4) Detailed Inspection Target Items

① Fig. 4.2.4-2 (Inspection Items on Pressure Parts for Katteneh No.6) indicates the items chosen for detailed inspection based on the past experience of the Study Team members.

Regarding the detailed inspection work to be implemented in the first stage general overhaul, it is proposed that the views of the specialists or supervisors from the original maker are taken into consideration.

② The same thing is proposed for the Other Proposed Items detailed in Fig. 4.2.4-3.

③ Moreover, Appendix-5 (Periodic Inspection Procedure for Boiler and Turbine) describes in detail the inspection items, work procedures, related items, and boiler and turbine attachments and auxiliary equipment etc., and it is proposed to conduct the detailed inspection in accordance with this.

(7) Proposal of Rehabilitation Plan for Unit No.6 (Electrical and Instrumentation)

Of the rehabilitation items described in 4.2.4(4), the following priority items shall be made the target of the Rehabilitation Plan.

1) Renewal of deteriorated Electrical Equipment

① Renewal of DC systems,
② Renewal of 380 V switchgears.

2) Remodeling of the existing instrumentation system from pneumatic to electrical

3) Renewal and Repair of Instruments

① Renewal of deteriorated instruments:

- Central control room indicators,
- Recorders
  (including new panel installation due to the adoption of chart recorders for electrical instruments)
- Transmitters, transducers,
- Level switches,
- Detectors (including thermo-couples, thermo-resistors),
- Others.

FIG. 4.2.4-2

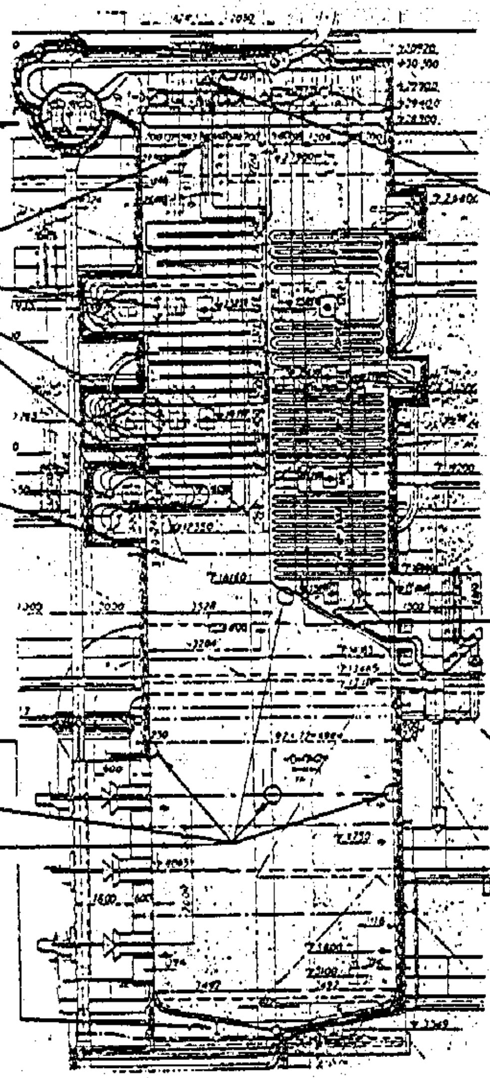
Katteneh P.S

Inspection Items on Pressure Parts for Katteneh No.6

Drum
(1) VI.
(2) PT 0f Weld Parts (Drum Inside) ; Weld Seam, Nozzle and Lugs.
(3) MT 0f Weld Parts (Drum Outside) ; Selected Parts of Longitudinal Seam Nozzle.

Super Heater Tube
(1) Wall Thickness.(UT)
(2) MT 0f Weld Parts of Lugs.

Furnace W/W Tube
(1) VI & PT 0f Weld Parts at Menbrane-bars for. Each opening,such as Burner Throats, AD openings and SB openings.
(2) PT 0f Welded Connection of Tie-bars for Buckstay.
(3) VI 0f Corner Condition of Buckstay.
(4) PT 0f Weld Parts of lugs on side wall for Furnace Hopper Support Girders.
(5) Thickness 0f every W/W Tube ; Side Walls, Front & Rear Walls.(UT)
(6) Tube Sampling Investigation ; Front and Rear Wall Left & Rear Walls(Burner Level), Slope Ports



Main Steam Pipe
(1) MT 0f Weld Parts of Support Lugs.
(2) VI(Fiber-scope) 0f Internal Surface (for drain attack)

S/H Outlet Header
(1) MT 0f Weld Parts of Tube Stubs.
(2) MT 0f Weld Parts of Drain Nozzle.
(3) ST 0f Outside Surface of Welded Part of Outlet Nozzle.
(4) VI(Fiber-scope) 0f Inside Surface of Outlet Nozzle.

Super Heater Tube
(1) Wall Thickness.(UT)
(2) MT 0f Weld Parts of Lugs.
(3) Tube Sampling Investigation.

Economizer Tube (Eco.)
(1) Wall Thickness.(UT)
(2) VI,Tube Outside Surface.(Corrosion)

Economizer Inlet Header
(1) VI(Fiber-scope) 0f Inside Surface of Tube Stubs.

SH Attemperator
(1) PT 0f Spray Nozzle for Fatigue Crack.
(2) VI (Fiber-scope) 0f Internal Pipe for Fatigue Crack.

Note ; MT:Magnetic particle test. PT:Penetration test. VI:Visual inspection. ST:Sump. test (replica) UT:Ultra sonic test.
SB: Soot Blower. AD:Access Door.

Other Inspection Items

Burner,Atomizer Inspection / Replace Factor

Burner ; } Erosion,Corrosion.
Atomizer ; }

Impeller ; High Temp. Oxidation,Corrosion.

Air Register ; Thermal Deformation Erosion.

Ignition Torch; Erosion, Deterioration.

Automated ; }
Facilities ; }

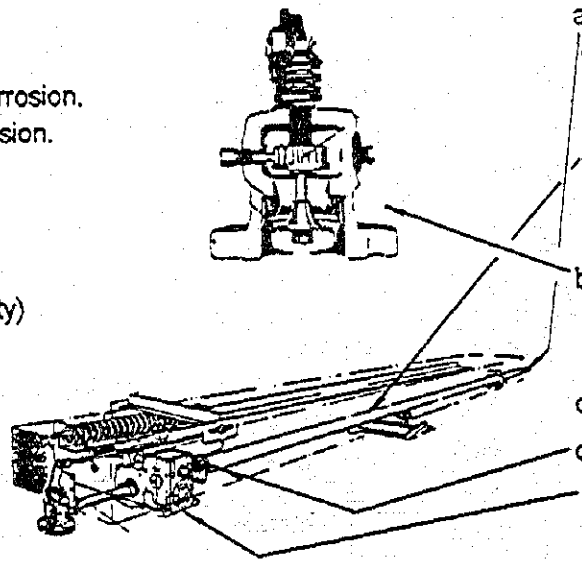
-Flame Detector ; Deterioration(Sensitivity)

-Limit Switch ; Deterioration

-Air Cylinder ; Deterioration

-Motor Drive ; Deterioration

(Burner Maintenance and Combustion Adjustment under Instruction of Burner Supplier every Year to be Carried Out)



Soot Blower System.

a. Nozzle, Lance Tube.(VI)

(1) Blockade of Blowing Nozzle

(2) Boiler Tube Damage due to Soot Blowing

(3) Nozzle ; (VI) Erosion, Corrosion,Crack(PT).

(4) Lance Tube, Feed Pipe ; Corrosion,Deformation.

(5) Gland ; Erosion, Corrosion.

(6) Start Point of Steam Blowing

b. Head Valve

(1) Valve Body, Valve Spindle.

(2) Valve Seat, Spring.

c. Wall Box.

d. Drive System.

(1) Gear Box.

(2) Gear,Bearing,Chain.

(3) Lubricant.

Air Heater

a. Heating Element.

(1) Element ;Corrosion / Erosion(VI),Weight

(2) Stiffener ; Corrosion / Erosion(VI),Plate Thickness(VI).

b. Seal Component.

(Radial Seal,Circumferential Seal,Rotor Seal.

(1) Corrosion / Erosion(VI)

(2) Clearance of Seal Materials(VI).,Adjustment.

c. Rotor.

(1) Welded Parts of Rotor ; (VI),(PT)

(2) Fit up Bolts, Pin Rack ; (VI).

d. Housing.(VI)

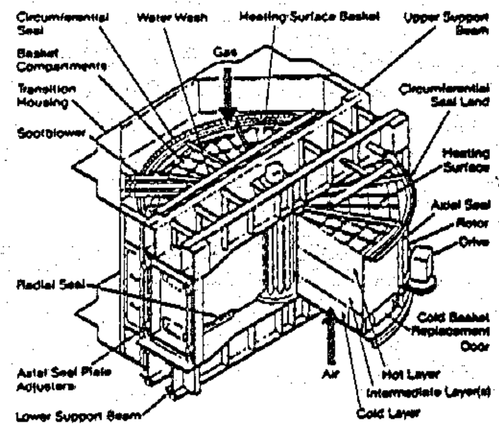
(1) Corrosion

(2) Deformation

e. Bearing(VI)

f. Rotor Balance

g. Confirmation of Seal,Clearance.
Confirmation of Air Leakage Percent During Performance Test.
(—Under Instruction of the Air Heater Supplier)



Note ; PT:Penetration test. VI:Visual inspection.

② Instruments to be Renewed in Line with Remodeling from Pneumatic to Electrical Systems

- Controller (pressure controller, level controller),
- Valve positioner/diaphragm with transmitter,
- Differential pressure transmitter,
- Others.

③ Renewal and repair of instruments selected based upon the results of the first stage overhaul.

4) Whether instruments are renewed, repaired or left as they are, calibration shall be performed on all items.

4.3 Implementation Schedule and Cost Estimation

4.3.1 Implementation Schedule

(1) Time Schedule

It was previously stated that the rehabilitation and renovation work should be implemented in the period between 1988 and 2000 when guaranteed capacity is forecast to be in excess of peak demand.

Fig. 4.3.1-1 indicates the Master time schedule that has coordinated the work schedules for each power plant indicated in Fig. 4.2.2-1, Fig. 4.2.3-1 and Fig. 4.2.4-1 in such a way to ensure that all rehabilitation and renovation work is completed between 1988 and 2000.

In addition, an alternative Master schedule Fig. 4.3.1-2 has prepared as an extended and easy schedule based on the fulfillment of the following conditions.

① Two (2) units will not be stopped simultaneously in the same power plant for overhaul.

② Three (3) units will not be stopped at the same time in selected thermal power plants for overhaul.

Overall planning must be commenced immediately and it must be possible to definitely commence the rehabilitation and renovation work in 1997 and 1998, in order to ensure that the work is implemented in accordance with this time schedule.

(2) Manning Schedule

Table 4.3.1-1 indicates the manning schedule for the inspection (first stage) overhaul.

This has been calculated based upon data from cases of detailed inspections actually carried out at the power stations in Japan. Thus, when the overhauls are actually implemented at the subject power plants in Syria, it will be necessary for the plant sides to bear this in mind and have full consultations with the original supplier supervisors in considering actual manning schedules.

Fig.4.3.1-1 Rehabilitation Master Schedule

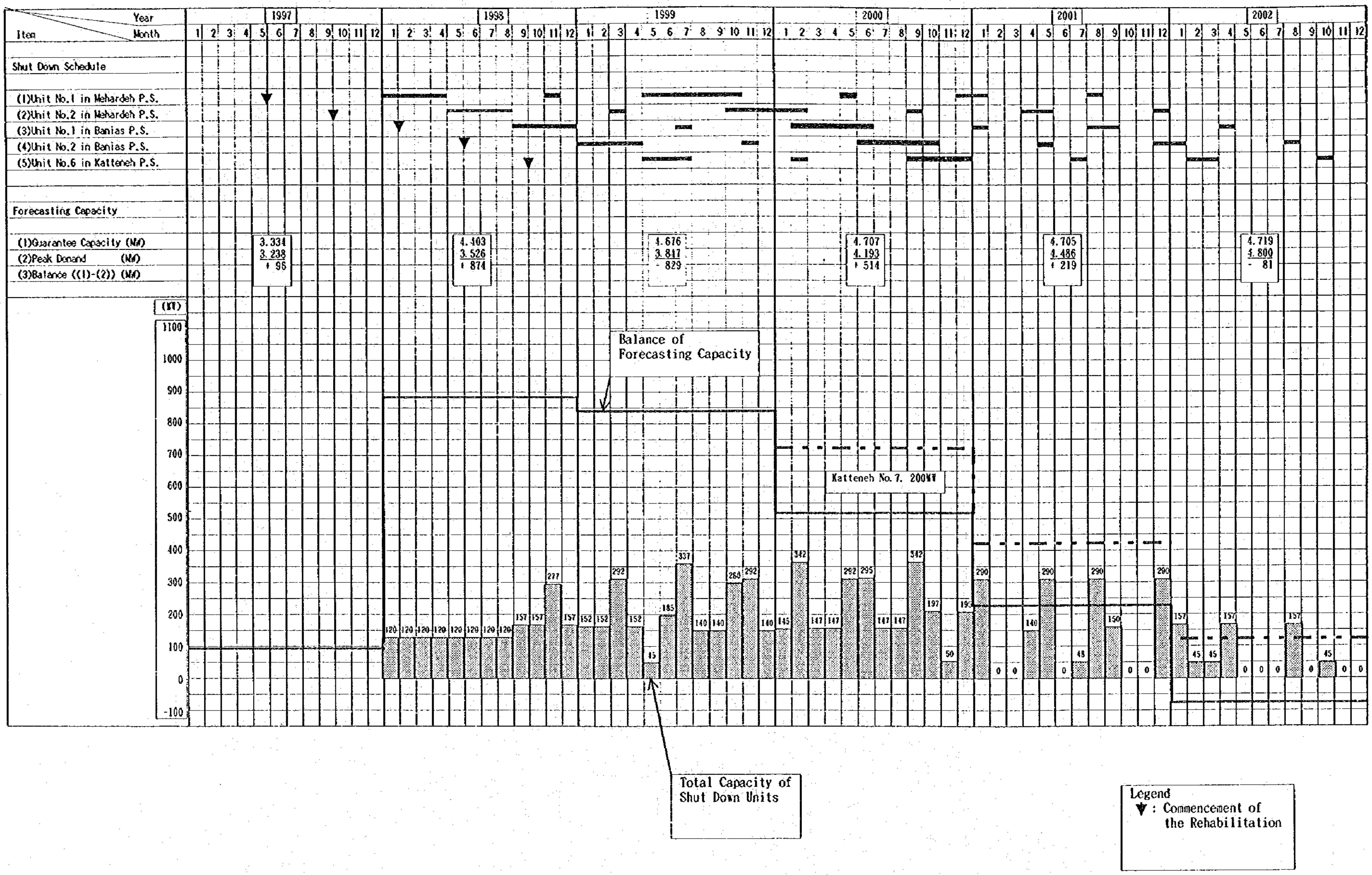
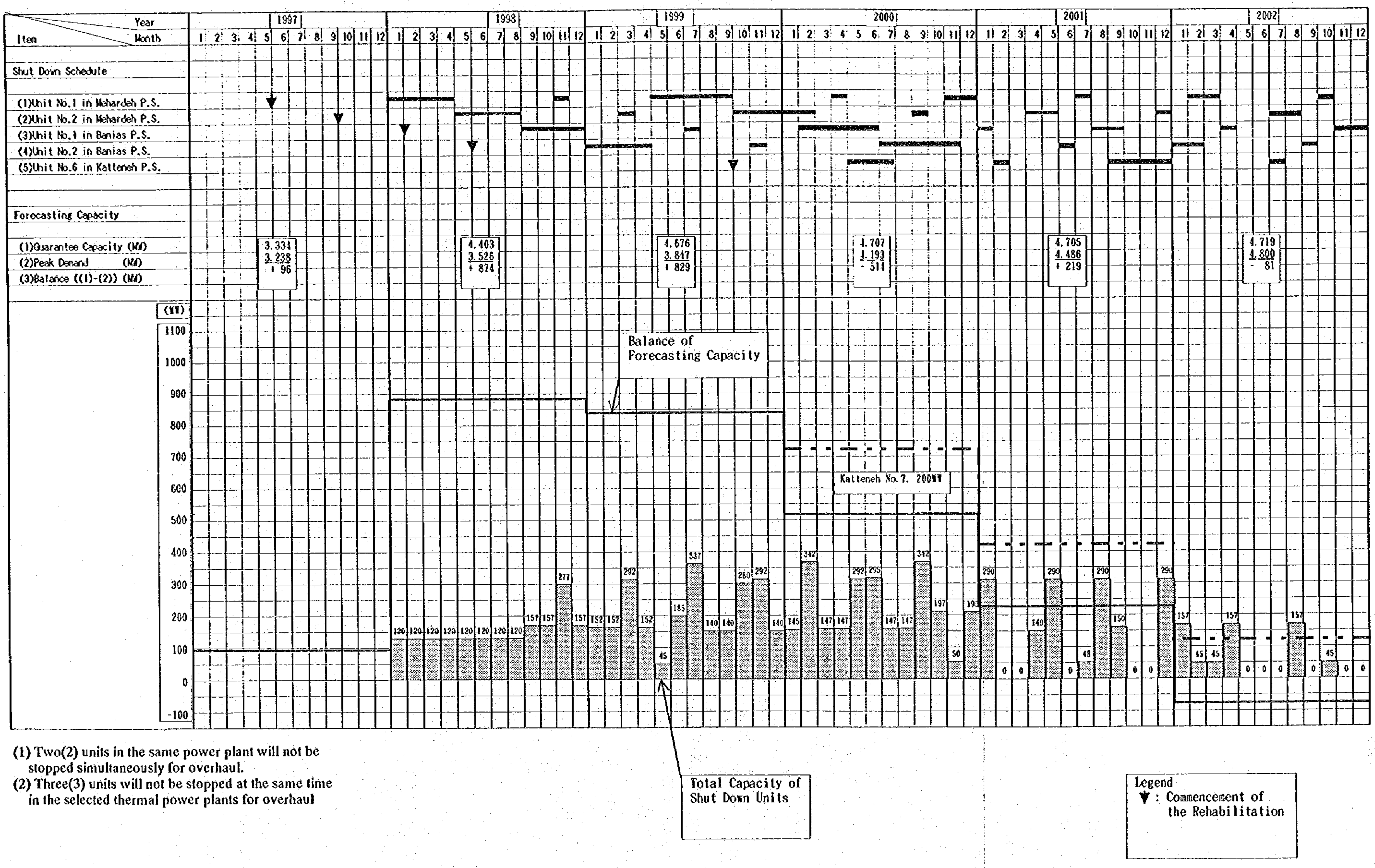


