should be obligated to monitor flue gas similar as in this study once or twice a year to estimate the pollutant emission amounts more accurately. The monitored data should be compiled as various emission factors by facility and fuel types and published to estimate more accurately emissions from the other factories where the actual monitoring is impossible. At the beginning if there is no domestic emission data available, overseas information such as #62 can be referred.

② Major Road Vehicle Traffic

Necessary data to estimate the pollutant emissions from vehicle traffic of major roads are road network map, vehicle traffic numbers, pollutant emission factors and so on. If there is no recent road map available, new road map shall be prepared, and the road network is digitized with the digitizer, etc. Running kilometers are estimated by multiplying road lengths of each section and vehicle traffics. Once or twice per year road traffic census studies including hourly traffic counting by vehicle types on major roads every several years are necessary. Chassis dynamo testings of representative vehicle types should be conducted, and emission factors by vehicle types to be obtained and published. Automotive Industries Research and Innovation Centre in Karaj has the Chassis dynamo meter for less than 3000 cc engine, and emission data provision from the centre is probable.

③ The Other Medium and Small Emission Sources

Pollutant emissions from the other medium and small factories were estimated by multiplying fuel consumption and emission factors, in this Study. Accuracy of fuel consumption statistics and spatial distributions of factories etc. are important. Setting the national grid systems and compiling statistical data into the grid system are the best way, but if it is impossible, the data should be compiled into the administrative units as precise as possible.

Minor road vehicle traffic besides major road is also necessary, and one way for the estimation is to conduct O.D. (Origin and Destination) traffic investigation and use them.

Types, amounts, and distributions of households fuel consumption is also used to estimate pollutants emissions with emission factors.

④ The Other Emission Sources;

In some cases, emission sources like ships, air planes etc. are also estimated depending on the regional characteristics.

B) Collection of Meteorological and Air Quality Data

① Meteorological Data

There were four surface meteorological stations for winds in each region in this Study. More stations are desirable for wider target regions and selection of representative stations among them are the best way, but some limitations like budget, staff etc. are also inevitable. For upper layer observation, around one week observation for each season is usual.

② Air Quality Data

Monitoring stations which measure air qualities continuously are divided into two categories. One is general stations which monitor representative air qualities in target region, and another is automobile stations which target the pollution from vehicle traffic. More stations should be sited and the categories of the stations be clarified. The number of the stations will be limited because of hardware costs and maintenance work loads etc. Measurement items like photochemical oxidants or ozone should be added in the region when NO_2 concentrations become higher because of vehicles traffic increment. These pollutants themselves may increase and the data will be also used for NO_2 simulation.

C) Integrated Regional Simulation

Regional simulations, which input all emission sources in the region and reproduce measured concentrations, are somewhat different from the EIA simulation which assess impact from a target emission source like a power plant. Generally, EIA for certain target is conducted with established regional simulation model. A power plant which generates the majority of emissions in the target region should positively cooperate with local environmental authorities which are responsible for the integrated regional simulation model establishment. If emission sources structure changes, revision of the once established regional model is important. Furthermore, new technical information should be examined and evaluated to improve the simulation method itself.

5) Required Resources

If the emission factors for vehicles and the data on factories spatial distributions etc. are provided, the manpower of Iranian experts necessary for the integrated regional simulation of one target region is shown in **Table 11.9.1**. The duration of the study is around one year, and foreign consultants will be necessary in some parts. The portion takes ten person-months and costs US$250,000 except transportation and living allowances.

Table 11.9.1 Manpower Necessary for Integrated Regional Simulation

Study Items	M/M	Contents & Resources	Staff
Data Collection & Check	1.0	Fuel Consumption, Distribution indices etc.	
Stack Gas Monitoring	3.0	50 stacks/4 stacks per weeek=Around 3 months	DOE
Traffic Counting	21.0	Weekday:50points X 8hours X 3times X 3persons/8hours =450M/Ds=15M/Ms Holiday:20points X 8hours X 3times X 3persons/8hours =180M/Ds=6M/Ms	1 Supervisor 2 Supporters
Travel Speed Investigation	1.0	Weekday:10routes X 1route/day X 2persons/routes=20M/Ds	1 Supervisor
Analysis of Emission Source Data	2.0	Data Confirmation, Emission Source	
Simulation Model Establishment	1.0	Calibration of Model Parameters	
Study Summary	1.0	Report Making	
Total	30.0		

M/M:Man Month, M/D:Man Day

or Person-Month, Person-Day

CHAPTER 12 CONCLUSION

The primary objective of this JICA Study was to contribute MOE to increase its technical capabilities. The JICA Team tried to transfer technologies required for the Iranian Counterpart Team to be able to carry out similar air pollution studies for around 20 remaining thermal power plants in Iran, for which the two target power plants, Tabriz and Esfahan, represented by mutual selection between MOE and JICA. Principles of EIA procedures for air and waste water were drafted as the second objective of the Study.

This JICA Study revealed that concentrations of SO_2 and NO_2 in ambient air were less than the National Air Quality Standards within 20 km of both Power Plants. Another pollutant monitored, SPM, was below the Standards of the annual average value. However, there is a possibility of exceeding the Standard of the daily average in Esfahan. As SPM is originated from various artificial and natural sources, power plants may not be the only source of the SPM pollution. A method was proposed as one of recommendations to clarify major sources of SPM in Esfahan.

