No. 5

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
MINISTRY OF ELECTRICITY(MOE)
THE SYRIAN ARAB REPUBLIC

MASTER PLAN STUDY
ON
REHABILITATION AND MANPOWER TRAINING
FOR
POWER PLANTS
IN
THE SYRIAN ARAB REPUBLIC

FINAL REPORT
SUMMARY

JULY, 1995

YACHIYO ENGINEERING CO.,LTD.

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MINISTRY OF ELECTRICITY(MOE)
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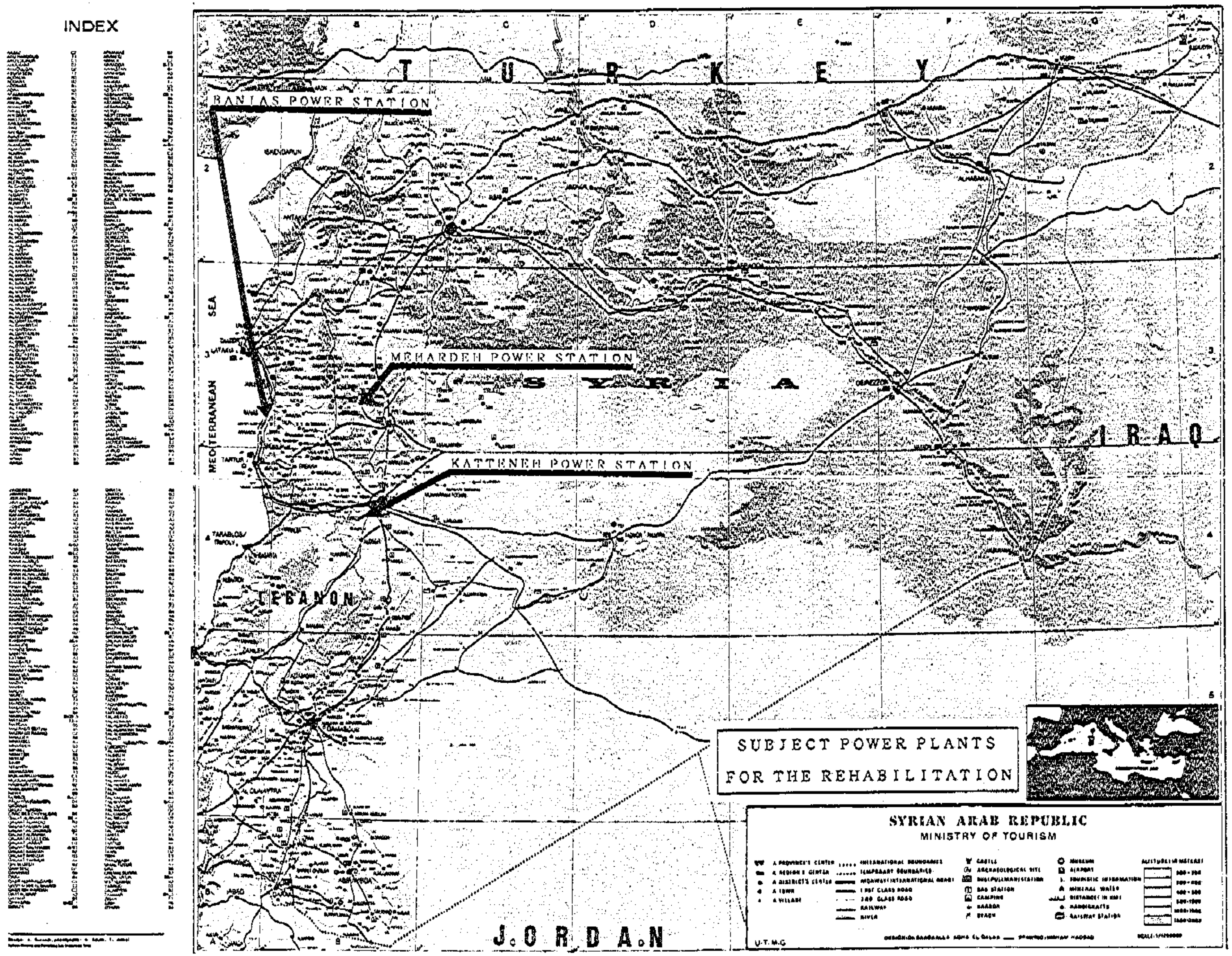
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CHAPTER 1 OBJECTIVES AND BACKGROUND OF THE STUDY

1.1 Study Outline

(1) In recent years, the Syrian Arab Republic (hereinafter referred to as Syria) has shown steady economic development (8.2%). One significant problem, however, is that the power supply falls short of the demand due to the delay in developing new power resources. In fact, this power supply shortage already comprises a constraint to general economic development, particularly development of the industrial sector, during the process of transition to a market economy. The Syrian Ministry of Electricity (MOE) has been actively promoting the development of new power resources in accordance with the basic social and economic development policies of the Government of Syria in order to alleviate the above-mentioned serious power supply shortage. As a result of these efforts, at Tishreen Power Plant, two 200 MW steam turbines started operation in February 1993 and April 1994 respectively, and two 100 MW gas turbines started operation in October and November 1994. Moreover, at the currently under construction Jandar Combined Cycle Power Plant, four 100 MW gas turbines started operation from November last year through this year. These additions together with an increased importance of hydroelectric power plants have meant that guaranteed capacity is expected to rise to approximately 105% of (approximately 2,880 MW) the peak demand (approximately 2,700 MW) by the end of this year (1995). As can be seen from this, major improvements are now being made to the power supply situation in the capital Damascus and the other major cities of Syria.

Under the above mentioned tight power supply situation, all existing power facilities, ranging from generation to transmission and distribution facilities, have been forced to operate at full capacity for long hours. The resulting lack of proper maintenance due to the lack of time for maintenance work has caused a deterioration of the output or performance of these facilities with an adverse effect on the electricity supply. Rehabilitation of the existing power facilities, in addition to the construction of new generation facilities, is imperative to end this vicious circle and to improve the reliability of the power supply facilities and systems. Also, renovation of the existing facilities should be considered to improve the system efficiency. As was mentioned earlier, if the currently under construction power plants and planned power plants are completed according to the schedule, the guaranteed capacity will exceed the peak demand up until 2001, and it is thus necessary to quickly plan and implement the plans for rehabilitation and renovation of the existing power generation facilities during this period.