Fig.4.3.1-2 An Alternative Rehabilitation Master Schedule



(1) Two(2) units in the same power plant will not be stopped simultaneously for overhaul.
(2) Three(3) units will not be stopped at the same time in the selected thermal power plants for overhaul

Table 4.3.1 Manning Schedule for First Stage General Overhaul

Work Area and Responsibility	Man-Month		
	Site Work	Planning Work	Total
Original Supplier Supervisor or Specialist			
① Boiler Pressure Parts	4.0	2.0	6.0
② Burner/Combustion Adjustment	1.5	0.5	2.0
③ Turbine	1.5	0.5	2.0
④ Condenser	1.5	0.5	2.0
⑤ Air Heater	1.5	0.5	2.0
⑥ Electrical	1.5	0.75	2.25
⑦ I&C	1.5	–	2.25
⑧ Valves	1.5	–	1.5
⑨ Boiler Water Gauge	0.5	–	0.5
⑩ Soot Blower	1.0	0.5	1.5
⑪ B.T.G. Performance Testing, and Management of and Coordination between B.T & G	16.0	4.0	20.0
Subtotal			42.0
Power Plant Staff			
① Engineer (boiler)	6.0	–	6.0
② Engineer (turbine)	4.0	–	4.0
③ Engineer (electrical)	2.0	–	2.0
④ Engineer (I&C)	1.0	–	1.0
⑤ Operator (boiler)	140	–	140
⑥ Operator (turbine)	100	–	100
⑦ Operator (electrical)	80	–	80
⑧ Operator (I&C)	40	–	40
Subtotal			373.0

4.3.2 Calculation of Estimated Work Costs

This section describes the rough calculation of the estimated costs involved in the rehabilitation and renovation works indicated in previous sections.

(1) Cost Calculation Conditions

The main preconditions used in calculating costs are described hereunder.

1) Standard Prices

The prices that exist as of February 1995 shall be assumed as standard, and increases in personnel expenses and constriction costs due to inflation shall not be included in the calculations.

2) Currency used for Cost Calculations

Costs shall be expressed in US $, and those items that are originally expressed in the local currency (Syrian pound) or in Japanese yen shall be converted to US $ using the following exchange rates:

1 US $ = 42.00 Syrian pounds
= 100 Yen

3) Taxes

It has been assumed in the cost calculations that import tax and all other taxes will be exempted.

4) The following personnel expense rates have been adopted for the cost calculations:

Power station engineers and technicians	:	400 US $/man/month
Original supplier supervisor and specialists	:	30,000 US $/man/month

5) Work costs have been estimated in the following way based upon data from past work cases experienced by the Study Team.

① Document Preparation Costs

100,000 US $ has been assumed for both Banias Power Plant and Mehardeh Power Plant, and 60,000 US $ has been assumed for Katteneh Power Plant.

② Sample Preparation and Analysis Costs for Replication Test

60,000 US $ per unit has been assumed.

③ Equipment for Inspection Overhauls

50,000 US $ per unit has been assumed.

④ Reheater and Superheater Renewal Costs

- At Banias Power Plant, assuming an approximately 200 WT renewal scale, 4,000,000 US $ has been estimated.
- At Mehardeh Power Plant, assuming an approximately 130 WT renewal scale, 2,600,000 US $ has been estimated.

⑤ I & C Renewal

Assuming that 1/3 of all systems will be renewed, 2,900,000 US $ per unit has been estimated.

⑥ Electrical Equipment Renewal

At Katteneh Power Plant, assuming that the work will include the replacement of all deteriorated electrical equipment, and also bearing in mind switchgear and DC system replacement, 2,000,000 US $ has been estimated.

⑦ Rehabilitation and Renovation Work Identified in the First Stage Overhaul Inspections

The work contents cannot be identified at the present time, however, the following costs are provisionally assumed.

Banias Power Plant	:	32,200,000 US $
Mehardeh Power Plant	:	27,800,000 US $
Katteneh Power Plant	:	7,600,000 US $

⑧ New Steam Turbine Generating Facility (STG) Installation at Katteneh Power Plant

The cost of this work has been estimated assuming a cost of 800 US $ per KW.

(2) Cost Totalling

The cost breakdown and total cost are indicated in Table 4.3.2-1. The total cost of the works comes to 263,000,000 US $.

Table 4.3.2-1 Cost Breakdown and Total Cost

No.	Item	Amount (US $)
1.	Rehabilitation of Banias Power Plant Unit No.1, Unit No.2	
1.1	First stage general overhaul	
①	Technical staff personnel costs (each power plant)	
②	Operator personnel costs (each power plant)	
③	Original supplier supervisor or specialist personnel costs	
④	Documents and drawings preparation costs	
⑤	Sample making and analysis cost	
⑥	Equipment and materials for inspection and overhaul	
	(1.1 Subtotal)	2,500,000
1.2	Second stage general overhaul	
①	Technical staff personnel costs (each power plant)	
②	Operator personnel costs (each power plant)	
③	Original supplier supervisor or specialist personnel costs	
④	Renewal of reheater (High temperature zone)	
⑤	Renewal of superheater (High temperature zone)	
⑥	Renewal of instrumentation and control equipment (including change over to electric instrumentation system, efficiency control system and maintenance management systems)	
⑦	Rehabilitation/renovation work selected in the first stage general overhaul inspection	
	(1.2. Subtotal)	44,500,000
	(1. Total)	47,000,000
2.	Rehabilitation of Mehardeh Power Plant Unit No.1, Unit No.2	
2.1	First stage general overhaul	
①	Technical staff personnel costs (each power plant)	
②	Operator personnel costs (each power plant)	
③	Original supplier supervisor or specialist personnel costs	
④	Documents and drawings preparation costs	
⑤	Sample making and analysis cost	
⑥	Equipment and materials for inspection and overhaul	
	(2.1. Subtotal)	2,500,000
2.2	Second stage general overhaul	
①	Technical staff personnel costs (each power plant)	
②	Operator personnel costs (each power plant)	
③	Original supplier supervisor or specialist personnel costs	
④	Renewal of reheater (High temperature zone)	
⑤	Renewal of superheater (High temperature zone)	
⑥	Renewal of instrumentation and control equipment (including change over to electric instrumentation system, efficiency control, and maintenance management systems)	
⑦	Rehabilitation/renovation work selected in the first stage general overhaul inspection	
	(2.2. Subtotal)	38,500,000
	(2. Total)	41,000,000

Table 4.3.2-1 Cont.

No.	Item	Amount (US $)
3.	Rehabilitation of Katteneh Power Plant Unit No.6	
3.1	First stage general overhaul	
①	Technical staff personnel costs (each power plant)	
②	Operator personnel costs (each power plant)	
③	Original supplier supervisor or specialist personnel costs	
④	Documents and drawings preparation costs	
⑤	Sample making and analysis cost	
⑥	Equipment and materials for inspection and overhaul	
	(3.1. Subtotal)	1,000,000
3.2	Second stage general overhaul	
①	Technical staff personnel costs (each power plant)	
②	Operator personnel costs (each power plant)	
③	Original supplier supervisor or specialist personnel costs	
④	Renewal of electrical equipment	
⑤	Renewal of instrumentation and control equipment	
⑥	Rehabilitation/renovation work selected in the first stage general overhaul inspection	
	(3.2. Subtotal)	14,000,000
	(3. Total)	15,000,000
4.	Installation of one new STG unit at Katteneh Power Plant	
	(4. Total)	160,000,000
Total Cost of Planned Works		263,000,000

4.4 Economic Analysis of the Rehabilitation

4.4.1 Methodology

As generally employed in the economic analysis of power sector projects, least cost method is applied to verify economic validity of the rehabilitation, comparing the unit cost with alternative generations, which can bear the same generation capacity as the proposed rehabilitation. In the economic examination, 10 % of the opportunity cost of capital is applied as other projects of the sector in Syria.

Economic consideration on electricity tariff is made because it might be more important and meaningful to study the tariff level than a common financial analysis in the circumstances of the sector. Currently in Syria, electricity tariff collected from consumers goes directly to the national treasury and both capital and recurrent expenditures for the sector are appropriated from the national budget. The tariff structure is determined through political process and set lower than those which can cover all cost for investment, operation and maintenance and financing. As the World Bank's Report on the "Electric Power Efficiency Study" in Syria in 1988 shows, the electricity tariff seems to be set substantially lower than long-run marginal cost (LRMC). A recommendation is made for appropriate tariff setting and its effective application.

4.4.2 Economic Examination of the Proposed Rehabilitation

(1) Selection of Alternatives

1) Generation Type of the Alternative Plant

Even though there could be various types of generation projects as the alternative of the rehabilitation, nuclear and hydraulic power generations are excluded in selection of the alternatives. There could be few chances in the near future in Syria to develop nuclear generation systems as commercial operations. Hydro-power generation is placed out of the examination in the Study because of the following reasons.

- Roles of hydro-power generations in the national electricity supply are different from those of thermal power generation to be rehabilitated because of heavy dependence of the former on hydrological conditions.
- Hydro-power generation plans should also be projected in the context of water resource development plan and be determined within multi-purpose water resource development projects of the basin.

- Hydro-power plants would be located far from the proposed thermal plants and would incur costs for transmission to provide the same benefits as the rehabilitation.

Then, construction of a thermal generating plant with the same capacity as the respective rehabilitation proposed in the Study is examined as the alternative of the proposed rehabilitation.

2) Location of the Alternative New Plants

All locations of the proposed rehabilitation are sited near industrial areas or areas with much demand of electricity at present and in the near future. The alternative new plant construction can be near the existing power plants to be rehabilitated. The alternative construction site is presumed to be located near the targeted power plants to be rehabilitated with the same capacity in order to minimized the cost for auxiliaries or transmission.

(2) Premises for the Economic Examination

The followings are presumed in this examination.

1) Rehabilitation and Construction Cost

International prices are applied. No future price escalation is estimated because of the recent market trends of power plants.

2) Project Life and Period of the Examination

Project life of the rehabilitation is assumed as 15 years, while that of the alternative construction as 35 years, presuming that the same maintenance system is applied.

(3) Comparison of Unit Capacity Costs

With the premises and assumptions mentioned in the above, unit capacity costs are calculated as shown in Table 4.4.2-1. Annual cost is calculated with the following formula:

$$\sum_{t=1}^{PL} \frac{c}{(1+r)^t} = UC$$

where,

PL ; project life (15 years for the rehabilitation, 35 years for the construction)

r ; discount rate (opportunity cost of capital, 10%)

c ; annual cost

UC ; investment cost per KW

Compared to the alternative construction case, rehabilitation will reduce annual cost per KW to 20%-37%, even though the project life of the construction case is assumed as 35 years, applying the same maintenance system as the rehabilitation case.

Table 4.4.2-1 Unit Capacity Cost for Both Cases

	Katteneh	Mehardeh	Banias
Installed Capacity	64MW	300MW	340MW
Discount Rate (Opportunity Cost of Capital)		10%	
Rehabilitation Case			
- Investment Cost (US$ million)	15.0	41.0	44.5
- per KW (US$)	234	137	138
- Project Life		15 years	
- Annual Cost (US$/KW)	31	18	17
Alternative Construction Case			
- Investment Cost (US$ million)	51.2	240.0	272.0
- per KW (US$)		800	
- Project Life		35 years	
- Annual Cost (US$/KW)		83	

Introduction of the proposed rehabilitation will increase a large amount of foreign currency savings by decreasing the purchase for the construction from foreign countries.

