Chapter 4 Follow-up Results of Master Plan Recommendations

4.1 Maintenance and Operation of Generation Units

The JICA and MOE Teams visited the Tabriz and Esfahan Power Plants as did in the Master Plan Study. The Unit No. 2 of the Tabriz Plant was not in operation, because of the preparation for conversion to natural gas.

The Teams analyzed current operation conditions (Table 4.1) and talked with shift operators about their operational intentions, main interests, understandings, etc. of power plant operation in the central control room, after investigation of each plant facility.

Table 4.1 Current Operational Data

	Tabriz		Esfahan		
	Design	No. 1	Design	No. 4	No.5
Data Taken Date & Time					
Output (MW)	368	350	320	319	320
Stack Gas Temp. (^{o}C)	160	205 & 228	170	180	173
Economizer Out Flue O_2 (%)	1.0	1.2	0.5	2	--
Condenser Water In (^{o}C)	21.6	23	33		
Condenser Water Out (^{o}C)	29.6	31	44.8	30	29
Condenser Vacuum (mmHgA)	38	34		41	39
(-mmHgG)			580	557	585

The altitudes of Tabriz and Esfahan are respectively 1362 and 1575 meters. Therefore, absolute pressures are 640 and 620 mmHgA approximately. Operational pressures of the condensers are indicated on the control panel of the Esfahan plant with gage pressure of mmHg. The –580 mmHgG is equal to 40 mmHgA.

Table 4.2 is a comparison of operational data with the ones reported in *Table 3.2.2* of the Master Plan Study. This comparison is to know the changes of the plants in 4 years. The data was copied from operators' log sheets for the same period and time with the ones in 4 years ago. The original copied data were attached as Appendix A.3-3 (Tabriz) and -4 (Esfahan).

Table 4.2 Operational Changes after 4 Years (Daily at 14:00 o'clock for one month)

	Items	1998		2002	
		Operation Ranges	Average	Operation Ranges	Average
Tabriz No.1 368MW (Data from 8/17 to 9/18)	Output (MW)	320-350	347	180-351	338.2
	Stack Gas Temp. (°C)	200-225	209	180-215	203.7
	Turbine Steam Temp.(°C)	535-539	538	538	538
	Turbine Reheated Steam Temperature (°C)	530-540	536	520-535	530.5
	Economizer Out O_2 (%)	0.005-0.9	0.3	0.2-5	2.8
	Condenser Water In (°C)	21-33	28.4	26-30	29.1
	Condenser Water Out (°C)	41-46	43.5	33-43.5	40.4
	Condenser Vac. (mmHgA)	50-69	56.5	30-65	57.9
Esfahan No. 4 320MW (Data from 7/23 to 8/21)	Output (MW)	210-320	270	251-291	281.1
	Stack Gas Temp. (°C)	155-188 147-175	174 161	186-208 145-193	199.4 157.8
	Turbine Steam Temp. (°C)	540	540	540-545	541.3
	Turbine Reheated Steam Temperature (°C)	540	540	541-548	543.4
	Economizer Out O_2 (%)	--	--	--	--
	Condenser Water In (°C)	30-33.5	31.5	30-35	32.6
	Condenser Water Out (°C)	36-46	41.1	40-45	42.5
	Condenser Vac. (-mmHgG)	540-575	559.2	518-549	534.5

Table 4.2 indicated that notable differences were found in Economizer Out O_2 of Tabriz No.1 Unit, and Stack gas temperatures and Condenser Vacuum degrees of Esfahan No. 4 Unit.

The following are discussions, recommendations and suggestions on each item recommended in the Master Plan Study.

(1) Degree of vacuum at condensers

Temperature of water flew into a condenser was low enough, because of winter when this follow-up study was carried out. Therefore, condensers of the Tabriz No. 1 and the Esfahan No. 5 were operated at the designed vacuum degree. Only the vacuum degree of the condenser of the Esfahan No. 4 was 23 mmHg higher than the designed.

The JICA Team discussed with a shift chief about this fact and confirmed that the cooling system including the water circulation pump was normal. Later obtained was information of possible steam leakage to lower pressure side in a high-pressure turbine since past several weeks. The JICA Team suggested that maintenance people must check possibility of leaks at a connected part of upper and lower rotor casings, drain piping connections jointed to the casings three months later when a regular maintenance would be scheduled. Also in the meanwhile, operators must pay attention on changes of vacuum degrees and temperatures of various parts and inform the phenomena to a representative of the turbine manufacturer who would visit for the scheduled maintenance.

