# Chapter 5 Results of Additional Study

## 5.1 Introduction

The study items requested by the Iran side in August 2000 included 1) Improvement of Steam Turbine Efficiency, 2) Fuel Oil Balance Study, 3) Improvement of Simulation Model, 4) Improvement of Cooling System and 5) Improvement of Wastewater Treatment System. Duplicated items with the items in the Master Plan Study were already discussed in Chapter 4.

Therefore, described in this Chapter are Improvements of Cooling System and Wastewater Treatment System, and two additional items requested during the Follow-up Study: Handling of PCB Wastes and Estimation of Social Costs.

## 5.2 Improvement of Cooling System

The JICA Team of the Master Plan Study had noticed steam condensate smoke from cooling towers of both Tabriz and Esfahan Power Plants. However, both Plants had/have not paid attention on the harmless smoke then and now. The annual report 'Electric Power Industry in Iran 2000/2001' published by MOE and Tavanir mentioned in its chapter of Environment that "complying with the policy of replacement of wet cooling tower by dry cooling tower to conserve water resources of the country". Technologies of design and construction of dry cooling towers are known in Iran. Four units of each 200MW capacity are in operation in the Montazeri Power Plant of the Esfahan Province.

The Follow-up Study Team found in the Esfahan Power Plant why this study item was requested in 2000 by the Iran side. Capabilities of the cooling towers in the Esfahan Plants had been decreasing year by year. Finally the Plant management decided to repair the small cooling towers of No. 1 and 2 units and found remarkable results of the repair: recovering of the capacities. The management finished the similar repair of the No. 3 Unit and has started to do the No. 4 Unit. The work on the Unit No. 5 will be in two years later. Reportedly the repair of the No. 4 Unit cooling tower is after 22 years or the first repair after construction. The repair work will proceed block by block. The first block of the No. 4 cooling tower was completed during the Follow-up Study. The work consists of replacing contact elements and repairing induced fan blades and replacing the fan cases.

The cooling towers of the Tabriz Plant are in better conditions than those of Esfahan. As it is in

the freezing area, the elements and the fans of the cooling towers have problems caused by freezing and icing. Therefore, the towers have been repairing periodically once in two years.

## 5.3 Improvement of Wastewater Treatment System

When this study item was requested by the Iran side, the Tabriz and Esfahan Power Plants had necessities to improve their wastewater treatment systems, ordered by the local environmental agencies or required to obtain ISO 14000 certificates. However, they had to improve by themselves due to the time limit.

The Tabriz Plant discharges its wastewater by underground conduit to a river 3 km apart. The local environmental agency samples and analyzes pollutants in the water. Examples of the analyses are given in Table 5.1.

Table 5.1 Analytical Data of Wastewater from Tabriz Power Plant

| Sampled | | | Feb/19/'02 | Mar/2/'02 | | |
|---|---|---|---|---|---|---|
| Site of sampling | | | Discharge Exit | Before Neutralize. | After Neutralize. | Discharge Exit |
| | Unit | Standards | | | | |
| pH | | 6.5 – 8.5 | 7.65 | | | |
| COD | mg/l | 100 | 82.8 | | | |
| DO | mg/l | 2 | 0.13 | | | |
| TDS | mg/l | -- | 1608 | | | |
| BOD | mg/l | 50 | 56 | | | |
| TSS | mg/l | 60 | 16 | | | |
| Ni | mg/l | 2 | | 102.2 | 17.8 | 0.57 |
| V | mg/l | 0.1 | | 2597 | 9.69 | 0.27 |
| Cu | mg/l | 1 | | 15.5 | 1.16 | 0.041 |
| Cr | mg/l | 0.5 | | 48.2 | 0.061 | 0.047 |

As shown in Table 5.1, BOD and V concentrations are over the national wastewater standards. Also reportedly the Plant had a problem of excess electro-conductivity of wastewater. In addition, a condition to get ISO 14000 was to install a sludge waste treatment system.

1) The vanadium compounds are contained in air heater washing water. The compounds can be removed by neutralization and settling. The Plant management has decided to construct two settling ponds (total 1050$m^3$) in addition to the existed 450$m^3$ pond (Appendix A.3-5). The construction was almost in completion when the JICA Team visited the Plan. The Team wishes the new additional ponds

will work satisfactory.