(4) Qualitative Analysis on the Benefits by the Introduction of the Proposed Rehabilitation System

Proposed rehabilitation system employs preventive maintenance and can reduce forceful outage. The loss and recovery cost for damage caused by outage and the cost for installation and operation of emergency generators by consumers, which generally grow rapidly in modern economies and societies, can be expected to be largely reduced by the implementation of the proposed system.

The reliability of the power generation will be improved by the introduction of the proposed rehabilitation. Enhanced reliability in operation will allow equitable planning through which optimal investment can be projected and consequently will allow considerable amount of savings from unnecessary investment while maintaining a certain level of reliability in power supply.

4.4.3 Recommendation of Electricity Pricing

(1) Current Situation on Electricity Tariff

Electrify pricing is important not only to meet the financial requirement of the utility establishment but also to control and manage the demand, to avoid over investment and ultimately to maximize the socio-economic benefit of electricity consumption.

Electricity tariff setting based on long-run marginal cost (LRMC), an incremental cost at which each type of user imposes on the national electricity supply scheme in the long run in terms of economic value, has been accepted by power sector establishments in many countries.

In 1988, the World Bank estimated in the Report mentioned above that the LRMC for low voltage user at peak time and at non-peak time are US cent 6.64/kwh and US cent 4.12/kwh, respectively, while the average tariff at that time was US cent 2.7/kwh.

Even though the tariff table was revised in 1992 and the proposed rehabilitation will allow lower LRMC when introduced widely in the country, the wide gap between LRMC and actual tariff seems not to be narrowed by now or soon. Further, economic exchange rate (not always same as the actual exchange rate) which was Syrian Pounds 20 to one US dollar applied in the Report, can be estimated to turn as high as Syrian Pounds 40 to one US dollar or more.

As shown in the tariff table revised in 1992, industrial and commercial consumers, including high voltage users, are paying relatively high charges, while domestic consumers, especially small consumers, enjoy lower tariff.

(2) Recommendation

Although LRMC does not determine tariff structure directly and the following matters should be taken account in formulation of pricing policy, the LRMC should be calculated as a benchmark and the adjustment from strict LRMC structure to the actual tariff table in view of the followings should be conducted explicitly.

- Financial viability for public utility establishments and for the national electricity service as a whole

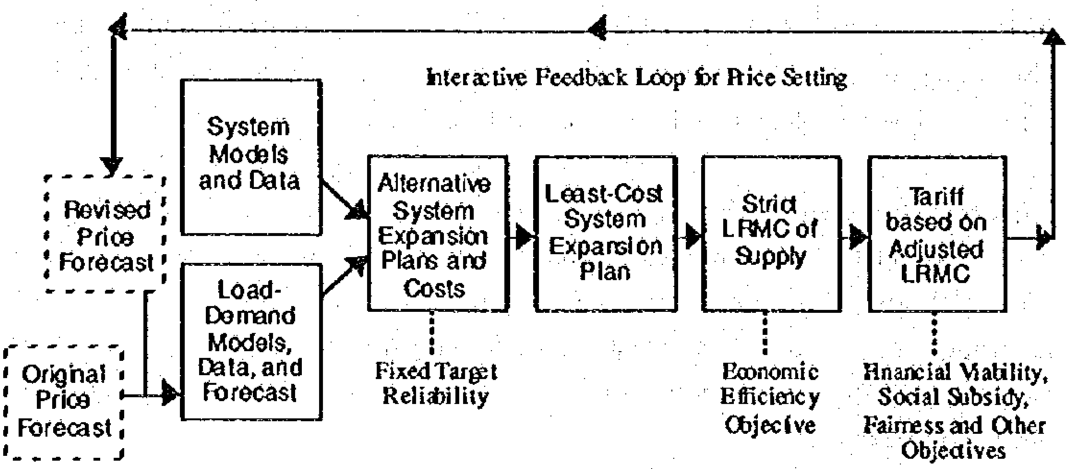
- Social subsidy or setting lifeline tariffs for low income groups or users in remote areas

- Available metering and billing techniques and customers' comprehension

- Other socio-economic policies, such as promotion of agriculture or specific industry with incentives or support of regional development

Price change should be made gradually. Electricity supply service is one of infrastructures for the economic and social activities. A sudden raise of the tariff could hinder appropriate development of those activities. Current frequency of the tariff revision, once in one to three years, might be acceptable for the country. The gap between adjusted LRMC and existing tariff structure should be fulfilled gradually.

As mentioned above, pricing has a large influence in demand, which is a start of the planning model, thus, continuous feedback activities, as shown in Fig. 4.4.3-1, are necessary.



(Source: M. Munasinghe & J.J. Warford, 1982)

Fig. 4.4.3-1 Interactive Feedback Loop for the Tariff Setting

Reference on detail theory and practices is recommendable to the following publications.

- "Electricity Pricing", 1982, M. Munasinghe & J. J. Warford, World Bank / Johns Hopkins University Press

- "Electricity Economics", 1977, R. Turvey & D. Anderson, World Bank / Johns Hopkins University Press
- "Expansion Planning for Electrical Generating Systems, 1984, International Atomic Energy Agency
- "The Economic of Power System Reliability and Planning", 1979, M. Munasinghe, World Bank / Johns Hopkins University Press

4.5 Recommendations

(1) The main cause of the declining output and thermal efficiency levels in the units has been the attachment of large quantities of soot to heating surfaces due to the use of HFO, which contains much sulfur and ash, as fuel.

Measures to counter this are cleaning with steam soot blowers during operation, and further cleaning as well as combustion adjustment of burners during the overhauls. In the case of HFO burning power plants in particular, it is recommended that cleaning be performed at least two times a year.

Another reason for the declined output and thermal efficiency levels has been instrumentation and control equipment breakdown, which meant that improvements to operating states, and especially control and improvement of excess air ratios, could not be performed. The renewal of instrumentation and control systems is proposed in order to overcome this problem.

(2) Operation in high level excess air situations shall be avoided in order to prevent deterioration of boiler efficiency levels and low temperature corrosion. Excess air control gages (that is to say O_2 meters) are, therefore, included in those instrumentation and control systems for which renewal is proposed.

(3) Defects that occur during operation shall be countered and repaired at an early stage before they develop into something serious. The delaying of countermeasures will only result in greater repair costs and repair time.

(4) In the first stage overhaul, it is proposed to conduct detailed inspections on the relatively hard to find boiler pressure parts of those units which have been in operation for more than 100,000 hours. Furthermore, the supervisor or specialist from the original supplier shall be requested to inspect and compile rehabilitation plans for the following areas. Then, during the second stage overhaul, the planned work on all defects shall be implemented.

At this stage, it is important that all necessary countermeasures for every one of the subject areas be implemented simultaneously during the period of the second stage overhaul. If one area is omitted or left over, it may become necessary to carry out additional isolated rehabilitation at a later stage, which will make it impossible to plan periodic inspection and repair schedules for future and so detract from the effectiveness of the overhaul work.

① Boiler pressure parts
② Burner combustion adjustment

③ Turbine
④ Condenser
⑤ Air heater
⑥ Electrical equipment
⑦ Instrumentation and control systems
⑧ Valves
⑨ Boiler water gauges
⑩ Soot blower
⑪ Boiler, turbine and generator performance testing, and management of and coordination between the boiler, turbine and generator

(5) Following the overhauls, performance tests shall be performed in order to confirm the results of the overhaul work.

(6) Regarding those units which have not been targeted by the Rehabilitation Study, it is proposed that operations be shut down for between one and a half months to two months per year in order to allow maintenance overhauls be carried out.

As is indicated in Fig. 4.3.1-1 and 4.3.1-2 (Rehabilitation Master Schedule), it is necessary to perform the necessary rehabilitation work of the general overhaul in the period between 1998 and 2000 (or 2001), when there is ample leeway in the power demand and supply balance throughout the whole of Syria.

However, if maintenance overhauls lasting between one and a half months and two months per year are carried out on the units not targeted by the Rehabilitation Study, the guaranteed power supply may not be able to satisfy the peak demand in 2000.

As is proposed in this Report, it is necessary to install a new 200 MW unit at Katteneh Power Plant and have it operating by 2000 in order to overcome this problem.

CHAPTER 5

NEW TRAINING CENTER CONSTRUCTION PLAN

CHAPTER 5 NEW TRAINING CENTER CONSTRUCTION PLAN

5.1 New Training Center Construction Plan Preconditions

5.1.1 Current Conditions of Operation and Maintenance at Power Plants

(1) Management System of Each Power Plant

a) Organization

The organization of each power plant is as shown in Fig. 5.1.1-1 with each plant manager directly connected to the Director General of the PEEGT. However, as of July 1994, the PEE, a subordinate organization of MOE, was split into the PEEGT and PEDEEE. Subsequent restructuring of the organization of PEEGT and the power plants is still undergoing and they are not operating normally. Since each department manager (from general affairs, accounting, procurement, contracting and other administrative departments to the equipment, machinery and instrumentation maintenance departments, as shown in the organization diagram) at each plant is directly responsible to each plant manager, each plant manager must grasp and solve everyday problems and is thus faced with too much responsibility. In addition, although each plant possesses a training section, it is not operated properly at any of the plants.

b) Staffing

Each power plant consists of operation and maintenance departments, and administration sections that assist these departments. The number of employees is quite large, more than three (3) times that of an average Japanese thermal power plant, compared simply (Refer to Table 5.1.1-1.) One reason for this is that, whereas in Japan actual maintenance and repair work is performed by subcontractors and/or sister companies, in Syria it is handled by each power plant's maintenance crew, which tends to be large. Even taking this into consideration and comparing actual operating staff, the staff at Syrian power plants is around two times larger than that of Japanese plants.

Between 10 to 30 employees leave each plant every year. They go to better paid positions either locally or abroad after gaining basic skills at the plants. Although every year each plant intends to take on new employees to supplement maintenance and technical staff, the average age of long-serving engineers is going up, and at

Katteneh power plant it is 55 or more. Finding more young and skilled engineers for positions in the operation and maintenance sections is vital.

The staff arrangements found at each power plant are indicated in Table 5.1.1-2 through 5.1.1-4. As can be seen from the tables, the number of staff with less than five years experience at Banias Power Plant and Mehardeh Power Plant, two main plants in Syria, account for approximately 50% of the total. This reflects the overall low technical levels of the staff and also the low rate of stickness of the staff to their posts. Looking at the staff numbers by category, engineers including assistant engineers in the maintenance and operation departments are the majority accounting for between 60% and 70% of the total. However, because there are few technicians involved in actual field maintenance work, there is a general inability to handle equipment troubles that occur on a daily basis.

With regard to welders too, there are relatively few skilled welders in terms of each plant size, and this is proving to be a big handicap in the execution of repair activities.

c) Current Operation and Maintenance Conditions

The operation shifts at each power plant, although differing slightly, are either three or four shifts with an average of 35 staff working on each. Operation records are kept in the form of daily reports, which are presented to the plant manager. However, each staff member is only responsible for monitoring and recording gages in his own work area, and there are not enough staff members who are in a position to grasp overall operating conditions. When troubles arise, operations are not stopped for repair purposes apart from cases of critical breakdown, and this is a clear reflection of the past acute power supply situation in Syria. (This situation is being improved with the start of operations at Jandar C/C Power Plant etc. providing some extra allowance in the overall generation capacity).

Except for Unit No.3 and Unit No.4 at Banias Power Plant, the setting of standard values for operation is not performed at the power plants. The reason for this is that most of the instruments at the plants are broken down and unable to be repaired due to the absence of spare parts. Equipment operation is thus performed manually by elderly staff. Except for Katteneh Power Plant, daily maintenance inspections are performed, however, there are differences in the inspection frequencies, inspection times and inspected equipment etc. between each plant. In particular, the forms provided by each plant's original equipment suppliers are used as inspection records (check sheets), and there is no unified format.

Moreover, inspections are performed separately by the operation and maintenance departments with the inspection activities divided between each work area. The establishment of unified daily inspection system is required in order to clarify responsibility for troubles and accidents.

Regarding data collection and the maintenance of records for long-term equipment diagnosis, this has been performed at Banias Power Plant since October 1994, however, such work should be implemented at the other plants too for rehabilitation purposes.

The current conditions of operation and maintenance at each power plant and the assessments by the Study Team are described in Table 5.1.1-5 and Table 5.1.1-6.

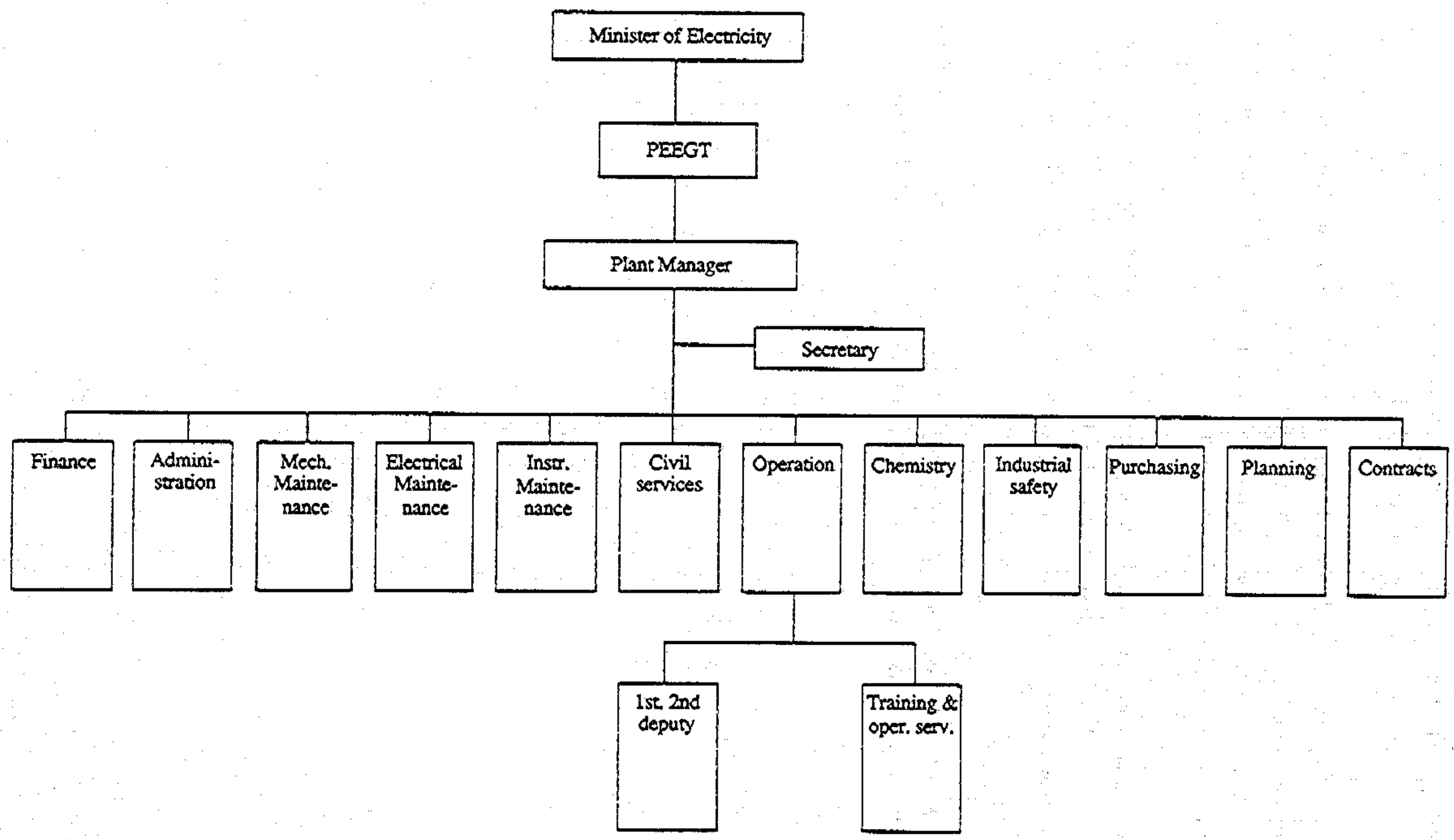


Fig. 5.1.1-1 Organization of the Each Plant

Table 5.1.1-1 Number of Staff of Each Power Plant

As of January 1995

Department	Name of Power Plant			Typical Power Plant in Japan (4 × 175 MW)
	Banias P/P	Mehardeh P/P	Katteneh P/P	
1) Maintenance Department	257	273	155	49 (200)
2) Operation Department	205	140	142	105
3) Chemistry Department	60	56	65	11
4) Civil Department	35	18	12	4 (15)
5) Administration Department	51	56	27	41 (5) and 6) combined)
6) Other Departments (Finance, Contracts, Planning, Purchasing, Industrial safety)	140	170	125	
Total	748	713	526	210 (215)

Average age of Employees	30	41	55	35

Note: Number of Staff shown in ( ) are additional number of workers employed by Subcontractors at the time of field work.