According to Table 4.2, the Esfahan No. 4 Unit was in operation far higher vacuum than the one in 4 years ago.

(2) Stack gas temperature

Both power plants are burning residual oil called Mazut during winter. The stack gas temperature at Tabriz No. 1 was 205 and 228ºC at both stack gas ducts, higher than the designed value of 160ºC. The 5 mm of thick scales on boiler tubes caused by Mazut firing made difficult heat absorption. Much more Mazut has to be burnt in order to evaporate enough steam to generate electric power as required. This excess-burning results higher stack gas temperature.

Although the stack gas temperatures of the Esfahan No. 4 and 5 Units were within 10ºC of the design value, Mazut will raise the temperatures if it is continuously burnt. The JICA asked an operator to control combustion airflow rates of both sides when it found the 17ºC of the temperature difference at both stack gas ducts of the No. 5 unit. The difference was reduced to 10ºC within 10 minutes of the control. Such a careful attention is mandatory to operate power plants to achieve energy saving and pollution control.

The temperature differences of the two stack gas ducts of the Esfahan No. 4 Unit were higher in this summer than those in 4 years ago as shown in Table 4.2. The plant management should instruct operators to record on log-sheet any abnormal phenomenon of plant operation, supposed reasons of the phenomenon and countermeasure taken by the shift accordingly.

(3) O_2 concentration of stack gas

Oxygen concentrations in stack gases at economizer outlets were 1.2% in the Tabriz No. 1 Unit and 2% in the Esfahan No. 4 Unit, when the JICA Team visited. The Esfahan No. 5 Unit was waiting arrival of the new analyzer for replacement. The Team suggested frequent chemical or instrumental analyses in one day by grab sampling to control appropriate combustion of the No. 5 Unit.

The Esfahan Plant has a portable instrument capable to analyze O_2, CO_2, CO, SO_2, NO, NOx, hydrocarbons, etc., with an electro-chemical sensing method. It was used to back check O_2 % indication on the control panels on a week. The O_2 concentrations at the outlet of the economizers of Esfahan No. 4 and 5 were in a range of 0.5～1.8% within 8 data obtained.

Table 4.2 indicated that the Tabriz No. 1 Unit has been operating under reasonable O_2 concentration after 4 years. The JICA Team pointed out elsewhere in the final report of the

Master Plan Study that O_2 % less than 1.0 was impossible for control by burning fuel oil at the outlet of the economizer. The analyzer in the Tabriz No. 1 seems to be well maintained after then.

(4) Performance of air heaters

The Tabriz Plant replaced elements of No. 1 Air Heater in 1997 and No. 2 in 1999.

The Esfahan Plant washed the elements of No. 4 Unit 3 weeks ago, and planned to replace them around in March 2003 and No.5's in 2 years later. It has a schedule of replacing elements in 4 years. Air temperature was 200^{o}C at the outlet of the Esfahan No. 4 Air Heater and 250 at No. 5. The No. 4 Air Heater is supposed to have corroded and deteriorated elements. If Mazut is continuously burnt in Esfahan or else, it must be reconsidered replacing elements in 4 years interval.

As pointed out in the final report of the Master Plan Study, differences of O_2 concentrations in stack gas at inlet and outlet of the air heater mean fresh air leakage or channeling to the stack gas. The Esfahan Plant presented 8 data showing the differences monitored by the testo-350 analyzer (Appendix A.3-7) at its No. 4 and 5 Units as in Table 4.3.

Table 4.3 Stack Gas O_2 % at Air Heaters of Esfahan Plant

Unit	Data	Average Inlet O_2 %	Average Outlet O_2 %
No. 4	3	1.17	6.1
No. 5	5	1.14	5.7

When the Master Plan Study was carried out, the O_2 concentration of stack gas at the inlet of air heaters was not monitored. However, almost all O_2 concentrations at the outlet of the air heaters of Esfahan No. 4 and 5 Units were over 10% measured by the JICA Equipment. The data (around 6%) in Table 4.3 indicates progress of maintenance and operation of the plant apparatuses, although there remains a question of accuracy of the testo-350 analyzer.

The Tabriz Plant presented to the JICA Team one data (Appendix A.3-7) monitored by the MOE laboratory on Oct. 26, 2002 with the testo-350. The data was 4.9% of O_2 concentration in the outlet stack gas of the air heater.

(5) Accuracy of operational instruments

The JICA Team confirmed that both power plants were regularly checking and calibrating operational instruments. As of the case of O_2 analyzer, panel indications should be confirmed with another methods such as chemical analyses or portable instruments in order to contribute better management of the plant operation. Difference of fuel oil tank level indications may be able to check its flow rates.