(2) At the same time, the MOE believes that the technical training of operation and maintenance staff working in the power supply sector is one of the highest priority issues facing the Ministry. This is because the relatively low technical level of engineers operating and maintaining the existing power supply systems has resulted in both the inefficient and ineffective operation and maintenance of the facilities and systems which is one factor contributing to the deteriorating power supply.

In order to materialise the technical training of operation and maintenance staff referred to above, the Government of Syria originally requested the Government of Japan to conduct a feasibility study for the Power Sector Training Center Construction Project as part of the Japan's development (feasibility) study programme in fiscal 1992. Through consultations held in February, 1994 between the Mining and Industrial Projects Identification and Confirmation Study Team dispatched by the Japan International Cooperation Agency (JICA) and the Government of Syria, it was agreed that a training programme would be incorporated in the Master Plan Study on Rehabilitation of Existing Power Plants. Based on this agreement, the Government of Syria made an official request to the Government of Japan to conduct a development study on the rehabilitation of existing power plants and on the improved efficiency of their operation and maintenance. In response to this request and entrusted by the Government of Japan, JICA dispatched the Preparatory Study Team to Syria in July, 1994 to confirm the background and components of the Syrian request. The Preparatory Study Team also consulted with the MOE as the Syrian counterpart organization for the Master Plan Study and the Scope of Work was signed by both parties on July 7th, 1994.

(3) In the meantime, the EU is planning to provide economic cooperation (loan) and technical cooperation (grant for 11 million ECU) for the power sector in Syria through the Government of Syria. The economic cooperation is intended to construct new transmission and distribution facilities while the technical cooperation involves a development study on the power transmission and distribution facilities and assistance for the establishment of a new training centre for transmission and distribution. Notes for technical cooperation were exchanged on December 1994 and the field survey was commenced on January 1995.

The contents of the EU technical cooperation can be summarized in the following manner.

1. Consulting Services and Equipment

Component	Consulting Services	Equipment	Total
(1) Project Implementation Unit (PIU)	1,300	400	1,700
(2) Trainings Support	1,750	1,000	2,750
(3) Sector Master Plan	850	500	1,350
(4) Transmission & Distribution	600	50	650
(5) Operation and Control	2,125	200	2,325
(6) Management Information System (MIS)	600	0	600
(7) Construction Project Supervision Asst.	800	100	900
Sub-Total	8,025	2,250	10,275
2. Training Abroad			326
3. Contingencies (3.7%)			400
Grand Total			11,000

(Note: Unit Thousand ECU)

1.2 Objectives of the Study

The Master Plan Study on Rehabilitation and Manpower Training for Power Plants (hereinafter referred to as the Study) has the following objectives.

(1) To confirm the background of the request, including Syria's socioeconomic realities in general and the conditions of the power sector in particular.

(2) To prepare a rehabilitation/renovation plan by selecting 3 - 4 thermal power plants which have high priority for rehabilitation out of the 14 existing thermal power plants.

(3) To prepare an operation and maintenance staff training plan for the effective and efficient use of thermal power plants.

1.3 Subject Area of the Study

The subject area of the Study encompasses the whole of Syria in order to include all 14 existing thermal power plants, including those at Mehardeh, Banias, Katteneh and Tishreen.

1.4 Scope and Contents of the Study

The Study has been conducted pursuant to the S/W and M/M (July 7th, 1994) agreed by JICA's Preparatory Study Team and the Government of Syria and the scope of the Study is as described below.

[Part 1] Macro Framework Study for Master Plan (including Socioeconomic Survey and Power Sector Survey)

[Part 2] Master Plan Study on Rehabilitation and Renovation of Existing Thermal Power Plants

[Part 3] Study on Manpower Training for Operation and Maintenance

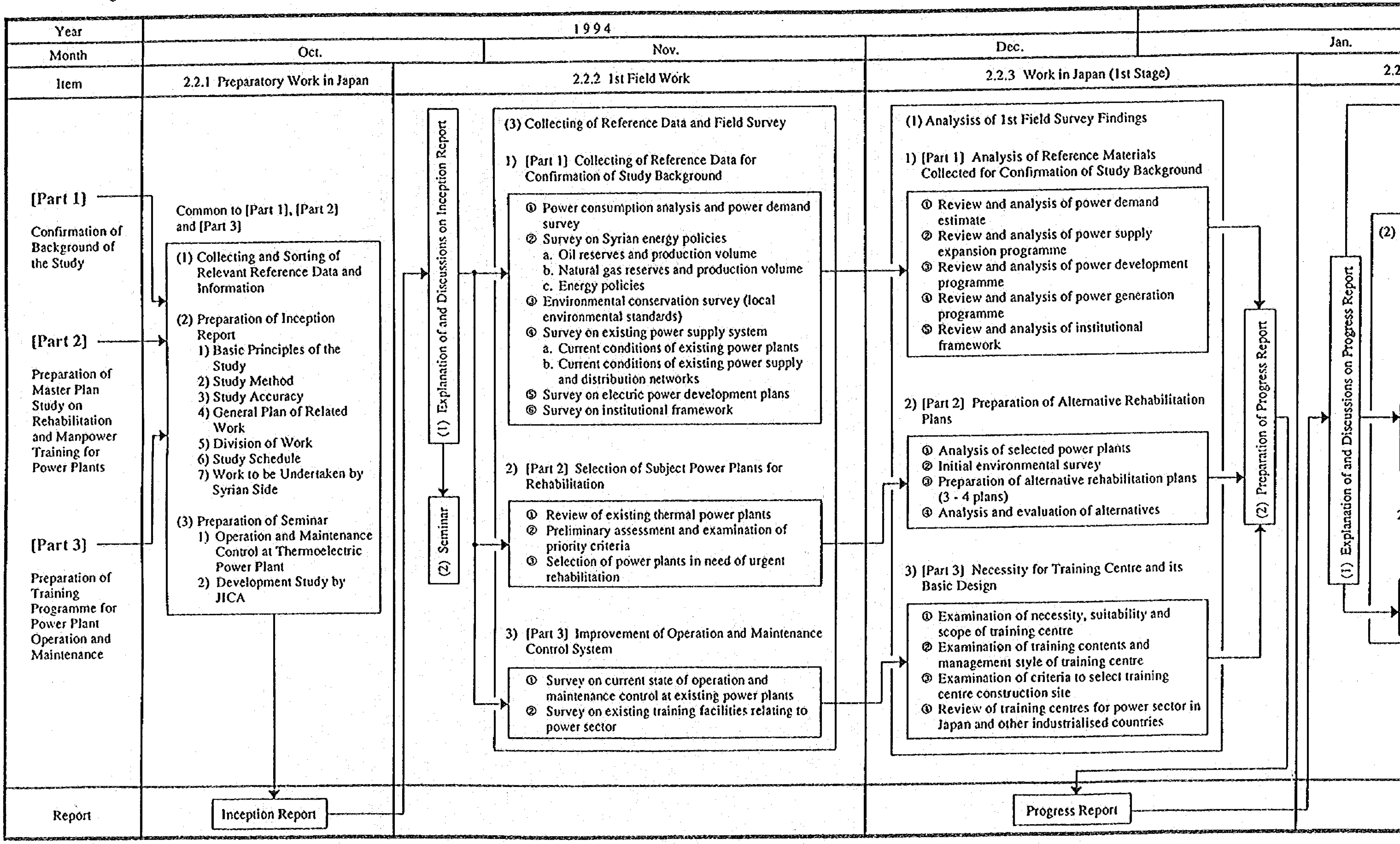
1.5 Study Implementation Schedule (Work Flow Diagram)