Table 511-2 Summary of Staff in Operation and Maintenance Department
Name of Power Plant: Banias Power Plant

As of January 1995

Nature of Staff	Category of Work			Years of Experience			Sub Total
	Mechanical	Electrical	Instrument	1 ～ 4	5 ～ 9	10 ～	
(1)Maintenance Department 1)Engineer	24	11	17	29	22	1	52
2)Assistant Engineer	61	22	34	74	30	13	117
3)Technician	36	10	8	27	13	14	54
4)Welder (skilled) (unskilled)	4 23	5 -	2 -	1 3	3 6	7 14	11 23
Sub-total	148	48	61	134	74	49	257
(2)Operation Department 1)Engineer		36		1	28	7	36
2)Assistant Engineer		127		40	27	60	127
3)Technician		17		7	1	9	17
4)Others		25		3	6	16	25
Sub-total		205		51	62	92	205

Table 511-3 Summary of Staff in Operation and Maintenance Department
Name of Power Plant: Mehardeh Power Plant

As of January 1995

Nature of Staff	Category of Work			Years of Experience			Sub Total
	Mechanical	Electrical	Instrument	1 ~ 4	5 ~ 9	10 ~	
(1)Maintenance Department 1)Engineer	23	13	26	31	19	12	62
2)Assistant Engineer	49	20	38	51	38	18	107
3)Technician	19	12	20	18	19	14	51
4)Welder (skilled) (unskilled)	2 15	- -	- -	- 11	- 1	2 3	2 15
5)Others	36	-	-	1	12	23	36
Sub-total	144	45	84	112	89	72	273
(2)Operation Department 1)Engineer	24			-	14	10	24
2)Assistant Engineer	80			10	30	40	80
3)Technician	20			-	10	10	20
4)Others	16			-	10	6	16
Sub-total	140			10	64	66	140

Table 511-4 Summary of Staff in Operation and Maintenance Department
Name of Power Plant: Katteneh Power Plant

As of January 1995

Nature of Staff	Category of Work			Years of Experience			Sub-Total
	Mechanical	Electrical	Instrument	1～4	5～9	10～	
(1)Maintenance Department 1)Engineer		16		-	-	16	16
2)Assistant Engineer		17		-	7	10	17
3)Technician		23		-	4	19	23
4)Welder (skilled) (unskilled)		4 6		- -	- -	4 6	4 6
5)Others		89		-	21	68	89
Sub-total		155		-	32	123	155
(2)Operation Department 1)Engineer		11		-	11	-	11
2)Assistant Engineer		29		-	-	29	29
3)Technician		45		-	-	45	45
4)Others		57		-	-	57	57
Sub-total		142		-	11	131	142

Table 511-5 Summary of Situation on Maintenance and Operation at Each Power Plant

Operation

Descriptions	Banias Power Plant	Mehardeh Power Plant	Katteneh Power Plant
(1) Operation Shift 1) Number of shift	4-shifts	3-shifts	4-shifts
2) Number of staff per shift	54 person	32 person	28 person
(2) Operation 1) Record keeping	Daily report to plant manager and maintenance department.	Daily report to plant manager.	Daily report to plant manager.
2) Special measures taken at abnormal situation	Operation and maintenance people will go together to check the defects and confirm the indicated value and necessary parts to replace.	In case the defected parts can be isolated ask maintenance people to repair without unit shut down. The unit shut down will be made at serious situation only.	Stop the unit when it may lead to serious accidents.
3) Setting of standard values	The values are being set for #3&4. As for #1 & #2 it can not be set because of the defects on instruments.	It is impossible to keep the standard values due to the defects on many number of instruments.	No standard values are set.
General Evaluation by the Study Team (Considered also the results of 1st and 2nd field survey)	Partly good	Not satisfactory	Not satisfactory

Table 511-6 Summary of Situation on Maintenance and Operation at Each Power Plant

Maintenance

Descriptions	Banias Power Plant	Mehardeh Power Plant	Kattench Power Plant
(1) Daily Patrole Inspection 1) Action taken (Yes/No)	Yes	Yes	Occasionally only
2) Number of inspection per day	Once a day	Twice a day(day &night)	(Every 60 days)
3) Time spent for one-inspection	2- hours/each	3-hours/each	-
4) Check sheet's existence	Existed	Not for all items	Existed
(2) Detail Inspection 1) Action taken (Yes/No)	Yes	Only when it becomes necessary	Yes
2) Frequency	Every month	-	According to the instruction of manufacturer
(3) Repair Work 1) Work order system	Well organized	Organized	Organized
2) Spare parts order system	Organized along with work order	Organized	Organized
(4) Long term data collection to diagnose the equipment	Started recently	No	No
General Evaluation by the Study Team (Considered also the results of 1st and 2nd field survey)	Partly good	Not satisfactory	Not satisfactory

(2) Technical Levels for Operation and Maintenance

Except for Banias Power Plant, although the daily operation and maintenance (O&M) staff of each plant is of a relatively advanced average age, these experienced staff members do not have the enough technical expertise to properly operate a power plant featuring the latest technology. Therefore, as is exemplified by Mehardeh Power Plant, repeated minor accidents are allowed to lead to the suspension of plant operations. At Banias Power Plant too in which the staff are relatively younger, the same thing is happening due to the inexperienced and untrained staff.

Except for Units No.3 and No.4 at Banias power plant, most of the measuring instruments required for day-to-day operation are out of order. Fuel adjustments are made based on visual observation and manual operation relying on the intuition and experience of outdated way by the elderly staff.

The following measures need to be put in place to ensure efficient operation of the plants:

1) Automatic operation from a central supervisory facility relying on instrument values
2) Collecting data on operation and failures on a daily basis and analyzing the results to establish preventive maintenance procedures including repair and replacement schedule
3) Grooming a staff with a high level of technical expertise and morale to ensure efficient operation

Each power plant has its own repair facility to make simple and minor mechanical and electrical repairs, but the lack of skilled technicians and welders, for example, leads to the repeated occurrence of the same types of failure.

This indicates that there are few engineers who know where to look for the cause of a failure and how to repair failures, and that the technology for doing so is not available.

(3) Spare Parts for Operation and Maintenance

1) Storage Conditions

Most of the spare parts at each power plant are small items supplied by the original suppliers at the time of plant construction. Surveys showed that each plant stores its parts well and orderly in a manner that allows immediate and easy access. Store keepers are properly assigned and control conditions are good.

2) State of Spare Parts Supply

The state of spare parts supplies differs between the plants. It is thought that this is due to differences in the frequency of repairs and replacement, a part of maintenance work. The fact that small spare parts are less used and are in good supply at power plants that exhibit large decline in output, seems to indicate that periodical maintenance and repair work have not been conducted.

As was frequently pointed out by maintenance personnel at each plant, major spare parts are in short supply. It takes a long time for ordered parts to be delivered. As is mentioned above, although small parts and consumables are in stock, there are few major spare parts.

Parts are ordered only when they become required, for example, when a worn or defective part is found in the disassembly of a component. Then it takes more than 2 years for the wanted part to be delivered as has happened in some cases. Improvements of the system are required to make the procurement of parts from overseas more efficient.

3) Examples Showing the Lack of Spare Parts at Existing Power Plants

Except for the recently commisioned Tishreen Power Plant and Banias Power Plant Unit No.3 and No.4, the control systems of almost all of the power plants are no longer automatic but manual. This is mainly due to the breakdown of control devices and instruments, and the lack of spare parts store for their repair. The insufficient spare parts stores have been caused by the failure to procure, in a planned fashion, parts for those areas most prone to breakdown, judging from past data.

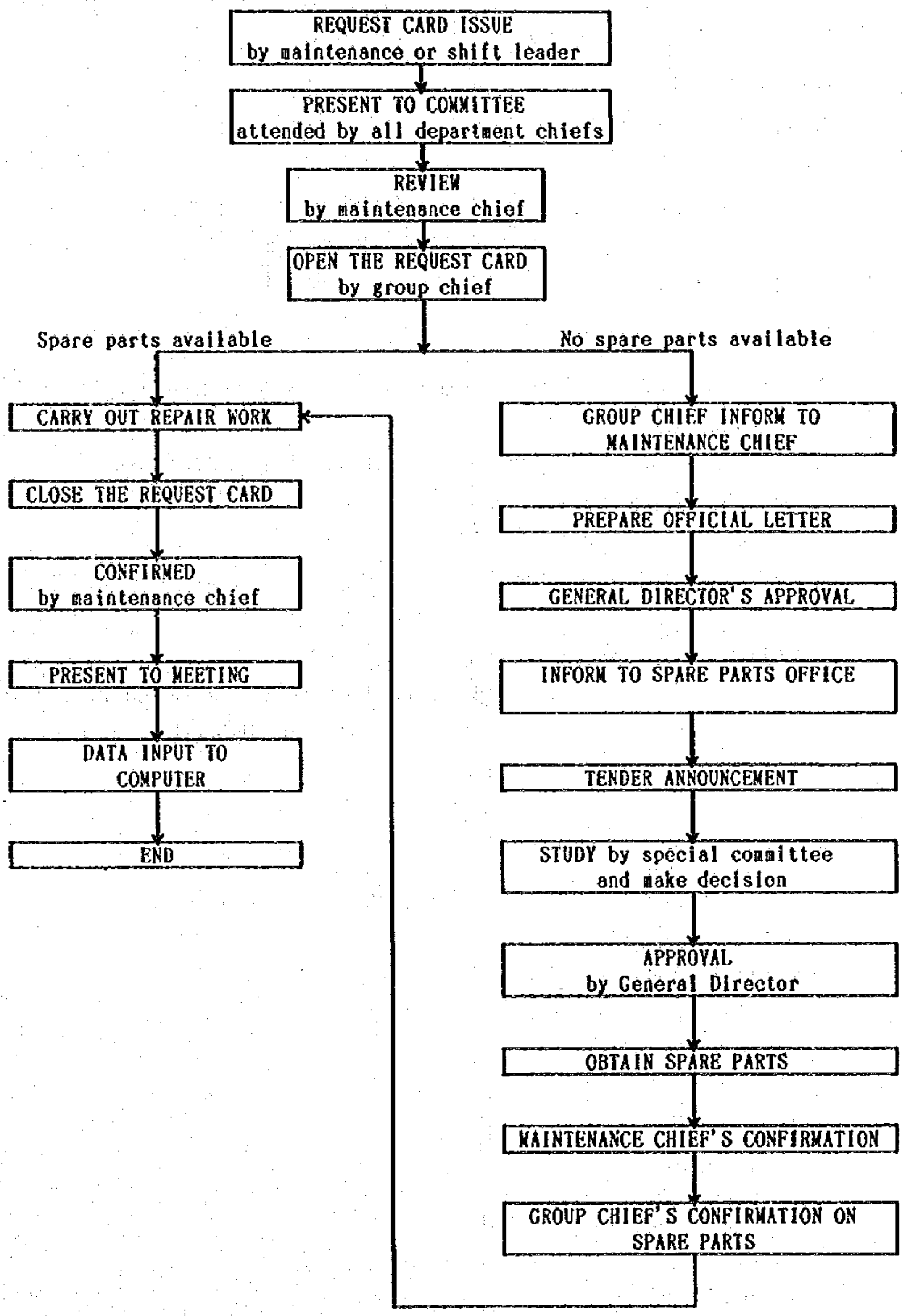
The typical ordering procedure for spare parts in Syria's thermal power plants is illustrated in Fig. 5.1.1-2. From this, the following can be inferred.

① After the identification of required spare parts, much time is taken for actual procurement due to intricate administrative procedures.

② The lack of spare parts is only noticed after breakdowns have actually occurred, indicating the failure of checking the required parts and planned procurement.

③ Repair data is stored in computer, however, this is not effectively utilized in spare parts management.

Fig. 5.1.1-2 Spare Parts Ordering System



5.1.2 Present Situation of Existing Technical Institutes

There are three institutes for educating technicians in operating and maintaining electrical facilities controlled by the Syrian Ministry of Electricity:

1. Adra Technical Institute
2. Aleppo Technical Institute
3. Lattakia Technical Institute

The following is a description of each institute. (as of November 1994)

(1) Adra Technical Institute

1) Outline

① Location: Approximately 20 km east of Damascus

② Established: 1975

③ Governing body: Syrian Ministry of Electricity (MOE)

④ Number of Students: 342

⑤ Common Areas (all institutes)

- Admission qualifications: Secondary school marks are used for deciding successful students
- Length of courses: 2 years for all courses
- Term: September-June (July and August are summer holidays).
- Curriculum: Prepared by Ministry of Higher Education (see Table 5.1.2-1.)

2) Number of Students by Course

Courses	1st Grade	2nd Grade
Electric Power Course	40	36
Electronic Course	45	55
Control Course	51	35
Mechanical Course	45	35
Total	181	161

3) Number of Staff

- Director and administrative staff	3
- Instructors	13
- Assistants Instructor	16
Total	32

4) Annual Budget

20,000,000 Syrian pounds (Average for the past few years)

5) Educational Facilities

① Electric power course

a. Generator circuit laboratory:

- Space: • Classroom 8 m × 10 m
  • Room for storing teaching materials 3 m × 3 m
- Main eqipment:
  • Benches for circuit connection experimentation
  • Measuring instruments (ammeters and voltmeters)
  • Motors
  • Modules for theoretical studies

b. Transmission line laboratory

- Space: • Workshop: 8 m × 20 m
  • Transmission and distribution training ground: 50 m × 50 m
- Main equipment:
  • High and low voltage cable termination and connection training materials
  • Materials for building steel towers for transmission lines and assembly training
  • Stringing materials for transmission and distribution lines
  • Indoor substation model
  • Indoor and outdoor transmission and distribution stringing (20,000 V and 200 V systems)
  • Outdoor pole climbing training facility (wooden and concrete poles)

② Electronic course

a. Computer laboratory

- Space: 4 m × 8 m
- Main equipment: Desktop Personal Computers (PC) (Japanese made: Datacare), etc.