Emissions from both power plants were found by this Study to be over than the standards proposed by DOE. However, there would be no excess emissions of SO_2, NO_2, and particulates in the future because of MOE's decision on exclusive burning of natural gas as soon as its supply becomes sufficient. Hence, there is no recommendation to control pollutants. As reference to other power plants, the control devices are described in this Report with necessary information in the Supporting Appendices for planning.

The JICA Team found that the energy efficiency was low in both plants because of insufficient budgets and lack of foreign currency for maintenance. Recommendation to save energy is also presented.

Pollution is a product of various factors and sources. One organization can not cope with, or solve it by itself. Cooperation of administrative organizations on monitoring and planning of countermeasures is quite important, in order to avoid further deterioration of the current environmental qualities of both areas. The JICA Team planned recommendations based on this standpoint. All the recommendations are summarized in **Table 12.1**. The JICA Team expects that the Iranian Counterpart Team would materialize these recommendations in the not-too-distant future.

The Study encountered behind the schedule due to delays of transportation and custom clearance of equipment, permission of upper layer observation, construction at the plants, and others. However, those delays were able to be overcome with the help of the Japan Embassy in Tehran, JICA Headquarters, and the Iranian Counterparts. The Counterparts and people at both power plants were all eager to receive transfer of technologies. The JICA Team expresses here its deep appreciation to all these people for their advice, guidance, encouragement, and cooperation.

The JICA Team hopes that the current air qualities will be kept or become cleaner, even when industrial activities or vehicle movements are progressively developed in Tabriz and Esfahan.

Table 12.1 SUMMARY OF RECOMMENDATIONS

No.	Title	Proposed Reasons	Organizations in Charge	Costs US$	Work Period	Remarks
1	Maintenance & Management of Power Plants	Lack of minds apt for operation and maintenance	MOE	--	Always	
2	Improvement of Steam Turbine Efficiency	For energy saving	MOE	5,000,000	3 months for Field Work	Cost for 1 Unit
3	Environmental Control Organization in MOE	To cope with complicated environmental issues	MOE	--	As soon as possible	
4	Plant Operator Training	To give basics of environmental control and energy save	MOE	96,500	As required	
5	Stack Gas Monitoring	To use for public relation and combustion control	MOE	--	Always	
6	Fuel oil Balance Study	To consume glut of fuel oil and to stop pollution proliferation	Budget & Planning Organization, DOE, Ministry of Industry, Ministry of Oil, MOE	--	4 years	
7	SPM Monitoring and Source Identification	To confirm SPM in Esfahan with National Standard and to plan countermeasures	DOE, MOE, Ministry of Industry, Ministry of Oil	510,000	3 years	
8	Improvement of Simulation Models		ditto	250,000	1 year	Estimated for 1 area

Note 1 Conversion rate : US$1.00=Rls.8000=¥120

Note 2 Costs exclude local wages, equipment transportation, field expenses, travel expenses from overseas, travel allowances, etc.

References

01 - 40 Collected by JICA in March and August, 1996
41 - 50 Possessed by SUR and TEB originally, except duplications with the above
51 - 60 Collected by the JICA Team during the First Field Work
61 - Collected by the JICA Team after the First Field Work

Note: pp total number of pages in the reference
p specific description on the page numbered

01
Title: Framework Legislation for Environmental Management in I. R. Iran
Notes: pp6; policy, description mostly of water, land, wildlife, etc.

02
Title: Number of Power Plants in The Country and Their Production during 1995
Notes: 1 sheet; total 77million MWh in 1995

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Title: National Power Plants Development up to 1999 - Second 5 Year Plan
Notes: 1 sheet; nothing for Tabriz and Esfahan

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Source: CCPP-Iran, Siemens

06
Title: Fuel Gas Specification with Different Source Origin; 1 sheet
Source: Gilan Power Station

07
Title: Laboratory Gas Chromatography Report
Source: Shahid Hashemi Nedoad Gas Treatment Plant; 1 sheet

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Title: Fuel Oil (Tehran, Esfahan-Arak)
Source: National Iranian Oil Company
Notes: specification and test method, 1 sheet

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Title: Location of Power Plant, Tabriz Power Plant
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Title: The Rates for Public Utilities in 1374 (1995-96); 4 sheets

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Title: Map of Islamic Republic of Iran - 1/1,600,000
Source: Gita Shenassi, 1984

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Source: World Bank - United Nations Development Programme, 7/1993,
Notes: Contents and introductions only; Economics, forests, range lands, fisheries, industry and mining, energy development, transport policies, human settlements, air quality and pollution control, water ditto, health, marine and coastal zone, biodiversity, refugees, education and public awareness

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Notes: The same contents with #16, different wordings, probably a draft of #16

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Title: Iran Center for Energy Studies
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Title: Tabriz Thermal Power plant - 2 x 387MW
Source: Karbassi, MOE, 1996,
Notes: pp18 copied, specifications with drawings

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Title: Year Record - 1374
Source: Esfahan Power Generation Management Co.

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Title: Weather Information
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Title: Answer to Question No. 8-2-1 & 8-3-1 of JICA Preparatory Team
Source: ICES?, pp4
Notes: Population and public facilities in the Tabriz region, gas & oil elements

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Title: Maps around Tabriz: 5166 II, 5266 III, 5266 II, 5165 I, 5265 IV, 5265 I
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Title: Guide Map of Azerbayjan-e-Sharqi-Gharbi & Ardabil Provinces, 1/600,000
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Title: Map of Esfahan City, 1/12,700
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Source: Embassy of the Islamic Republic of Iran in Germany, Nov. 1995

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