4.2 Improvement of Steam Turbine Efficiency

The turbine at the Tabriz No. 1 Unit had adjusted its warp more than 10 years ago and experienced vibration of 75 microns 6 months ago. The vibration was reduced to less than 65 microns by balancing. Hence there is no more problem. The one at the Tabriz No. 2 has been in operation without further problem of vibration that was corrected in 1998 after the scheduled maintenance.

The JICA Team of the Master Plan Study recommended replacing a high-pressure turbine rotor, etc. of the Tabriz No. 2 Unit. However, because of high cost, the plant management holds the recommendation and instead has placed an order of a balance measurement instrument for precaution. With the help of the instrument, the power plant will be able to react quickly when vibration starts again. The JICA Team suggested the management to consult with the turbine supplier for the step-by-step method that would make possible to fulfill the previous recommendation without replacement of the rotor.

The turbines at the Esfahan Nos. 4 and 5 have no record of repair or else recently. However, as mentioned previously, the turbine No. 4 may have been in trouble of steam leakage. The JICA suggested to inspect the inside of the turbine at the next scheduled maintenance and to prepare for an appropriate countermeasure with consulting for the turbine supplier.

4.3 MOE's Environmental Control Organization

The Master Plan Study recommended MOE to expand its environment department and to establish an environmental control organization in each power plant. MOE has reacted to this recommendation by installing the environment departments in the Tavanir organization and in large steam power plants. Tavanir is the organization to generate, distribute and sale electric power as a part of the MOE organization.

The annual report "Electric Power Industry in Iran 2000-2001" published MOE and Tavanir contains a section of Environment and described pollution caused by stack gases and waste water emitted from power plants. It recognized excess emissions over the national regulations and promised to convert its fuel to natural gas, to introduce more effective combined cycle generation methods, to install dry cooling system to save water consumption, to treat waste water, etc. Also it states in the report to organize an environmental department in each power pant and to publish data related with pollution, and to carry out an environmental impact assessment for newly planned power generation plant. The Master Plan Study recommended these three items three years ago.

The environment department of MOE was re-named as the 'Environment Group' with reduced member from the ones of 3 years ago. Some of the ex-members of the department were in the Energy Planning Bureau and Energy Efficiency Organization. The latter Organization is predestined to move into a part of Tavanir in the near future. The mandates of the Environment Group in MOE are to plan strategies. Other organizations in MOE or Tavanir carry out the plans authorized by the government or parliament.

The environment group of MOE is in charge of planning of various projects and simulation for EIA of new power plants. The Energy Efficiency Organization has been devoting in certifying energy consumption of various house appliances with many additional engineers, and the Energy Planning Bureau has been monitoring stack gases of power plants and their surrounding atmospheric air using the JICA Equipment. The Bureau is also in charge of development of new energy sources such as thermal and sun. The preparation of EIA reports is the duty of the Bureau with subsidy to private organizations.

The two environment departments of both power plants visited were busy to work on matters related with ISO 14000, to treat wastewater, and to tackle PCB problems (described later). Stack gas will not be a problem anymore after the full completion of year-around natural gas burning in 2003.

4.4 Plant Operator Training on Pollution

The reason of this recommendation in the Master Plan Study was that engineers and operators of power plants could contribute to reduce pollutant emissions by realizing sources and countermeasures of the emissions. The JICA Team expects that the plant environment department will lead the training of operators and engineers with the cycle of Plan-Do-Check –Act (planning, carrying out the plan, checking the results of carrying out and acting to the results by revising the original plan), in order to complete the requirements of ISO 14000.

Amounts of gaseous pollutant emissions can be reduced by energy saving resulted from higher efficiency of operation. Emissions in wastewater can be reduced by improved operational technologies with careful and attentive minds. Therefore, the JICA Team summarizes as follows based on its perception of differences between Iran and Japan in power plant operation.

(a) Training of young operators

A power plant is an organized unit of boiler, turbine, and their operation control system, etc. and has to respond quickly to changes by orders of the central dispatcher. All the people in the power plant have to complete precisely one's given duties.

It is customary to assign a young operator for the minimum and easy job or low-level work in his group. However, if he is sharp and passionate on his job, he will not satisfy with his assigned job. Therefore, the chief of the group has to take advantage of their tendency and give wider knowledge and technology of the power plant operation when they are young. For example, the chief should give an operator in charge of pump and fan to forward to combustion and boiler control.