This classroom was built in 1994 and is used for 2 hours of operation training weekly for 2nd grade students. The 1st grade students use the classroom for theoretical studies only.
The PCs have been provided by MOE.

b. Electronic circuit classroom

- Space:	• Classroom:		10 m × 10 m
	• Room for storing teaching materials:		4 m × 4 m
- Main equipment:	• Oscilloscopes		
	• Electronic components (resistors, capacitors, etc.)		

③ Control course

a. Plant control laboratory

- Space: 8 m × 15 m
- Main equipment:
  • Console control panel (for teaching staff)
  • Selfstanding control panel
  • Control practicing plant (loop equipment)

④ Mechanical course

a. Steel processing and welding laboratory

- Space: 6 m × 25 m
- Main equipment:
  • Welding booths (3 m × 4 m)
  • Electric welding apparatus
  • Gas weld and cutting apparatus
  • Machine vises
  • Drilling machines
  • Grinders
  • High-speed cutters
  • Anvils
  • Steel plate rolling machines
  • Flat iron cutters

b. Prime mover laboratory

- Space: 8 m × 35 m
- Main equipment:
  • Drilling machines
  • Air compressors

- Machine vises
- Vehicle differential gear assemblies
- Engine mission assemblies

c. Machine processing laboratory

- Space: 8 m × 20 m
- Main equipment:
  - Machine vises
  - Grinders
  - Electric hacksaws
  - Drilling machines
  - Milling machines
  - Lathes
  - Anvils
  - Work benches

⑤ Safety lecture hall

- Space: 6 m × 12 m
- Main equipment:
  - 16 mm Projector
  - Slides
  - Safety gears
  - Safety signs

⑥ Drawing room

- Space: 10 m × 25 m
- Main equipment:
  - Drawing tables (700 × 700)

6) Other Details

① After graduation

All graduated students are obliged to work for the MOE and are posted at substations and power plants.

② Student dormitory

There is no dormitory as yet. The school leases 5 buses from a firm to transport the students between home and school.

Construction of a library and a dormitory started in 1985, but due to financial problems work had to be stopped without finishing works, and the buildings still remain unfinished.

③ Student origins

Students come from all over Syria, although most are from the Damascus area.

④ School problems

- Training and/or teaching equipment is lacking due to insufficient budget. Thus most teaching is text-book based rather than practical.
- The Institute is too far from Damascus and has no dormitory.

7) Assessment

Compared to Lattakia and Aleppo Institutes (described below), this institute provides good courses and has fairly good teaching materials. Still, graduated students cannot relieve the operation and maintenance staff shortages at Syrian power plants even if they are given responsible positions from the start. They require at least 3 to 4 years of on-the-job training to become really useful.

However, this institute is providing good elementary and basic technical education for students who wish to study advanced technology. Much is expected of the institute in its role as a preparatory school, but the current problems of insufficient training materials, lack of a dormitory and other facilities first have to be solved.

(2) Aleppo Technical Institute

1) Outline

① Location:	Approximately 15 km north of Aleppo city
② Established:	1987
③ Governing body:	Syrian Ministry of Electricity (MOE)
④ Number of Students:	69

2) Number of Students by Courses

Courses	1st Grade	2nd Grade
Distribution Course Electronic Course Control Course	Total: 48	Total: 21

* As of the fiscal year of 1994 a power generation course is expected to be added to the above.

3) Number of Staff

- Instructors	18
- Technical Assistants - Administrators	17
Total	35

4) Annual Budget

- 14,500,000 Syrian pounds (S.P.)
  - a. 3.0M. S.P. : Salaries of instructors and employees
  - b. 8.5M. S.P. : Building Construction costs
  - c. 0.8M. S.P. : Leasing school buses
  - d. 2.2M. S.P. : Teaching materials, maintenance, light and heating

5) Educational facilities

① Distribution Course

a. Electric circuit laboratory

- Space: • 8 m × 10 m
- Main equipment:
  - Ammeters
  - Voltmeters
  - Digital voltmeters
  - Variable resistors
  - AC/DC converters
  - Instrument panels

b. Distribution and connection laboratory

- Space: • 8 m × 8 m
- Main equipment: • Multi-purpose test benches

c. Measuring instrument laboratory

- Space: • 9 m × 9 m
- Mian equipment:
  - Variable resistors
  - Work benches

② Electronic Course

a. Electronic circuit laboratory

- Space: • 8 m × 12 m
- Main equipment: • Oscilloscopes
  • Frequency counters
  • Test benches

b. Electronic measuring instrument laboratory

- Space • 8 m × 8 m
- Main equipment: • Experimental benches:
  • Oscilloscopes
  • AC/DC converters

③ Control Course

a. Control classroom

- Space: • 8 m × 8 m
- Main equipment • Experimental benches
  a. Circuit testing tables
  b. Instrument practice tables

④ Mechanical laboratory

- Space: • 8 m × 18 m
- Main equipment: • Lathes
  • Milling machines
  • Drilling machines
  • Grinders
  • Machine vices
  • Electric welding apparatus
  • Oxy-Acetylene welding apparatus
  • Work benches

⑤ Drawing classroom

- Space: • 8 m × 12 m
- Main equipment • Drawing tables

6) Other Details

① After Graduation

Unlike Adra Institute, graduating students are not obliged to work for the MOE, but 60% to 70% of the students join the MOE.

Most of the other graduated students join companies where their abilities are of greatest use.

② There is no dormitory now, but there are plans for building one.

③ Student Origin

About 30% of the students are from Aleppo and a fair number come from Homs and Hama which are close to Aleppo.

④ Other Training Schemes

a. Summer Training Scheme

For one month during the summer holidays, students must receive OJT at the MOE. In return, the Institute allows MOE technicians to use its facilities for their own training. Around 50 technicians from the MOE take part in this.

b. Special Training Plan

As well as the summer training scheme, the Institute plans to hold short-term training programs for staff (engineers and technicians) of the MOE and MOE-related corporations, starting from the year of 1994.

Related corporations: PEEGT: 6 corporations

PEDEEE (distribution): 14 corporations

⑤ Future Plans

a. Students: planned to rise to 1,000.

b. Facilities: construction of dormitory, dining hall and gymnasium.

⑥ School Problems

- Low salaries for instructor and staff
- Commuting problems
- No lodgings for staff and students

- The budget is not enough to purchase the required teaching materials and equipment.

7) Assessment

About 20 buildings of this institute in the vast campus, which is located on a hill with a good view of the surroundings, are completed. However, only 69 students have enrolled so far which is far few for an institute that is planned for 1000 students. It is as if only the building of the facility had gone ahead without giving much thought to else. Its location in the northern part of the country sets it apart from other institutes and makes it difficult to enroll students because of the student dormitory is not yet completed. There are also few teaching materials, but this is likely to be improved when the institute is reorganized into a training facility for transmission line distribution systems, as part of the EU technical assistance (grant aid). If a thermal power generation training center is established through aid from Japan, it is hoped that this, together with the aforementioned institution will become pillars in the area of power generation-related training in Syria.

(3) Lattakia Technical Institute

1) Outline

① Location: Approx. 15 km north of Lattakia city
② Established: 1991
③ Governing body: Syrian Ministry of Electricity (MOE)
④ Number of students: 171

2) Number of Student by Course

Courses	1st Grade	2nd Grade
Transmission Course Distribution Course	80	22
Steam Generation Course	63	6
Total	143	28

3) Number of Staff

- Administration	32
- Instructors	30
Total	62

4) Annual Budget: 15,000,000 Syrian pounds (S.P)

Breakdown

a. Staff and instructor salaries: 3M. S.P

b. Expanding and repairing campus facilities: 8M. S.P

c. Cost of equipment and materials 4M. S.P

5) Educatinal Facilities

① Transmission course

Training materials consist only of some old disconnecting switches, insulators, stringing hardwares and electric cables. Thus, most teaching is restricted to textbook studies and visual modules.

② Distribution course

Although the distribution course is separate from the transmission course, the same laboratory and training materials are used.

③ Steam power generation course

A few engine components and tools are equipped; the teaching centers on textbook studies and visual modules.

6) Other Details

① Graduated students

Students are not required to join the MOE on graduation and are free to join the company of their choice. Students who enter the MOE are posted at power plants, substations and transmission line maintenance facilities around the country.

Data on how many of the students go on to the MOE was not provided.

② Student dormitory

There is no dormitory, but there are plans for building one. The area around the institute is not populated and most of the students commute to Lattakia by school bus which is provided free of charge.

③ Origin of students

The students come from all over Syria.

④ School problems

a. The institute is inconveniently located and there are few busses.
b. No communication facilities
c. Frequent outages of electricity make it difficult to run the school.

7) Assessment

The campus is located in a promising environment and the large 20 hectare campus means that future expansions will not pose a problem. The administration facility and all facilities that are being built are high quality. The problem is that there are almost no teaching materials available and these that do exist are not sufficient for a technical institute. The curriculum exercise ratio of 60% leaves questions to be answered.

MOE operates this institute which is one of three electric and mechanical technical institutes around the country. However, as a school for producing mid-range engineers and technicians, the level of education is elementary, and doubts exist as to how far graduates can prove useful in actual working environments.

Table 512-1 Study Curriculum of Existing Mechanical and Electrical Institutes

Objects and their rates	First Year						Second Year					
	Specilization of Transmission + Distribution (12)	Weekly hours		Specialization of Steam Generation (12)	Weekly hours		Specialization of Transmission + Distribution (11)	Weekly hours		Specialization of Steam Generation (12)	Weekly hours	
		Practical	Theoretical		Practical	Theoretical		Practical	Theoretical		Practical	Theoretical
Theoretical objects 40%	Arabic language	-	2	Arabic language	-	2	Arabic language	-	2	Arabic language	-	2
	English language	-	2	English language	-	2	English language	-	2	English language	-	2
	Culture of socialism and nationalism	-	2	Culture of socialism and nationalism	-	2	Culture of socialism and nationalism	-	2	Culture of socialism and nationalism	-	2
Technical objects 50%	Mathematics	-	2	Mathematics	-	2	Basis of electrical engineering	-	4	Basis of electrical engineering	-	4
	Resistance materials	-	2	Theoretical mechanic	-	4	Electrical equipment	2	2	Electrical equipment	2	2
	Technology of electrical materials	-	2	Hydraulic	-	2	—	-	-	Control + supervision	-	2
	Topography	2	1	—	-	-	—	-	-	—	-	-
Specializing + Practical objects 60%	Basis of electrical engineering	3	4	Basis of electrical engineering	3	4	Connection and control circuit	3	-	Connection and control circuit	3	-
	Engineering drawing	3	-	Engineering drawing	3	-	Meters and protections	3	-	Industrial drawing	3	-
	Industrial security	2	-	Industrial security	2	-	Shuntings and discovering of faults	2	-	Mechanical maintenance	3	-
	Welding + Iron, Smith's business	2	-	Welding + Iron, Smith's business	2	-	Ground networks	2	2	Steam station	3	2
	Charge + Discharge	3	-	Elevation + turning	2	-	Aerial networks	2	2	Generation substations	-	4
	—	-	-	Thermodynamic	-	4	Bittings and maintenance of station power	2	2	Industrial chemistry	-	2

5.1.3 Necessity and Urgency of the New Training Center

(1) The Need for Training of Operation and Maintenance Personnel

The most advanced power plant in Syria, Jandar C/C with four gas turbines, has already put into operation, providing an output of 400 MW at present. The contract for Aleppo power plant (S/T, 1000 MW) was concluded with Japanese Contractor and actual construction is commenced. Besides this, the Government of Japan is now considering OECF loans to finance the Al-Zara power plant (S/T, 600 MW). As well as these already completed large sophisticated power plants, the further construction of new power plants will be necessary in order to satisfy future power demand levels, as is inferred from the long-term power demand forecast. It is clear that thermal power plants will have to be mainly responsible for meeting this demand.

However, as was indicated in the previous sections, the field surveys found technical levels among the operation and maintenance staff of the existing power plants to be extremely low. In fact, only 10% of all staff possess a certain degree of technical skill, and this is leading to problems in the performance of daily operation and maintenance activities. Considering this and the fact that more power plants will be built in the future as was mentioned above, there is a distinct possibility that the lack of skilled operation and maintenance staff will lead to some plants becoming unable to continue operations.

In order to rectify this situation, the re-education and retraining of operation and maintenance staff not attaining certain technical levels at the existing plants, and the nurturing of staff for currently under construction and new thermal power plants that will be built in the future are matters of the utmost importance and require immediate attention.

Although the three institutes, Adra, Aleppo and Lattakia, educate MOE technicians, the results of the field survey indicate that the skills of students graduated from any of these institutes are insufficient for the minimum level required to operate and maintain the power plants. Furthermore, only a little on-the-job training is provided at each power plant individually. In order to nurture engineers and technicians who can handle operation and maintenance at thermal power plants, and to improve the technical skills of personnel at existing power plants, the establishment of a new training center to provide intensive training in advanced technology is indispensable and urgently required.

(2) Calculating the Number of Power Plant Staff that Require Training

The need for training of operation and maintenance staff at the power plants is pointed out in the above section (1). This section shows a calculation of the number of operation and maintenance staff at Syrian thermal power plants that have to be retrained.

1) Basis of calculation

a) The number of engineers and technicians to be retrained who are working in existing power plants was calculated based on the Study Team evaluation through the first and second field survey results.

b) During the survey we held discussions with several engineers at each power plant. The information they provided and the problems they pointed out in maintenance and operation in running the power plants were also considered to calculate the number of personnel that need retraining.

c) The number of engineers and technicians required at the power plants that are being built or that are planned was calculated based on the number of staff at existing power plants.

2) Number of Staff that Need Training or Retraining

Table 5.1.3-1 shows the number of staff at each plant who require training or retraining. The numbers are as follows:

a) Maintenance Devision

- Number of engineers and technicians that require training: 2,295

b) Operation Division

- Number of engineers and operating personnel that require training: 1,587

The number shown above are minimum requirements calculated based on the number of personnel at existing, under construction, and planned power plants. The required number of staff for unknown possible future projects are not included in the above numbers.