2) The JICA Team assumes that selecting appropriate operating conditions can reduce the excess BOD in the active sludge facilities.
3) The Tabriz Plant management had prepared to solve the electro-conductivity problem before the Master Plan Study by introducing new river water in addition to the underground water. The underground water has high conductivity (3500 micro s/cm) and naturally the wastewater has higher conductivity. The new river water has a conductivity of about 1/10 of the underground water's. The water used in the Plant is the half and half mixture of the river and underground waters.
4) Water has to be softened before use in the Plant as coolant. The water is mixed with lime milk and coagulants. The resulted sludge is removed in a thickener and dried by a filter before trucking.

The Esfahan Power Plant discharges its wastewater after treatment (Appendix A.3-6) to the Zayande River. The Plant presents wastewater samples to the local environmental agency and receives the analytical results. As shown in Table 5.2, almost all items are below the national standards.

Table 5.2 Analytical Data of Wastewater from Esfahan Power Plant
(Sampled on July/20/'02)

| | unit | Standard | Site of Sampled | | | |
|---|---|---|---|---|---|---|
| | | | Exit of Neutralization | Nos. 1, 2, 3 Discharge Exit | Overflow of Thickener | Nos. 4, 5 Discharge Exit |
| pH | | 6.5 – 8.5 | 12.8 | | | |
| COD | mg/l | 60 | | 64 | 12 | 40 |
| BOD | mg/l | 30 | | 20 | 8 | 15 |
| TDS | mg/l | - | 1386 | 762 | 13.8 | - |
| SS | mg/l | 0 | 2463 | - | 866 | - |
| Cl | mg/l | 1 | | 0.43 | - | 0.41 |
| Na | mg/l | - | 248 | - | - | - |

During the three years after the Master Plan Study, there were cracks of a seal on the bottom of an equalization lagoon.

1) Wastewaters of chemical wash of Nos. 1,2 and 3 boilers of the Esfahan Power Plant were previously mixed with sludge of water softening and bleed water of cooling towers, and flew into settling ponds (two in alternate use) where

suspended materials are settled, dried and trucked out. As shown in Table 5.2, COD was a little excess of the standard. Therefore, the wastewaters are going to be mixed with through the new water conduit and be treated with the wastewaters of chemical wash of No. 4 and 5 boilers. The treatment is a sequential process of equalization, neutralization, settling, thickening, and filtration.

2) Changing the old PVC liner with a new PE liner solved the crack problem of the equalization lagoon, when the Follow-up Team visited the Plant.

The Zayande River is the source of potable water of the Esfahan Municipality. However, many wastewaters flow in from factories, residential, agricultural activities, etc. Comprehensive countermeasures are expected before substantial damages will be revealed.

## 5.4 Handling of PCB Wastes

The managements of two power plants asked the Follow-up Team experiences in Japan on PCB storage and disposal.

The Tabriz Plant once collected PCB wastes from transformers in 60 standard 1 bbl drums. Later the wastes were transferred to an around 20 $m^3$ horizontal vessel placed in an open underground pit, through a tin trough. The drums were still there near the pit. A removable ladder was there in the pit for easy access to the vessel with a standard cock in a drain line.

The Esfahan Plant kept the unused transformers in a warehouse as without touch, and studying to make PCB wastes harmless by solidification.

The JICA Team introduced the handling in Japan as follows:

The unused transformers have to be stored in a warehouse under strict cautions without touching. If the PCB wastes are removed from the transformers, the wastes must be stored in a tank placed on an impermeable foundation surrounded impermeable dike having a double capacity of the tank. The tank has to be covered to avoid direct sunshine. Recently Tokyo Electric Power Company has started operation of two chemical decomposing plants of PCB waste, in order to make it nonpoisonous.

The Follow-up Team expects that Tavanir will lead the solution of the handling problems, instead of each power plant solving independently.

## 5.5 Estimation of Social Costs

MOE asked the Follow-up Team for possibility of JICA's technical assistance to estimate social costs of air pollutants from power plants. MOE needs this assistance to prepare for the 4th 5 year Development Plan that will include reduction of the governmental subsidies on general services such as electricity, gasoline, milk, flour, etc., and to evaluate competitiveness and development possibility of new energy sources against the steam power plants.

An engineer of MOE tried to estimate the costs using factors proposed by the US-EPA. However, there were many uncertainties on the estimation and difficulties to include differences of social structures.

As there was no experienced person in the Follow-up Team, the request of the Iran side was recorded in the minutes of meeting and the Team promised to convey the request to the JICA Headquarters. Also the Team asked to prepare and present an easily understandable TOR to JICA through the official route.