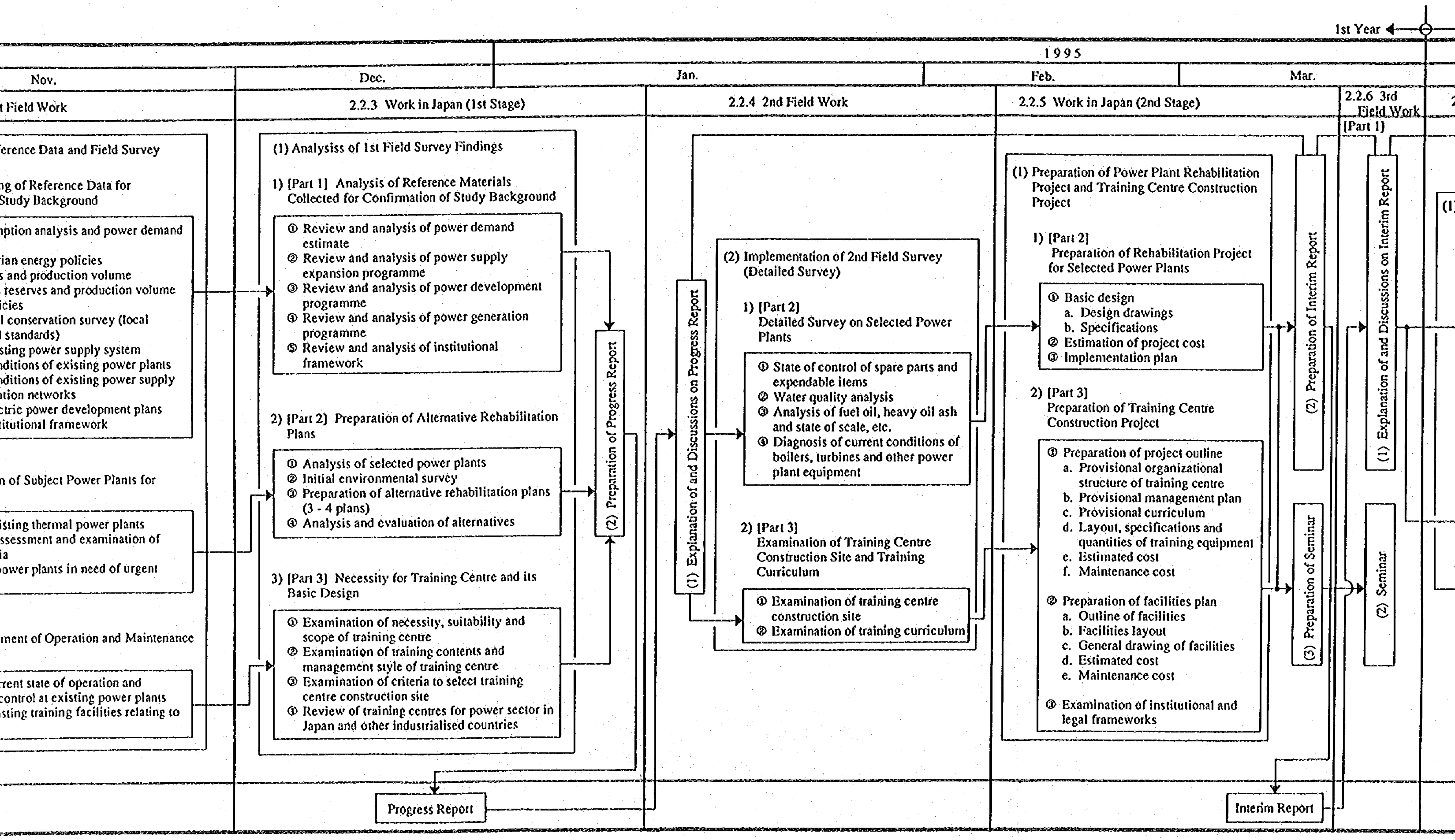
The overall implementation schedule of the Study is as illustrated in the work flow diagram (see Fig. 1.5-1).