Table 5.1.3-1 Number of engineers, technicians and operation staff that require training and education

Field / Name of power plant (capacity)		Maintenance Section			Operation Section		
		Total number of engineers and technicians (See note 1.) at present	Number of engineers and technicians that do not need training (See note 2.)	Number of engineers and technicians that need training (See note 3.)	Total number of engineers and technicians (See note 1.) at present	Number of engineers and technicians that do not need training (See note 2.)	Number of engineers and technicians that need training (See note 3.)
Existing power plants	Banias Power Plant (680 MW)	257	50	207	205	30	175
	Mehardheh Power Plant (630 MW)	273	30	243	140	20	120
	Katteneh Power Plant (154 MW)	155	30	125	142	20	122
	Tishreen Power Plant (400 MW + 200 MW)	200	30	170	150	20	130
	Swedieh Power Plant (150 MW)	130	20	110	70	10	60
	Tayem Power Plant (90 MW)	130	20	110	70	10	60
	Gas Turbine Power Plant (20 MW × 14 P/S)	140	30	110	210	30	180
Plants that are under construction or planned	Jandar C/C Power Plant (600 MW)	200	—	200	100	—	100
	Aleppo Power plant (1000 MW)	300	—	300	200	—	200
	Al-zara Power Plant (600 MW)	250	—	250	150	—	150
	Gas Turbine Power Plant (300MW × 2 P/S)	300	—	300	200	—	200
	Combined Cycle Power Plant (150 MW × 2 P/S)	200	30	170	100	10	90
Total		2,535	240	2,295	1,737	150	1,587

Note 1: Based on data collected at each power plant and PEEGT during the First and Second Field Survey.
Note 2: Based on survey team evaluation made during the First and Second Field Survey.
Note 3: Note 1 – Note 2

5.1.4 Relationship Between Existing Technical Institutes and the New Training Center

Information collected at the three existing MOE Technical Institutes (Adra, Lattakia and Alleppo) indicates that graduated trainees from these institutes find it difficult to fulfill their work when posted at a power plant, especially the practical aspects of operation and maintenance work.

As stated in Section 5.1.2, the role of the existing institutes should be defined as schools for learning basic operation and control skills, and the New Training Center should aim to train more advanced practical skills and technology. By clarifying objectives in this manner, the activities at the existing institutes will be greatly revitalized.

5.2 Conceptual Design of the New Training Center

5.2.1 Management and Control System

(1) Organization

The proposed organization of the New Training Center is as indicated in Fig. 5.2.1-1. In order to allow the functional management of the Center and to raise the effects of the training program, the organization shall comprise a staff of 60 under the command of the General Director and be divided into the following three departments and one section:

- Administration Department
- Maintenance Training Department
- Operation Training Department
- Planning Section

The staffing of each department is shown in Table 5.2.1-1 and Table 5.2.1-2, while Table 5.2.1-1 shows the required number of Syrian instructors and necessary qualifications of instructors for each training course.

(2) Management and Control

The General Director shall assume the ultimate responsibility for all areas of the Training Center including the compilation and implementation of training plans, enrollement of trainees, appointment of instructors, maintenance of the Center including facilities, equipment and materials, and the running of the dormitory and canteen etc. Moreover, in order to ensure that the management and control of the Training Center is implemented unhindered, the General Director shall maintain constant links with the Center's supervisory organization, the PEEGT, and shall strive to maintain an understanding of the operation and maintenance problems that exist in each of the thermal power plants so that such relevant information can be utilized properly in the compilation of training plans including the selection of training equipment and materials.

Each department director shall be responsible for the management and control of his own department and shall assist the General Director in the overall management and control of the Training Center. The scope of work and role of each of the departments are described below.

1) Maintenance Training Department

The Maintenance Training will consist of the following 4 courses.

- Mechanical Course
- Electrical Course
- Control and Instrumentation Course
- Welding Course

Except for the Welding Course, each course will require the placement of one chief instructor, two or three instructors and two more assistant instructors.

The Welding Course will be positioned as part of the Mechanical Course in terms of organization and will require the placement of one instructor and two assistant instructors, each of whom will be a specialist in the field of electrical welding and gas cutting.

Each chief instructor shall coordinate with and report to the department director, provide instructions and guidance to the instructors and assistant instructors on the execution of classes and also share the teaching responsibilities with the other instructors, in order to ensure that each training course is managed and conducted in a smooth fashion. The assistant instructors will mainly act in a supporting role to the instructors by arranging and preparing training materials for classes, and, at the same time, they shall strive to master teaching techniques with the aim of some day being promoted to the post of instructor. The assistant instructors shall also be responsible for the maintenance of teaching materials.

2) Operation Training Department

The Operation Training Department shall conduct a Boiler Course, Turbine Course and Electrical Facility Course. Each of the courses will require the placement of one chief instructor and two or three instructors. The responsibilities of the chief instructors will be the same as for the chief instructors in the Maintenance Training Department and they shall share teaching duties with the instructors according to the contents of each curriculum.

Fig. 5.2.1-1 Proposed Organization Chart of New Training Center

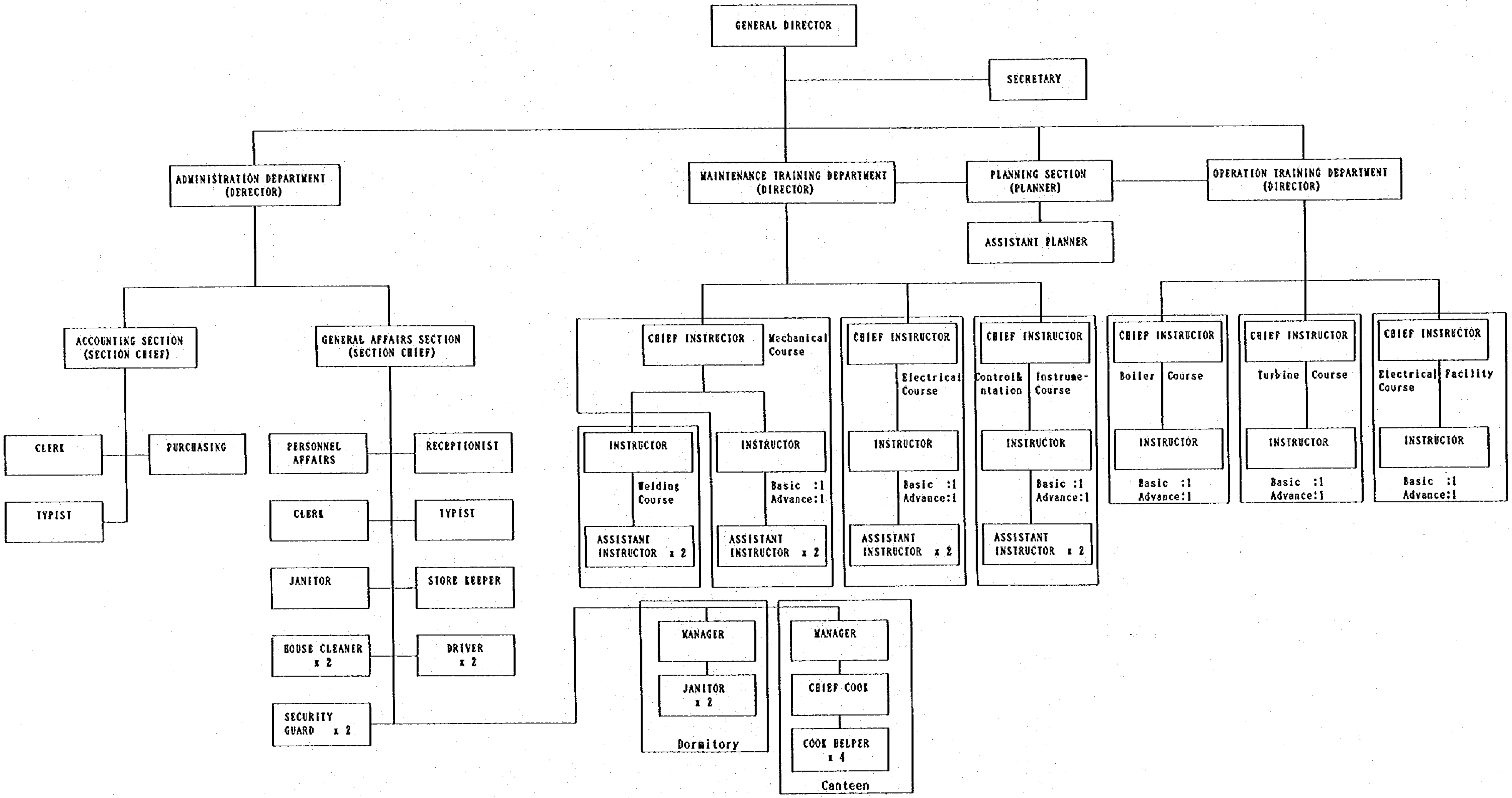


Table 5.2.1-1
Summary of Necessary Instructors in Accordance with Training Courses (Syrian Staff)

Courses	Department Directors	Chief Instructors	Instructors	Assistant Instructors
1)Maintenance Training Department	1			
① Mechanical Course		1		
a) Basic & General Course			1	1
b) Advanced Course			2 (STx1, GTx1)	1
② Electrical Course		1		
a) Basic Course			1	1
b) Advanced Course			1	1
③ Control & Instrumentation Course		1		
a) Basic Course			1	1
b) Advanced Course			1	1
④ Welding Course			1	
a) Electric Welding				1
b) Gas Welding				1
2)Operation Training Department	1			
① Boiler Course		1		
a) Basic Course			1	
b) Advanced Course			1	
② Turbine Course		1		
a) Basic Course			1	
b) Advanced Course			1	
③ Electrical Facility Course		1		
a) Basic Course			1	
b) Advanced Course			2 (STx1, GTx1)	
3)Planning Section			1	1
Sub-Total	2	6	16	9
Total	33			

Table 5.2.1-2

Expected Total Staff Including Instructors in New Training Center (Syrian Staff)

Personnel	No.	Qualifications/Experience
1)-General Director	1	-
-Secretary	1	-
2)Maintenance Training Department		
-Director	1	Engineer / 15years or more
(Mechanical Course)		
-Chief Instructor	1	Engineer/ 10years or more
-Instructor (Basic & General Course)	2	Assistant Engineer/ 5years or more (STx1, GTx1)
-Instructor (Advanced Course)	1	Assistant Engineer/ 5years or more
-Assistant Instructor	2	5years or more in the technical field
(Electrical Course)		
-Chief Instructor	1	Engineer/ 10years or more
-Instructor (Basic & General Course)	1	Assistant Engineer/ 5years or more
-Instructor (Advanced Course)	1	Assistant Engineer/ 5years or more
-Assistant Instructor	2	5years or more in the technical field
(Control & Instrumentation Course)		
-Chief Instructor	1	Engineer/ 10years or more
-Instructor (Basic & General Course)	1	Assistant Engineer/ 5years or more
-Instructor (Advanced Course)	1	Assistant Engineer/ 5years or more
-Assistant Instructor	2	5years or more in the technical field
(Welding Course)		
-Instructor	1	Assistant Engineer/ 5years or more
-Assistant Instructor (Electric & Gas Welding)	2	Skilled in the field
3)Operation Training Department		
-Director	1	Engineer / 15years or more
-Chief Instructor (Boiler)	1	Engineer/ 10years or more
-Instructor (Boiler, Basic)	1	Assistant Engineer/ 5years or more
-Instructor (Boiler, Advance)	1	Assistant Engineer/ 5years or more
-Chief Instructor (Turbine)	1	Engineer/ 10years or more
-Instructor (Turbine, Basic)	1	Assistant Engineer/ 5years or more
-Instructor (Turbine, Advance)	2	Assistant Engineer/ 5years or more (STx1, GTx1)
-Chief Instructor (Electrical Facilities)	1	Engineer/ 10years or more
-Instructor (Electrical, Basic)	1	Assistant Engineer/ 5years or more
-Instructor (Electrical, Advance)	1	Assistant Engineer/ 5years or more

Cont'd…

Personnel	No.	Qualifications
4)Planning Section		
-Planner	1	Assistant Engineer/ 5years or more
-Assistant Planner	1	5years or more in the technical field
5)Administration Department		
-Director	1	-
(Accounting Section)		
-Section Chief	1	-
-Purchasing	1	-
-Clerk	1	-
-Typist	1	-
(General Affairs Section)		
-Section Chief	1	-
-Personnel Affairs	1	-
-Clerk	1	-
-Typist	1	-
-Receptionist	1	-
-Driver	2	-
-Store keeper	1	-
-Janitor (for facility maintenance)	1	-
-Security Guard	2	-
-House Cleaner	2	-
(Dormitory):Subordinate section of General Affairs		
-Manager	1	-
-Janitor	2	-
(Canteen): -ditto-		
-Manager	1	-
-Chief Cook	1	-
-Cook Helper	4	-
Total	62	

Note: Division directors and chief instructors shall be equipped with an english language ability both writing and speaking.

3) Planning Section

The Planning Section will be run by one planner and one assistant planner, and will be responsible for preparing the following plans while coordinating closely with each department.

(a) Training curriculum

(b) Training plan

(c) Procurement plan for training equipment and materials

4) Administration Department

The Administration Department will consist of the General Affairs Section and the Accounting Section. The General Affairs Section will be responsible for personnel management, general administrative affairs, store keeping and security etc., all necessary to the overall management of the Training Center. The General Affairs Section will also operate the dormitory and canteen.

The major responsibilities of the Accounting Section will be general accounting affairs, calculation of staff salaries, purchase of and binding of contracts for equipment and materials, and the planning of the Center's operating fund. The Accounting Section will consist of one section chief, one clerk, one purchasing responsibility and one typist.

5.2.2 Training Plan

(1) Basic Concept of Training

1) Concept of Training Curriculum

The objective of the establishment of the New Training Center is the development and retraining of operation and maintenance staff working in thermal power plants. The training offered in the Center to fulfill these objectives shall be centered around practical skill training that will immediately prove useful at the power plants. The following two main courses will be conducted over each of the specialities.

- Maintenance Training Course
- Operation Training Course

Each of the above two courses shall be basically divided into a Basic (and General) Course and an Advanced Course. Trainees who complete the Basic Course will be qualified to act as assistants to the maintenance or operation staff at power plants, while those who complete the Advanced Course will be qualified to act as chief of the operation or maintenance staff. The Welding Course is designed to foster welding experts.

① Maintenance Training Course

The Maintenance Training Course will comprise the Basic and General Course, the Advanced Course and the Welding Course. Except for the Welding Course, each course shall be further divided into Mechanical Course, Electrical Course and Control and Instrumentation Course. With consideration of training effectiveness, the number of trainee in each course is fixed as 15 for the Basic and General Course and 10 for the Advanced Course. The planned number of graduates of this training is 170 per year. The training periods, numbers of trainees and number of class sessions per year for each of the courses are as indicated below.

	Training Period	No. of Trainees	Annual Class Sessions
a) Basic & General Course			
• Mechanical Course	5 months	15	2
• Electrical Course	5 months	15	2
• Control & Instrumentation Course	5 months	15	2
b) Advanced Course			
• Mechanical Course	5 months	10	2
• Electrical Course	5 months	10	2
• Control & Instrumentation Course	5 months	10	2
c) Welding Course	5 months	10	2

Note : In the Basic and General Course, trainees (45 in all) from each specialist course shall receive lectures for two months on common subjects in order to provide them with the basic level of knowledge required for power plant staff.