(b) Training and allocation of specialists

Each apparatus of the power plant has its own characters that are unable to describe in a manual especially during from the start-up to generation at the rated capacity. A turbine may have extreme vibration at the medium revolution.

Here the JICA Team suggests training and allocating specialists in each power plant. The specialists may be for boiler, turbine, control instrument, etc. The specialists must have reputation from plant people on his specialty about 'ask him at first for solution'. The specialists are needed to keep stable operation and protective maintenance based on facility diagnosis.

(c) Better communication between each section in the plant

Communication between each section must be mandatory in a power plant, especially between generation and maintenance sections. Equipment abnormality can be detected and assumed further development at its first stage with the cooperation of maintenance and operation sections and planned for preventive maintenance and countermeasures.

The four items given above - 1) Careful attention described in the Article 4.1, 2) Training of young operators, 3) Training of specialists, and 4) Better communication in the plant – will attain energy saving and reduce pollution in the power plants.

MOE, Tavanir, and both power plants asked the JICA Team a possibility of operator training in Japan. The JICA Team introduced the JICA's group training program with comments of difficulty of direct training of operators from language problems. If MOE or Tavanir has an interest of training of operation instructors, they may contact JICA for the program and propose to join through the official route.

MOE, Tavanir, and both power plants also expressed to the JICA Team a desire of receipt of any publications related with 'power plants and pollution' regularly. The JICA Team may try to find them, although it had no knowledge of the English publication of the related title in Japan.

4.5 Stack Gas Monitoring

The final report of the Master Plan Study recommended that each power plant should monitor its stack gases periodically. MOE and Tavanir believe they have obligated to monitor their emissions as one of the larger emission sources, although the National regulation does not require each pollutant source to monitor its emissions. Therefore, they have planned to have one model plant monitoring its stack gas emissions continuously. However, the plan was on the shelf without materialized because of high investment costs. The JICA Equipment was used to monitor stack gas emissions from the Mashad and Toos Power Plants in the Province of Mashad in the past. The portable analyzers, testo-350, were used to monitor emissions from the Tabriz Plant irregularly and the Esfahan Plants regularly (Appendix A.3-7).

The Follow-up Study Team recommended, that power plants still burning Mazut should monitor their emissions using the JICA Equipment at least once a year or more, and any steam power plant should do using a portable analyzer once a month or more often from two reasons: as an obligation of large emission source and to check the performance of the on-line continuous O_2 analyzer. The obtained data must be compiled and published annually in the Yearbook or other appropriate method.

4.6 Fuel Oil Balance Study

The JICA Team of the Master Plan Study recommended that MOE with other competent authorities should organize a committee to solve surplus production of fuel oil or Mazut by power plants' conversion to natural gas. The meeting between representatives of MOE and Ministry of Oil concluded that high sulfur Mazut would have plenty of markets in the world now and future. Therefore, no action on this recommendation of the Master Plan Study was taken.

The Follow-up Team suggested that they should immediately start for preparation of planning and preparation of countermeasures when they would perceive any hint of the change of markets.

4.7 Regional SPM Monitoring and Source Identification

The Master Plan Study Team found that there was a possibility of SPM (suspended particulate materials) concentration over the national ambient air standard in the region of Esfahan. Therefore, it recommended that MOE should talk with the local Environmental Agency to organize a project to identify SPM sources and prepare for reduction measures.

MOE presented a Persian version of the Summary Report of the Master Plan Study. However, no interest was reportedly shown from the agency. The Follow-up Team could not feel high SPM concentration, because it was in winter.

4.8 Simulation Model Improvement

As the counterpart Team of the Master Plan Study was only consisted of people from MOE, it was difficult to gather enough information of other stationary and mobile emission sources (under management of other authorities) than power plants. This was the reason of the recommendation of the simulation model improvement. The improve model can be used to investigate the pollution mechanisms and plan adequate countermeasures. The two local Environmental Agencies of Tabriz and Esfahan did not respond to the Persian version of the Summary Report.

MOE has lost its interest on the simulation of the both regions. However, as MOE needs a simulation model to prepare an environmental impact assessment report for the newly planned plant, MOE has detailed questions on the previous models. The Follow-up Team suggested that MOE should contact the person in charge during the Master Plan Study. And it suggested that it would be easier for MOE to simulate a dispersion of air pollutant from a future power plant as the single source with knowing current concentrations (as a background) of pollutants and meteorological data and without concerning other stationary and mobile sources, if the future plant would be located in a remote and sparsely populated area. The JICA Team mentioned to use ISCST3 model[1] of the US-EPA for the purpose.

1 Industrial Sources Complex in a Short Term, Version 3