The field surveys were conducted over the following periods:

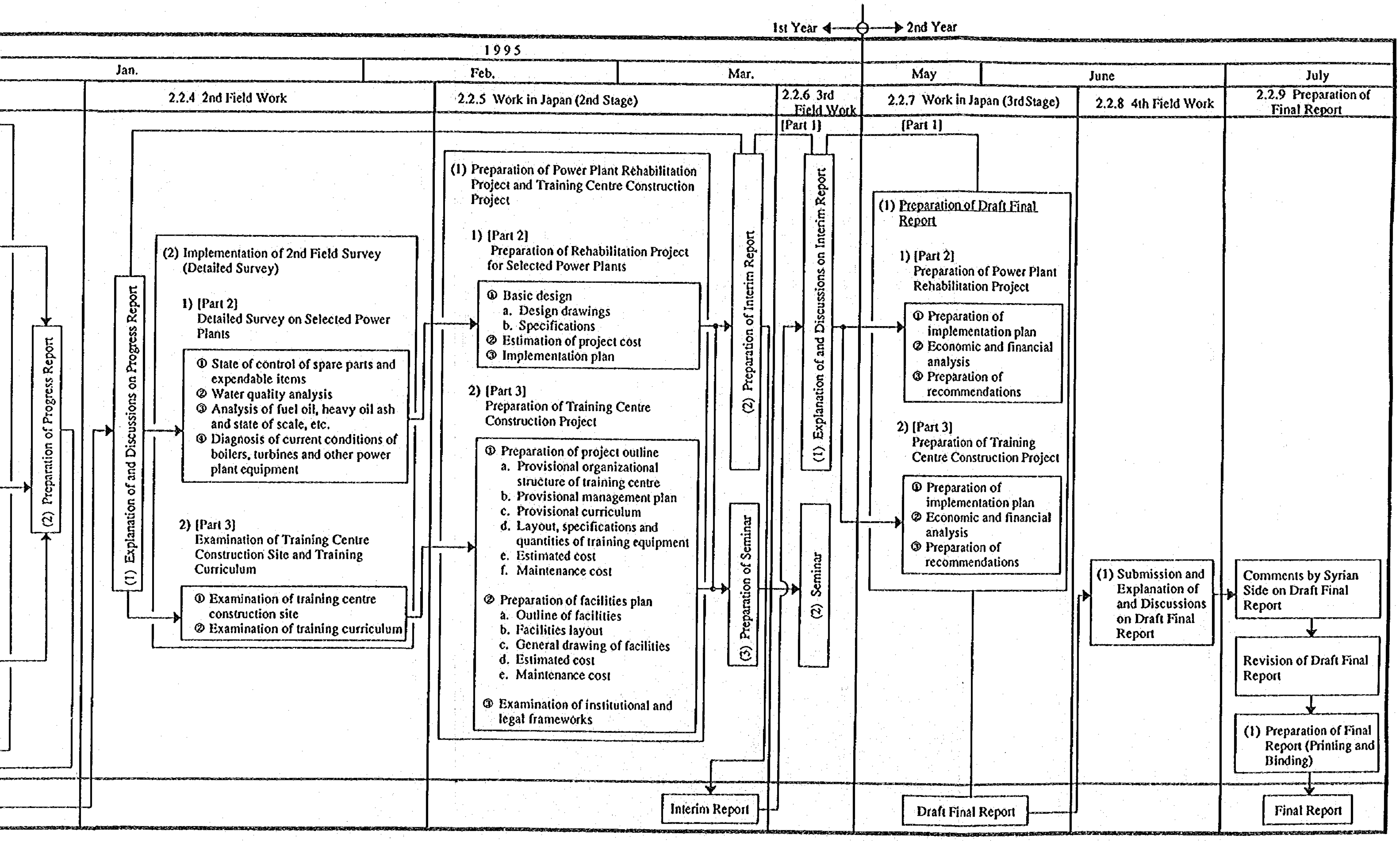
(1) First Field Survey	:	October 28, 1994 through December 2, 1994,
(2) Second Field Survey	:	January 12, 1995 through February 7, 1995,
(3) Third Field Survey	:	March 10, 1995 through March 24, 1995
(4) Fourth Field Survey	:	June 6, 1995 through June 20, 1995.

Fig. 1.5-1 Study Work Flow Diagram





1st Year
1995
Nov.
Dec.
Jan.
Feb.
Mar.
t Field Work
2.2.3 Work in Japan (1st Stage)
2.2.4 2nd Field Work
2.2.5 Work in Japan (2nd Stage)
2.2.6 3rd Field Work
ference Data and Field Survey
ng of Reference Data for
Study Background
nption analysis and power demand
ian energy policies
s and production volume
reserves and production volume
icies
l conservation survey (local
l standards)
isting power supply system
nditions of existing power plants
nditions of existing power supply
ation networks
ctric power development plans
itutional framework
n of Subject Power Plants for
isting thermal power plants
ssessment and examination of
ia
ower plants in need of urgent
ment of Operation and Maintenance
rrent state of operation and
control at existing power plants
sting training facilities relating to
(1) Analysisis of 1st Field Survey Findings
1) [Part 1] Analysis of Reference Materials Collected for Confirmation of Study Background
① Review and analysis of power demand estimate
② Review and analysis of power supply expansion programme
③ Review and analysis of power development programme
④ Review and analysis of power generation programme
⑤ Review and analysis of institutional framework
2) [Part 2] Preparation of Alternative Rehabilitation Plans
① Analysis of selected power plants
② Initial environmental survey
③ Preparation of alternative rehabilitation plans (3 - 4 plans)
④ Analysis and evaluation of alternatives
3) [Part 3] Necessity for Training Centre and its Basic Design
① Examination of necessity, suitability and scope of training centre
② Examination of training contents and management style of training centre
③ Examination of criteria to select training centre construction site
④ Review of training centres for power sector in Japan and other industrialised countries
(2) Preparation of Progress Report
(1) Explanation of and Discussions on Progress Report
(2) Implementation of 2nd Field Survey (Detailed Survey)
1) [Part 2] Detailed Survey on Selected Power Plants
① State of control of spare parts and expendable items
② Water quality analysis
③ Analysis of fuel oil, heavy oil ash and state of scale, etc.
④ Diagnosis of current conditions of boilers, turbines and other power plant equipment
2) [Part 3] Examination of Training Centre Construction Site and Training Curriculum
① Examination of training centre construction site
② Examination of training curriculum
(1) Preparation of Power Plant Rehabilitation Project and Training Centre Construction Project
1) [Part 2] Preparation of Rehabilitation Project for Selected Power Plants
① Basic design
a. Design drawings
b. Specifications
② Estimation of project cost
③ Implementation plan
2) [Part 3] Preparation of Training Centre Construction Project
① Preparation of project outline
a. Provisional organizational structure of training centre
b. Provisional management plan
c. Provisional curriculum
d. Layout, specifications and quantities of training equipment
e. Estimated cost
f. Maintenance cost
② Preparation of facilities plan
a. Outline of facilities
b. Facilities layout
c. General drawing of facilities
d. Estimated cost
e. Maintenance cost
③ Examination of institutional and legal frameworks
(2) Preparation of Interim Report
(3) Preparation of Seminar
[Part 1]
(1) Explanation of and Discussions on Interim Report
(2) Seminar
(1
Progress Report
Interim Report