In the case of the Welding Course, repeated training is recommended to the graduates periodically even after the 5-months of training is finished, and based upon evaluation made at each stage, skill certification test shall be carried out. Skill levels shall also be checked in the other courses to allow certification to be performed.

② Operation Training Course

The Operation Training Course will consist of the Basic Course and the Advanced Course, whereby trainees who complete the Basic Course will move up to the Advanced Course. Therefore, as a rule, immediate entry into the Advanced Course will not be allowed.

The Basic Course will mostly involve operation training using the simplified simulator installed at the Center, while the Advanced Course will involve more practical training using the two simulators at Jandar C/C Power Plant. With consideration of training effectiveness, the number of trainees in each course shall be fixed as 10 trainees. The planned number of graduates of this training is 60 per year.

Students who finish five months of training shall continue to receive training on a periodic basis. At each step, skill assessment and certification shall be done.

The training periods, numbers of trainees and number of class sessions per year for each of the courses are as indicated below.

	Training Period	No. of Trainees	Annual Class Sessions
a) Basic Course			
• Boiler Course	2 months	10	2
• Turbine Course	2 months	10	2
• Electrical Facility Course	2 months	10	2
b) Advanced Course			
• Boiler Course	3 months	10	2
• Turbine Course	3 months	10	2
• Electrical Facility Course	3 months	10	2

2) Qualification for Admission

In order to receive training at the New Training Center, trainees must have graduated one of the three MOE-run institutes or be recognized as possessing an equivalent academic ability, and have years of experience in the operation or maintenance of a power plant.

3) Training Objective of Each Training Course

① Maintenance Training Course

a) Basic and General Course

Common Subjects

Before advancing to the specialist courses, trainees shall learn about the basic concept of power plants mainly using models of equipment and instruments, OHP and wall charts etc. They shall also learn about basic safety, handling of slinging work and handling of overhead articles on site.

The trainees shall also obtain necessary maintenance skills through practical training in tool handling, hand finishing and measurement error etc. using various tools and measuring instruments.

Mechanical Course

As well as learning about the basics of mechanics and machines, trainees shall also obtain necessary maintenance techniques and skills through disassembling and assembling the equipment and instruments in the workshop (small pumps, valves etc.).

Electrical Course

As well as learning about the basics of electromagnetics and power generation, trainees shall also obtain necessary maintenance techniques and skills through disassembling and assembling the electrical equipment and understanding circuits for auxiliary equipment in the workshop.

Control and Instrumentation Course

As well as learning the basics of control system, trainees shall also obtain necessary maintenance techniques and skills through disassembling and assembling various instruments in the workshop.

b) Advanced Course

Mechanical Course

Trainees shall obtain higher level maintenance techniques and skills through the disassembling and inspecting, assembling, measuring and testing (test running) large workshop equipment and instruments (fans, pumps, turbine governors etc.).

Electrical Course

Trainees shall obtain higher level maintenance techniques and skills through disassembling, assembling and testing large electrical equipment in the workshop including operation test of protection system.

Control and Instrumentation Course

Trainees shall obtain higher level maintenance techniques and skills through disassembling, assembling and testing workshop control devices and equipment, and gaining an understanding of APC (Automatic Plant Control) through lectures.

c) Welding Course

Trainees shall obtain necessary maintenance techniques and skills through practical training in the use of shield metal arc welders , TIG welders and other types of welding machine and through practical training in gas cutting.

② Operation Training Course

a) Basic Course

Trainees shall learn how to make proper decisions and take proper steps for monitoring and control of thermal power plants and to handle cases of emergency alarm and accident, and learn the actual process of operation under emergency alarm conditions as well as normal start-stop operation of the unit through utilizing the simplified simulator.

b) Advanced Course

Trainees shall master techniques concerning more practical operation, monitoring and control of thermal power plants and the handling of accidents, through utilizing the two existing simulators at Jandar C/C Power Plant.

After trainees have completed the Operation Training Course at the Training Center, they will then have OJT training at the power plants in order to provide with a more practical training at their work places.

(2) Training Curriculum

Based upon the above mentioned training concept and training objectives, the curriculums for each course have been compiled as indicated in Table 5.2.2-1.

(3) Training Schedules

The training schedules for each course based upon the aforementioned training outlines and training curriculums have been compiled in the manner shown in Table 5.2.2-2.

Table 5.2.2-1 Training Curriculum

I. Maintenance Training Course

(1) Basic and General Course

Common Subjects for Mechanical, Electrical and C & I Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Basics (Boiler, Turbine Generator)	(1) Fundamental theory (2) Machine Construction (3) Operating mechanism (4) Maintenance and inspection methods (5) Others		
2. Safety and sanitation	(1) Dangerous and hazardous materials (2) How to handle slinging work and heavy materials (3) Fire prevention (4) Environmental sanitation		
3. Tools and instruments	(1) Types of tools and how to handle them	• Tool handling • Benching • Measurement work	

(1) Basic and General Course

1) Mechanical Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Liquid penetrant testing	(1) Basic principles	• Inspection procedures and criteria	
2. Ordinary valves	(1) Types, structure, machine applications and selection methods	• Disassembly, inspection and renovation	
3. Centering	(1) Centering methods	• Centering	Alignment
4. Electric operated valve	(1) Structure of drive unit and methods for adjustment (2) Disassembly, inspection and assembly methods	• Disassembly, inspection, assembly and divergence adjustment	
5. Measuring instruments	(1) Types of measuring instruments and how to use them	• Measuring	
6. Vibration	(1) Basic principles of vibration (2) Vibration meter functions	• How to use a vibration meter	
7. Copper and other pipes		• Cutting, bending and processing pipes and connections	
8. Small pump inspection	(1) Types, structure and applications of pumps	• Selecting, preparing and putting away tools for disassembly and inspections	

(1) Basic and General Course

2) Electrical Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Centering	(1) Centering procedures	• Centering	Alignment
2. Vibration	(1) Basic principle of vibration (2) Functions of vibration meter	• Use of a vibration meter	
3. Wiring	(1) Basic principle of sequences	• Connecting wires	
4. UVR, OCR * Under Voltage Relay (UVR) * Over Current Relay (OCR)	(1) Basic and operating principles of UVR and OCR	• Relay unit tests	
5. Distribution panel and circuits for auxiliary equipment	(1) Wiring design (2) Selecting wiring tools (3) Procedures for wiring distribution panel (4) Inspection and testing procedures	• Sequence operation • Distribution panel wiring • Wiring inspections • Assessing inspection and test results	
6. Small electric motor	(1) Structure and disassembly, inspection and assembly procedures	• Disassembly, inspection, assembly and trial run	
7. Medium Voltage Cable	(1) Terminating procedures	• Cable termination procedures	up to 66 kV

(1) Basic and General Course

3) Control and Instrumentation Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Adjusting valve	(1) Basic principles, structure and operation principles of adjusting valves	• Disassembly and inspection of an actuator • Performance test	
2. Manometer Pressure switch	(1) Outline of structure and principle	• Adjustment of a manometer and pressure switch • Use of a pressure tester	
3. Recorders	(1) Principle and structure	• Disassembly test • Device unit test	
4. Chemical instruments	(1) Principle and structure of a PH meter (2) Principle and structure of a conductivity meter (3) Principle and structure of a turbidimeter (4) Fuel analyzer	• Buffer test • Adjusting conductivity meter • Adjusting turbidity meter	
5. Control drive	(1) Operating mechanism of an electric control drive (2) Operating mechanism of a pneumatic control drive	• Disassembly and assembly of electric control drives • Disassembly and assembly of pneumatic control drives	

(2) Advanced Course

1) Mechanical Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Non-destructive testing	(1) Basic principles, inspections and criteria for each non-destructive inspection	• Liquid penetrant testing • Magnetic particle inspection • Ultrasonic test • Radiographic examination (using film) • System (sump) test	
2. Air compressor inspection	(1) Types, structure and applications of air compressors (2) Disassembly, inspection and assembly methods	• Selecting, preparing and putting back disassembly and inspection tools • Disassembly, inspection and assembly of air compressor • Performing test runs and keeping records	
3. Ventilator inspection	(1) Types, structure and applications of ventilators (2) Disassembly, inspection and assembly methods	• Selecting, preparing and putting back disassembly and inspection tools • Disassembly, inspection and assembly of ventilator	
4. Horizontal type pump inspection	(1) Pump types and functions (2) Disassembly, inspection and assembly methods	• Selecting, preparing and putting back disassembly and inspection tools • Disassembly, inspection and assembly of pump • Performing test runs and keeping records • Balance adjustment	
5. Vertical type pump inspection	(1) Pump types and functions (2) Disassembly, inspection and assembly methods	• Selecting, preparing and putting back disassembly and inspection tools • Disassembly, inspection and assembly of pump • Performing test runs and keeping records	
6. Turbine control valve inspection	(1) Structure of turbine control and structure and functions of control valves (2) Disassembly, inspection and assembly (3) Methods for adjusting valves	• Selecting, preparing and putting back disassembly and inspection tools • Disassembly, inspection and assembly of control valve • Valve adjustment • Keeping records	
7. Main stop valve inspection	(1) Structure of turbine and structure and functions of main stop valve (2) Disassembly, inspection and assembly (3) Methods for adjusting valves	• Selecting preparing and putting back disassembly and inspection tools • Disassembly, inspection and assembly of main stop valve • Valve adjustment • Keeping records	

(2) Advanced Course

2) Electrical Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Metal Clud panel (GCB, VCB) Power center (ACB)	(1) Panel, breaker specifications, structure and basic principles of breakers (2) Disassembly and inspection procedures and adjustment and testing procedures	• Panel test, disassembly, inspection and testing and adjustment of breakers	
2. Automatic voltage regulator	(1) Principle and structure of AVR (2) Testing, measuring and adjustment procedures	• AVR statics • AVR dynamics • Adjustment	
3. Large electric motor	(1) Structure and insulation material characteristics of motors (2) Disassembly and inspection procedures	• Disassembly, inspection and assembly of 6 kV class motors • Instrumentation, measurement and inspection	
4. Analog relay for generator	(1) Operating principle and configuration of a main relay (2) Testing and adjustment procedures (3) Frequency control	• Use of testing equipment • Relay unit test • Single and comprehensive tests of relays • Putting records in order	

(2) Advanced Course

3) Control and Instrumentation Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Local control device	(1) Pneumatic control device a. Operating principles of each device (2) Electronic control of each device a. Operating principle of each device b. Feed-back control	• Disassembly inspection and calibration of single items • Rotation, shaft location and eccentricity • Adjusting eccentricity detector	
2. Turbine supervisory instrument	(1) Category and principle of detection procedures (2) Principle and structure of each supervisory device	• Rotation, elongation and elongation difference • Disassembly test of vibration meter	
3. APC system (Automatic plant control)	(1) Characteristics of drum and once-through boiler (2) Outline of boiler control		

(3) Welding Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Arc welding	(1) Type of welding procedures (2) Shielded metal arc welding (3) TIG welding (4) Welding equipment and tools (5) Welding rod and welding materials (6) Welding procedures	• Arc welding work • TIG welding work • Inspections to be performed after welding (DC and AC welding)	
2. Gas cutting	(1) Gas cutting (2) Use of devices and tools	• Gas cutting work	

II. Operation Training Course

(1) Basic Course

Subjects	Training Program		Remarks
	In Classroom	In Laboratory	
1. Basics	(1) Fundamental theory (2) Machine Construction (3) Operating mechanism (4) Maintenance and inspection methods (5) Others		
2. Normal operation	(1) Monitoring control (2) Alarms		
3. Start and shut down	(1) Start and stop the units (2) Assessing and control for alarms (3) Periodic tests	Simulators	

(2) Advanced Course

1. Normal operation		This is basically a further development of the basic course using the simulators of Jandar and Banias power plants to teach operation procedures and supervision technology that is as close to the real things as possible.	
2. Handling accidents	Example of serious tripping accidents to cope with: • Low level on drum water • Low pressure on fuel • Low vacuum on condenser • Excessive vibration • Low oil pressure on bearing	As above However, skills for handling accidents are also taught.	

Table 5.2.2-2 Training Schedule for New Training Center

Training Courses	No. of Trainees Per Class	Training Schedule	Total No. of Trainees to be Graduated
(1) Maintenance Training Courses			
1) Basic and General Course			
① Mechanical Course	15	2M | 3M | 2M | 3M	15T×2S=30
② Electrical Course	15	2M | 3M | 2M | 3M	15T×2S=30
③ Control & Instrumentation Course	15	2M | 3M | 2M | 3M	15T×2S=30 (90)
2) Advanced Course			
① Mechanical Course	10	5M | 5M	10T×2S=20
② Electrical Course	10	5M | 5M	10T×2S=20
③ Control & Instrumentation Course	10	5M | 5M	10T×2S=20
3) Welding Course	10	5M | 5M	10T×2S=20 (80) 170
(2) Operation Training Courses			
1) Basic Course			
① Boiler Course	10	2M | 2M	
② Turbine Course	10	2M | 2M	
③ Electrical Facility Course	10	2M | 2M	
2) Advanced Course			
① Boiler Course	10	3M | 3M	10T×2S=20
② Turbine Course	10	3M | 3M	10T×2S=20
③ Electrical Facility Course	10	3M | 3M	10T×2S=20 (60)
		Total	230

Note: M - Months
T - Trainees
S - Number of annual session

5.2.3 Conceptual Design of Equipment to be Installed

(1) Main Equipment List

Necessary training equipment and materials for the New Training Center are selected based on the curriculum and training schedules described in section 5.2.2 and are listed on Table 5.2.3-1.

(2) Main Equipment Layout Plan

Layout of main equipment and materials to be installed in the New Training Center are shown on the Attached Drawing No.5.2.4-4 and No.5.2.4-6.