1st Year
2nd Year
1995
Jan.
Feb.
Mar.
May
June
July
2.2.4 2nd Field Work
2.2.5 Work in Japan (2nd Stage)
2.2.6 3rd Field Work
2.2.7 Work in Japan (3rd Stage)
2.2.8 4th Field Work
2.2.9 Preparation of Final Report
(2) Preparation of Progress Report
(1) Explanation of and Discussions on Progress Report
(2) Implementation of 2nd Field Survey (Detailed Survey)
1) [Part 2] Detailed Survey on Selected Power Plants
① State of control of spare parts and expendable items
② Water quality analysis
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f. Maintenance cost
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a. Outline of facilities
b. Facilities layout
c. General drawing of facilities
d. Estimated cost
e. Maintenance cost
③ Examination of institutional and legal frameworks
(2) Preparation of Interim Report
(3) Preparation of Seminar
[Part 1]
(1) Explanation of and Discussions on Interim Report
(2) Seminar
Interim Report
[Part 1]
(1) Preparation of Draft Final Report
1) [Part 2] Preparation of Power Plant Rehabilitation Project
① Preparation of implementation plan
② Economic and financial analysis
③ Preparation of recommendations
2) [Part 3] Preparation of Training Centre Construction Project
① Preparation of implementation plan
② Economic and financial analysis
③ Preparation of recommendations
Draft Final Report
(1) Submission and Explanation of and Discussions on Draft Final Report
Comments by Syrian Side on Draft Final Report
Revision of Draft Final Report
(1) Preparation of Final Report (Printing and Binding)
Final Report

CHAPTER 2 OUTLINE OF STUDY-IMPLEMENTATION

The Study, the scope and contents of which were explained in Section 1.4, is being proceeded in accordance with the schedule indicated in the Inception Report. The activities of the Study and those results are summarized as follows.

2.1 Power Plants Rehabilitation Plan

2.2.1 Selection of Power Generation Facilities to Undergo Rehabilitation and Renovation

As a result of the consultations held with the Syrian side, based upon the findings of the First Field Survey and the criteria for the selection of power plants to undergo rehabilitation and renovation, the following were selected as the target power plants of the rehabilitation and renovation plan.

① Katteneh Power Plant, Unit No.3, 4, 5 and 6
② Mehardeh Power Plant, Unit No.1 and 2
③ Banias Power Plant, Unit No.1 and 2

Furthermore, the present conditions and problems (nominal capacities, available capacities, initial operation dates, total operation and stoppage hours, used fuels, heat efficiency, equipment suppliers etc.) of the surveyed power plants are described in Chapter 4.

2.1.2 Examination of Power Plant Rehabilitation Alternative Proposals

The first rehabilitation alternative proposals for the power plants identified based upon the findings of the First Field Survey are as follows.

(1) Katteneh Power Plant

1) Rehabilitation Alternative Proposals for Unit No.3, Unit No.4 and Unit No.5

① Change fuel from HFO to NG.
② Using HFO as the fuel, install a soot blower, change the economizer tube arrangement and change the air heater to a horizontal series tube arrangement.
③ Change the air heater to a rotating regenerative type.
④ Renew the deteriorated electrical instrumentation and gages.
⑤ Instead of rehabilitation, install a new 200 MW unit.

2) Rehabilitation Alternative Proposals for Unit No.6

① Renew the gas O_2 meter.

② Periodically clean the rotating regenerative air heater.

③ Replace the elements of the rotating regenerative air heater.

④ Dismantle and inspect the rotating regenerative air heater.

⑤ Fix the air and gas leakages in the ducts and renovate the insulation material and cover plates.

⑥ Renew the deteriorated electrical instrumentation and gages.

⑦ Perform a detailed inspection on each part of the unit.

(2) Mehardeh Power Plant Unit No.1 and Unit No.2

① Renew or renovate the operation control equipment and systems.

② Dismantle and inspect the rotating air heater.

③ Fix the air and gas leakages in the ducts and renovate the insulation material and cover plates.

④ Rehabilitate the condenser of Unit No.2.

⑤ Perform a detailed inspection on each part of the units.

(3) Banias Power Plant Unit No.1 and Unit No.2

① Replace or rehabilitate operation control gages and instrumentation systems.

- Change the instrumentation systems from air types to electrical types.
- Renew the gages.

② Perform calibration of the gages.

③ Install gas O_2 meters at the air heater inlets and outlets.

④ Repair the gas thermometers at the air heater inlet and outlet in Unit No.2.

⑤ Dismantle and inspect the rotating air heater, and wash and inspect or replace the elements.

⑥ Perform a detailed inspection on each part of the units.

2.1.3 Rehabilitation Proposals

Based upon the analysis of data and information collected in the course of the First Field Survey and the rehabilitation alternatives prepared in the first stage work in Japan, detailed surveys on each of the power plants were carried out in the Second Field Survey. The detailed results of the surveys and the specific rehabilitation proposals are described in Chapter 4.

The outline of the contents of the rehabilitation proposals for each of the subject power plants agreed upon with the Syrian side is given below.

Plant Name and Units	Boiler	Turbine & Generator	Control & Instruments
Banias Unit-1 & 2	1. Detailed inspection, Cleaning and Repair 2. Renewal of Reheater and Superheater	1. Detailed inspection and Repair	1. Renewal of Control System (From Pneumatic to Electric) 2. Renewal of Instrument and Electrical equipment
Mehardeh Unit-1 & 2	1. Detailed inspection, Cleaning and Repair 2. Renewal of Reheater and Superheater	1. Detailed inspection and Repair	1. Renewal of Control System (From Pneumatic to Electric) 2. Renewal of Instrument and Electrical equipment
Katteneh Unit-6	1. Detailed inspection, and Cleaning	1. Detailed inspection and Repair	1. Renewal of Control System (From Pneumatic to Electric) 2. Renewal of Instruments and Electrical equipment
Katteneh Unit-3, 4 & 5	These units are too defective to restore the performance. Therefore, no rehabilitation alternatives are proposed. Instead, a new installation of NG and/or HFO fired 200MW unit is proposed.		

2.2 New Training Center Construction Plan

2.2.1 The Need for Training of Operation and Maintenance Personnel

Through the survey and discussion with the Syrian side, the study team found technical levels among the operation and maintenance staff on the existing power plants, educational levels and grade of educational facilities on existing Technical Institutes, to be very low. Accordingly, the Study Team found the necessity and urgency of the establishment of new training center where the necessary training can be executed. In addition, it was agreed that the candidate site of the new training center will be in Jandar C/C power plant site.

2.2.2 Training Curriculum, Management and Organization etc. of the New Training Center

Proposals for the training curriculum, management and organization of the New Training Center were explained to and discussed with the Syrian side. Consultations were also held to discuss specific issues such as numbers and ability of necessary instructors and training equipment and materials etc..

The issues that were agreed upon in the discussions held between the Syrian side and the Study Team are as follows.

(1) Training Courses and Schedules

The training courses to be offered in the New Training Center and the training schedules are as indicated in Chapter 5. There are a total of 13 courses consisting of seven maintenance courses and six operation training courses, and the term of each course will be two to five months.

(2) Necessary Syrian Instructors and Staff

The instructors and staff that are necessary for operating the New Training Center are as indicated in Chapter 5. The Syrian side has agreed to prepare the instructors and staff by the time the Center is opened.

(3) Training Equipment and Materials

Because the Study Team and the Syrian side were able to reach an agreement over the basic issues of training schedules, organization and staffing during the Second Field Survey, the Study Team prepared a list of the main items of training equipment and materials and explained and discussed this with the Syrian side. The contents of the training equipment and materials proposed and discussed are indicated in Chapter 5.

CHAPTER 3 CONFIRMATION OF THE STUDY BACKGROUND

3.1 Power Demand Forecast

3.1.1 National Development Plans

(1) 5-Year National Economic and Social Development Plans, 1960 - 1990

The 5-Year National Economic and Social Development Plan commands the status of a state-level development plan in Syria. Since the launching of the 1st Plan in 1960, seven plans have so far been implemented. The first six plans covered 30 years of political upheaval, ranging from the federation with Egypt to the third Middle East War. The economic development during this period was inevitably affected by the political situation.

(2) Ongoing 7th 5-Year National Economic and Social Development Plan (1991 - 1995)

While the 7th 5-Year Plan (1991 - 1995) is currently being prepared, its components have not yet been announced. As the 6th Plan gave priority to "agricultural development to improve the food supply self-sufficiency and promotion of the food processing industry", "promotion of industrial production and the development of oil and natural gas resources" and "expansion of the power generating facilities", it is assumed that the 7th Plan will inherit these policy priorities. The target GDP growth rates in the Sixth 5-Year Development Plan is 8.26%/year.

(3) Outline of Priority Issues for National Development Plan

In implementing the National Economic and Social Development Plan, top priority is given to 4 issues, i.e. promotion of agriculture, energy development, export promotion and environmental care. (See Table 3.1.1-3)

Table 3.1.1-3 Priority Development Issues

Issue	Main Policies	Concrete Measures
1. Promotion of Agriculture	• Increased production to achieve self-sufficient food supply • Processing of agricultural products	• Improvement of irrigation facilities • Dissemination of processing technologies
2. Energy Development	• Development of oil (light oil) and natural gas resources • Increased power generation • Development of water resources	• Exploitation of oil and gas fields • Proper management and construction of power plants • Wider availability of drinking water supply
3. Export Promotion	• Promotion of oil exports	• Development of processing technologies and quality control
4. Environmental Care	• Prevention of water and air pollution	

Source: JICA Country Data on Syria in Fiscal 1993

3.1.2 Industrial Development Plans

Based on the 5-Year Plan, various national-level development projects have been in progress in each sector as outlined below.

(1) Agricultural Development

- Irrigation
- Water resources development plan

(2) Energy Development

- Utilization of gas produced at oil fields
- Commercial production at Al Kadir Oilfield
- Utilisation and commercialisation of natural gas resources (joint programme with EC)

(3) Export Promotion

- Fuel exports to Cyprus (Benlos Refinery)
- Cotton spinning factory

3.1.3 Trends of GDP

Syria's average annual GDP growth rate once reached more than 10% in the early 1970's due to the realistic economic policies but sharply dropped to as low as 2% in the 1980's due to the worsening of the economic environment. Since the late 1980's, it has recovered to around 8%, partly because of the contribution of newly developed oil fields, etc..

The total GDP in 1992 was 370.99 billion Syrian pounds (SP) with a per capita GDP of 28,630 SP or 2,551 US$.

The GDP composition by sector shows 30% for primary industries, 21% for secondary industries and 49% for tertiary industries, indicating a relatively good balance between different types of industries.

3.1.4 Power Demand Forecast

For the present Study, only fragmentary data could be obtained for the power demand by sector and for components of the current 7th 5-Year Plan.