Table 5.2.3-1

List of Necessary Training Equipment & Materials
for New Training Center

I . Maintenance Training Course

(1) Basic & General Course

- Common Subjects -

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Basics	-Audio visual equipment			
	· Video recorder with CRT	1	set	
	· Video camera	1	set	
	· OHP	3	sets	
	-Visual aid (Boiler/Steam turbine/Gas turbine/Generator)	1	lot	*Visual aid → Wall chart
(1)Boiler	-Plastic model of boiler			
	· Main body	1	pc	
	· Drum	1	pc	Common use with a basic course of operation training course.
	· Safety valve	1	pc	
	-Plastic model of rotating air-heater	1	pc	
	-Plastic model of heat exchanger	1	pc	
	-Burner	1	pc	
	-Soot blower	1	pc	
(2)Turbine	-Plastic model of steam turbine			
	· Main body	1	pc	
	· Rotor	1	pc	
	· Governor	1	pc	
	· Condenser	1	pc	
	-Plastic model of gas turbine	1	pc	
	-Graphic panel of boiler & turbine steam water supply system	1	set	
	-Bearing(Journal/Thrust/Ball)	1	lot	
	-Hydraulic coupling	1	set	
(3)Generator & Transformer	-Plastic model of rotor	1	pc	
	-Cutaway model of smalT/R	1	pc	
2. Tools and measuring	-Measuring instruments	1	lot	
	-Electric operated over head crane (5ton)	1	set	Common facility

1) Mechanical Course (Basic & General)

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Liquid penetrant testing	-Dye check kit Kit cotains: · Cleaning liquid · Penetrant liguid · Exposure liquid -Test piece -Loupe (Various scale)	1 1 1	lot lot lot	
2. Ordinary valves	-Gate valve, 4" ~ 10" -Glove valve, 4" ~ 10" -Check valve, 4" -Steam drain trap -Solenoid valve -Packing cutter set -Packing tool set -Packing: Gland packing " Sheet packing -Cutaway model (Gate Valve)	1 1 1 1 1 1 1 1 1 1	lot lot lot lot lot lot lot lot lot pc	
3. Centering (Alignment)	-Dial gauge -Magnet base	1 1	lot lot	
4. Electric operated valve	-Electric operated gate valve -Electric operated glove valve	1 1	pc pc	
5. Measuring	-Caliper (Inner & Outer) -Micrometer(Inner &Outer measure) -Gap gauge	1 1 1	lot lot lot	

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
6. Vibration	-Vibration meter - -ditto- (portable type)	2 2	sets sets	
7. Piping	-Pipe cutter -Bending tool -Flaring tool -Copper tube -Fittings	1 1 1 1 1	lot lot lot lot lot	
8. Small pump inspection	-Loop equipment for water	1	set	Common use
	-General tools *Including; Lath, Milling machine Grinder, Electric drill Machine vise, Anvil.	1	lot	

2) Electrical Course (Basic & General Course)

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Centering (Alignment)	- Dial gauge - Level instrument - Gap gauge - Adjustment liner - Horizontal pump with motor	1 1 1 1 1	lot lot lot lot set	
2. Vibration	- Vibration meter	1	set	Common use with 6.
3. Wiring	- Sequence practice panel	3	sets	
4. Protection relay system	- Protection relay practice panel	1	set	
5. Switchboard auxiliary	- Sequence practice panel	-	-	
6. Small electric motor	- (Loop equipment) • Electric motor for small pump use • Small electric motor - Disassembling tools for centering	 4 4 1	 pcs pcs lot	
7.Medium voltage cable (Up to 66KV)	- Cable termination materrials (Various size) - Termination tools - Dielectric test equipment - Jointing terminals	1 1 1 1	lot lot set lot	
	- Common items • Multi tester • Insulation resistance tester • Wiring tools - Other general tools and measuring instruments	 1 1 1 1	 lot lot lot lot	

3) Control & Instrumentation Course (Basic & General)

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Regulating valve	- Regulating valve			
	• Pneumatic type	1	pc	
	• Hydraulic type	1	pc	
2. Manometer & Pressure switch	- Manometer (Various pressure)	1	lot	
	- Pressure switch (Various pressure)	1	lot	
	- Pressure test equipment	2	sets	
	- Thermometer			
3. Recorder	- Temperature Recorders			
	• Chopper bar type recorder	1	set	
	• Pen type recorder	1	set	
	- Recorder for manometer	1	set	
	- Transducer	1	lot	
4. Chemical instrument	- pH meter	1	pc	
	- Conductivity meter	1	pc	
	- Turbidity meter	1	pc	
	- Fuel analizer	1	set	
	- O_2 analizer	1	set	
5. Control drive	- Electric control drive device	1	lot	
	- Pneumatic control drive device	1	lot	
	- Disassembling tools	1	lot	
	- Common items			
	• Disassembling tools	1	lot	
	• Special tools for adjustment and calibration of recorder	1	lot	

(2) Advanced Course

1) Mechanical Course

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Non-destructive testing	- Dye check kit	1	lot	Common use
	- Magnetic particle inspection set	1	lot	
	- Ultrasonic testing set	1	set	
	- Radio graphic examination set	1	set	Portable type
	- Film exposure equipment	1	set	
	- Reflecting microscope	1	set	
	- Sump film	1	lot	
	- Test piece	1	lot	
2. Air compressor inspection	- Air compressor (Large)	1	pc	Reciprocating type
	- Air compressor (Small)	2	pcs	
	- Tollory chain block	1	pc	
3. Ventilator inspection	- Ventilating fan (Large)	1	pc	
	- Packing	1	lot	
	- Fan rotor supporting frame	1	pc	
4. Horizontal type pump inspection	- Horizontal pump set (Multi-stage type:2-stage)			
	• Double suction type	1	set	On loop equipment
	• Single suction type	1	set	On loop equipment
	- Packing	1	lot	
	- Shaft supporting frame	1	pc	

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
5. Vertical type pump	- Vertical pump set (Single stage) - Packing - Shaft suporting frame	1 1 1	set lot pc	On loop equipment
6. Turbine control valve	- Control valve - Gasket & Packing	1 1	set lot	For governor (Hydraulic drive)
7. Main stop valve	- Main stop valve - Gasket & Packing	1 1	pc lot	
8. Intercept valve	- Intercept valve	1	pc	
9. Safety valve (Boiler)	- Safety valve	1	pc	
10. Balancing	- Balancing machine with a sample of rotor (Small type)	1	set	
	-Common items • Disassembling tools • Measuring tools • Slinging tools	 1 1 1	 lot lot lot	

2) Electrical Course (Advanced)

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Metal clad panel (GCB,VCB) Power center (ACB)	- Gas circuit breaker (GCB)	1	set	22kV class
	- Vacuum circuit breaker (VCB)	1	set	22kV class
	- Air circuit breaker	1	set	600V class
	- Test panel	1	set	
2. Automatic voltage regulator	- Automatic voltage regulator panel	1	set	
	- Testing device	1	set	
3. Large electric motor	- Electric motor(6kV)	2	pcs	
	- Rotor supporting frame	1	pc	
4. Analog relay for generator	- Relay panel	1	lot	
	- Current relay	1	lot	
	- Voltage relay	1	lot	
	- Power relay	1	lot	
	- Differential relay	1	lot	
	- Testing device	1	set	
	- Common items			
	• Disassebling tools	1	lot	
	• Slinging tools	1	lot	
	• Measuring tools	1	lot	

3) Control & Instrumentation Course (Advanced)

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Local control device	- (Loop equipment) - Pneumatic control device - Electric control device	- 1 1	- lot lot	Common use
2. Turbine supervisory instrument	- Detectors (Rotation,Eccentricity, Shaft position) - Ductilometer - Elongation differential meter - Vibration meter (with attachments)	1 1 1 1	lot set set set	
	- Practical materials for inspection of electronic card system	1	lot	

(3) Welding Course

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
1. Arc welding	-Electric welding machine	10	sets	
	-Argon arc welding	5	sets	
	-Welding protector	1	lot	
	-Weldingrods	1	lot	
	-Welding practice materials	1	lot	
	-Disc thunder	5	pcs	
	-Cutting machine	1	pc	
	-Dye check kit	1	lot	Common use
	-Pre-heating & heat treatment materials	1	lot	
2. Gas cutting	-Oxy-acetylene welding & cutting apparatus	5	sets	
	- Tools for cutting torch	1	lot	

(4) Common Tools for Maintenance Course

1) Mechanical Repair and Measurement Equipment

Items	Remarks
1) Gauge block	
2) Knife for thread control	
3) Surface gauge with graduated rod	
4) Universal angle protractor	
5) Sliding caliper calibrated in fiftieths	
6) Sliding depth caliper	
7) Bore measuring instrument	
8) 10mm centesimal comparator	
9) 50mm centesimal compartor	
10) Comparator holder with magnetic base	
11) Mobile set of drawers with 4 drawers	
12) Set of double fork wrenches	
13) Set of pin extractors	(2-3-4-5-6-8)
14) Flat chisel	
15) Cross-cut chisel	
16) Set of male allen wrenches	
17) Adjustable monkey wrench	
18) Flat jaw pincers	
19) Pincers for circlips	for holes,with curved jaw
20) Pincers for circlips	for shafts,with curved jaw
21) 250mm self-locking pincers	concave jaws
22) Diagonal nippers	
23) Universal pincers	
24) Straight-bladed shears	
25) Set of flat tip screwdrivers	
26) Set of phillips tip screwdrivers	
27) Hammers	
28) Plastic head hammers	
29) Hacksaw	
30) Set of second-cut files (5pcs)	
31) Scriber	
32) Safety goggles	
Workshop Equipment	
33) Set of double-ended wrenches	
34) Set of percussion fork wrenches	
35) Set of percussion box wrenches	
36) Set of male allen wrenches	
37) Flat jaw pincers	
38) Pincers for circlips	for holes,with curved jaw

(4) Common Tools for Maintenance Course

1) Mechanical Repair and Measurement Equipment

Items	Remarks
39) Pincers for circlips	for shafts,with curved jaw
40) Self locking pincers	concave jaws
41) Diagonal nippers	
42) Universal pincers	
43) Straight-bladed shears	
44) Set of phillips tip screwdrivers	
45) Set of universal extractors	
46) Set of second-cut files	
47) Set of socket wrenches	complete with accessories
48) Set of double box wrenches	
49) Set of spiral drill bits	
50) Set of drill bit adaptors	
51) Set of screw taps and threading dies	
52) Various tools (hacksaw,oilers,scribers etc.)	
53) Portable electric drill	
54) Tool cabinet and racks	
<u>Other Equipment</u>	
55) Heat exchangers	

(4) Common Tools for Maintenance Course

2) Electrical Repair and Measurement Tools

Items	Remarks
1) Portable electrodynamic ammeters	
2) Portable electrodynamic voltmeter	
3) Single phase portable wattmeter	
4) Snap-on ammeter	
5) Portable earth resistance meter	
6) Portable single-phase voltage converter	
7) Portable three-phase voltage converter	
8) Phase induction converter	
9) Portable index frequency meter	
10) Portable electrodynamic phasemeter	
11) Wheatstone bridge	box with built-in galvanometer to measure resistance
12) Stabilized power supply	
13) Variable resistor	
14) Ratio meter	to measure the turns ratio of 1/1000 transformers
15) Electric magnet galvanometer	
16) Indicator of the phase direction	
17) Portable three-current rating shunt	
18) Liner slider rheostats	-10 ohm/10A -50 ohm/5A -100 ohm/2.5A -500 ohm/1A -1000 ohm/1A -10000 ohm/1A
19) Portable amperometric transformer	
20) Portable voltage transformer	
21) Universal test meter	
22) Portable relay tester	
23) Set of insulated cables	
24) Electrical laboratory bench	
25) Piller drill	
26) Fault locator	
27) Computerized workstation	composed of: personal computer,printer,data display (2 sets)
28) Oscilloscope	
29) Magnetic board	
30) Work bench	
31) Portable electric drill	
32) Set of drill bits	
33) Air compressor	
34) Set of screw taps and threading dies	complete with accessories
35) Various tools	hacksaw,oiler,chisels,etc.

(4) Common Tools for Maintenance Course

2) Electrical Repair and Measurement Tools

Items	Remarks
36) Set of double ended wrenches	6-32mm
37) Set of male allen wrenches	
38) Set of flat tip screwdrivers	
39) Set of phillips tip screwdrivers	
40) Sliding gauge, 1/50	
41) External micrometer, 0-25	
42) Set of round, flat and half-round files	
43) Set of socket wrenches	
44) Tool cabinets and racks	
<u>Other Equipment</u>	
45) Protections	
46) Electric motor	
47) Inverter	

(4) Common Tools for Maintenance Course

3) Instrumentation and Control Equipment

Items	Q'ty	Unit	Remarks
1) Pressure controller			
-Pneumatic controller	1	set	
-Electric controller	1	set	
2) Temperature measurement & maintenance			
-Temperature source	1	pc	0 to 80℃
-Kinds of sensor & proves	1	set	
-Temperature transducer	1	set	
-Temperature switch	1	pc	
-Adjustment the temperature controller (Tools)	1	set	
3) Volume & flow control (Fuel : Light fuel,Gas)			
-Fuel oil counter oval with tools & calibration circuits	1	set	

II . Operation Training Course

Subjects	Equipment and Materials			Remarks
	Items	Q'ty	Unit	
(Basic Course)				
1. Basics	-	-	-	
2. Normal operation	-	-	-	
3. Start & shut down and emergency shut down and mal-operation	- Simulator	1	set	Basic-simplified simulator
(Advanced Course)				
1. Normal operation	(Simulators installed at Jandar C/C will be used.)	-	-	
2. Handling accidents	- ditto -	-	-	

5.2.4 Conceptual Design of Facilities to be Constructed

(1) Candidate Site for the New Training Center

The Jandar C/C construction site was chosen for the New Training Center Construction Site during Second Field Survey based on the results of discussions and the repeated field survey by the team and Syrian side.

The reasons for choosing the Jandar C/C construction site were as follows;

1) A large area around the Jandar C/C construction site is owned by the MOE and can be freely used for the New Training Center.
2) The operation training can be performed through effectively using two (2) simulators which have been installed at the Jandar C/C construction site.
3) The site is located in the center of Syria and will prove convenient for students.
4) Necessary infrastructure such as access road, water, power and telephone lines is already in place.

Attached drawing No.5.2.4-1 shows the location of the Jandar C/C construction site.

(2) Facility Layout Plan

Facilities necessary for the New Training Center are summarized as follows;

1) Buildings

- Administration Building
- Laboratory Building
- Workshop Building
- Canteen
- Dormitories for students
- Apartments for staff
- Director's House
- Gate house

2) Facilities

- Elevated water tank
- Septic tank(s) and soakage pit(s)
- Parking Area
- Fence and gate
- Outdoor Lighting

Layout Plan of the buildings is shown on the attached Drawing No.5.2.4-2.

(3) Conceptual Design Drawings for Main Facilities

Conceptual Design Drawings for Main Facilities are attached as follows;

Drawing No.	Drawing Titles
No.5.2.4-2	General Layout of Main Facilities
No.5.2.4-3	Laboratory Building (Plan, Section, Elevations)
No.5.2.4-4	Main Equipment Layout Plan (Laboratory)
No.5.2.4-5	Workshop Building (Plan, Section, Elevations)
No.5.2.4-6	Main Equipment Layout Plan (Work Shop)
No.5.2.4-7	Administration Building (Plan, Section, Elevations)
No.5.2.4-8	Canteen (Plan, Section, Elevations)
No.5.2.4-9	Dormitory (Plan)
No.5.2.4-10	Dormitory (Section, Elevations)

5.2.5 Rough Cost Estimation for Training Equipment and Facilities

(1) Training Equipment

The following shows a rough estimation of the cost of procuring the equipment and materials necessary for the New Training Center.

1)	Equipment and Materials Cost	
	- Mechanical Training Course equipment and materials	k¥330,000
	- Electrical Training Course equipment and materials	k¥170,000
	- C&I Training Course equipment and materials	k¥150,000
	- Operation Training Course equipment and materials	k¥280,000
	Subtotal	k¥930,000
2)	Transportation Cost (sea and land)	k¥90,000
3)	Installation Cost	k¥80,000
	Total	k¥1,100,000

(2) Facilities

Construction costs for buildings including building services such as lighting, plumbing, heating and fire prevention equipment, and for outdoor facilities such as elevated water tank, septic tank(s) and soakage pit(s), parking area, fence and gate and outdoor lighting are roughly estimated based on Japanese standard cost as follows;