Instead, the power demand forecast prepared by PEEGT upto until 2020 (see Table 3.1.4-1) was given to the Study Team. Examination of this forecast revealed it to be reasonably appropriate although rather optimistic. The PEEGT forecasts a demand increase based upon actual records of power demand over the last 30 years as well as taking into consideration of the followings.

① Power demand increase rate in the last 30 years
② National Development Plan
③ Likely power demand of new large projects
- 2 fertiliser plants (Palmyra and Hasake) : 20 - 30 MW/plant
- 3/4 textile or clothing plants (Idleb and Lattakia, etc.) : 15 - 20 MW/plant
- Iron works (Al-Zara/Homs) : 120 - 150 MW
- 3/4 cement plants (Damas, Hama and Hasake, etc.) : 30 MW/plant
- Irrigation projects
- Others

④ Future regional development plans
⑤ National and local economic and political conditions
⑥ Population growth forecast for each region

Table 3.1.4-1 Power Demand up Until 2020

Expected Power Demand

As End of Jan.1995

YEARS	1995	1996	1997	1998	1999
Peak load demand	2,725	2,970	3,238	3,529	3,847
Energy demand(GWH)	16,285	17,750	19,348	21,089	22,987

YEARS	2000	2001	2002	2003	2004
Peak load demand	4,193	4,486	4,800	5,136	5,496
Energy demand(GWH)	25,056	26,810	28,686	30,695	32,843

YEARS	2005	2006	2007	2008	2009
Peak load demand	5,881	6,233	6,607	7,004	7,424
Energy demand(GWH)	35,142	37,251	39,486	41,855	44,366

YEARS	2010	2011	2012	2013	2014
Peak load demand	7,870	8,342	8,842	9,373	9,935
Energy demand(GWH)	47,028	49,850	52,841	56,011	59,372

YEARS	2015	2016	2017	2018	2019
Peak load demand	10,531	11,163	11,833	12,543	13,295
Energy demand(GWH)	62,934	66,710	70,713	74,956	79,453

YEARS	2020
Peak load demand	14,093
Energy demand(GWH)	84,220

3.2 Power Supply System Improvement Plans

3.2.1 Existing Power Supply System

(1) Power Generation Plants

The nominal and available power generation capacities in Syria are shown in Table 3.2.1-1. Of the total nominal capacity of 3,577 MW, 898 MW (approx. 25%) are provided by hydropower generation with the remainder provided by thermal power generation (steam power and gas turbine). Although diesel generation facilities exist, the generation output is negligible and the MOE intends to decommission the diesel facilities as soon as possible.

Table 3.2.1-1 Existing Power Generation Plants as of 1994

Name of Power Plant (PS)	Type of PS	Type of Fuel	Nominal Capacity (MW)	Available Capacity in 1994 (MW)	Gross in 1994 (GWH)
Baath + Small Hydro	3 WT	Hydro	98	50	337
Banias	4 ST + GT	HFO + DO	710	640	3,761
Hameh	3 ST	HFO	35	5	27
Katteneh	4 ST	NG + HFO	154	70	233
Mehardeh	4 ST + GT	NG + HFO + DO	660	580	3,403
Frame 5 Gas Turbines	14 GT	DO	280	20	112
3 in Aleppo					
5 in Damascus					
2 in Hama					
2 in Homs					
2 in Latakia					
Swedieh	5 GT	NG + DO	150	150	1,074
Tayem	3 GT	NG + DO	90	90	632
Thawra	8 WT	Hydro	800	500	2,121
Tishreen	2 ST	NG + HFO	400	360	2,102
	2 GT	NG + HFO	200	200	149
Refi. + SPC					279
Total			3,577	2,665	14,230

HFO: Heavy Fuel Oil NG: Natural Gas DO: Distillate Oil

(2) Power Transmission Lines

The power transmission system in Syria consists of a 400 KV grid and 230 KV grid. The former is intended to link to Jordan and Turkey for the interchange of electricity.

3.2.2 Improvement Plans

(1) Power Generation Facilities Construction Plan

The power plant expansion programme of the PEEGT is shown in Table 3.2.2-1. This aims to double nominal capacity by the end of 1997, as shown below.

· Existing nominal capacity (November, 1994)	:	3,570 MW
· Additional nominal capacity	:	3,430 MW
· Total nominal capacity in 1997	:	7,000 MW

Table 3.2.2-1 Power Plant Expansion Programme

Plant Name	Type	Fuel	Nominal Capacity (MW)
Nasrieh	Gas Turbine	HFO + NG	300
Zezoon	Gas Turbine	HFO + NG	300
Jandar	Combined Cycle	NG	600
Aleppo	Steam Turbine	HFO + NG	1,000
Al-Zara	Steam Turbine	NG + HFO	600
Tishreen (Yosef)	Water Turbine	HYD	630
Total Capacity (MW)			3,430

Among the relevant projects, the contract for the new Jandar Combined Cycle Power Plant (600 MW) was won by Mitsubishi Heavy Industries in Japan and installation work is currently in progress (Four 100 MW gas turbines have already been put into operation) to meet the completion date at the end of 1995. Similarly, the contract for the Tishreen Dam Hydropower Plant (630 MW) was won by a Chinese contractor while the work contract for the Aleppo Thermal Power Plant (1,000 MW) was concluded with Mitsubishi Heavy Industries on November, 1994.

(2) Transmission and Distribution Facilities Improvement Plan

For some time, the Government of Syria has been requesting the EU's assistance for the preparation of a transmission and distribution improvement plan. The relevant project has now entered the stage of full-scale implementation with an EU grant.

The project intends;

① The preparation of a master plan for the power transmission and distribution systems in Syria,

② Review of the distribution command facilities, including the communication system, and preparation of a rehabilitation plan for such facilities, and

③ Preparation of a training programme for transmission and distribution-related personnel, supported by the provision of training materials and equipment as well as the dispatch of experts.

The total grant amounts to 11 million ECU and the agreement was signed in November, 1994.

3.2.3 Manpower Training Plan Related to Power Supply System

Many Syrian engineers working in the power sector are acutely aware of the lack of sufficient training for operation and maintenance staff at power plants. No effective measures have been implemented due to the shortage of foreign currency reserves for procurement of training materials and training system problems.

Against this background, the Government of Syria has requested the EU's provision of manpower training in the transmission and distribution fields and the Government of Japan's preparation of a training programme for power generation-related staff and the construction of a relevant training centre. It is desirable, therefore, that the EU and Japan actively cooperate with each other to assist manpower development in Syria's power sector by coordinating their respective project phases.

3.3 Power Plants Rehabilitation Plan and the Power Balance

The purpose of rehabilitation is to restore the available capacity to the original design levels of maximum continuous rating, which were confirmed by the initial performance test, and also to improve the net thermal efficiency.

The Government of Syria's Long-term Power Generation Plan and the power demand forecast for up to 2020, including the new power plants, are as indicated in Tables 3.4.2-1 and 3.4.2-2 and Fig. 3.4.2-1 and 3.4.2-2.

Providing that the construction of the planned new power plants goes according to this Plan, it is expected that the tight power supply situation, which lasted up until 1994, will be improved.

In other words, from 1997, by which time Jandar Power Plant (600 MW by the end of 1995), Nasreyah Power Plant (300 MW by 1996) and Zezoon Power Plant (300 MW by 1996) will have commenced full operations, and by which time guaranteed capacity will be in relatively large excess of peak demand, it is thought that the utilization of this reserve power will enable this period to be used for the implementation of detailed inspections and rehabilitation of the facilities at the existing power plants.

The Syria side has compiled its plans based upon the assumption that the useful life of steam turbine power generation facilities is 25 years and that the useful life of gas turbine power generation facilities is 20 years, and operations of Katteneh Power Plant and Mehardeh Power Plant Unit No.1 and No.2 are planned to be stopped due to deterioration in 2005, and Banias Power Plant Unit No.1 and No.2 are planned to be stopped in 2007.

However, in order to keep pace with the rapidly increasing power demand, it is imperative to prolong the useful lives of the power generation facilities targeted for rehabilitation and renovation through the implementation of the Rehabilitation Plan that includes detailed inspections and overhauls in the period between 1995 and 2001 when guaranteed capacity will be in excess of peak demand. The actual rehabilitation and renovation work can be commenced from 1997, when it is forecast that guaranteed capacity will be in large excess of peak demand. If the future plans for the construction of new power plants will not be backed up by the rehabilitation of existing plants, it is forecast that the power supply situation will again be deteriorated.

Table 3.4.2.-1 Available Installed Capacity of Power Plants

As End of Jan. 1995

PLANT NAME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Thawra	450	450	450	450	450	450	450	450	450	450	450	450	450
Baeth & small hydro	48	48	48	48	48	48	48	48	48	48	48	48	48
Katteneh	70	50	50	45	45	50	48	45	45	45	50	0	0
Mehardeh (1,2)	270	260	250	240	280	290	280	280	270	240	260	0	0
Mehardeh(3,4)	310	310	300	300	300	280	300	290	260	270	270	260	260
Banias (1,2)	300	310	300	315	305	295	300	315	305	295	295	295	148
Banias (3,4)	320	310	310	300	320	320	310	310	300	300	320	310	310
Tishreen thermal	360	360	360	340	320	380	380	380	380	380	380	360	360
Tishreen extention (GT)	200	200	200	200	200	200	200	200	200	200	200	200	200
Swedie	145	150	145	140	150	145	140	150	145	140	150	140	140
Tayem	90	87	85	90	87	85	85	90	87	85	85	90	90
Gas turbine	60	0	0	0	0	0	0	0	0	0	0	0	0
Swedie (SPC)	85	20	20	20	20	20	20	20	20	20	20	20	20
RIF(H)	48	48	48	48	48	48	48	48	48	48	48	48	48
RIF(B)	0	0	0	0	0	0	0	0	0	0	0	0	0
Tishreen hydro	0	0	150	400	400	400	400	400	400	400	400	400	400
Jandar	500	600	600	600	600	600	600	600	600	600	600	600	600
Basel (nasreyh)	300	300	300	300	300	300	300	300	300	300	300	300	300
Zezoon	0	300	300	300	300	300	300	300	300	300	300	300	300
Aleppo	0	0	200	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
EL-Zara	0	0	0	300	600	600	600	600	600	600	600	600	600
TOTAL	3,556	3,803	4,116	5,436	5,773	5,811	5,809	5,826	5,758	5,721	5,776	5,421	5,274

PLANT NAME	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Thawra	450	450	450	450	450	450	450	450	450	450	450	450	450
Baeth & small hydro	48	48	48	48	48	48	48	48	48	48	48	48	48
Katteneh	0	0	0	0	0	0	0	0	0	0	0	0	0
Mehardeh (1,2)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mehardeh(3,4)	260	260	260	260	130	0	0	0	0	0	0	0	0
Banias (1,2)	0	0	0	0	0	0	0	0	0	0	0	0	0
Banias (3,4)	310	310	310	310	310	155	0	0	0	0	0	0	0
Tishreen thermal	360	360	360	360	360	360	360	360	360	360	180	0	0
Tishreen extention (GT)	200	200	200	200	200	200	200	0	0	0	0	0	0
Swedie	84	0	0	0	0	0	0	0	0	0	0	0	0
Tayem	90	60	0	0	0	0	0	0	0	0	0	0	0
Gas turbine	0	0	0	0	0	0	0	0	0	0	0	0	0
Swedie (SPC)	20	20	20	20	20	20	20	20	20	20	20	20	20
RIF(H)	48	48	48	48	48	48	48	48	48	48	48	48	48
RIF(B)	0	0	0	0	0	0	0	0	0	0	0	0	0
Tishreen hydro	400	400	400	400	400	400	400	400	400	400	400	400	400
Jandar	600	600	600	600	600	600	600	300	0	0	0	0	0
Basel (nasreyh)	300	300	300	300	300	300	300	0	0	0	0	0	0
Zezoon	300	300	300	300	300	300	300	300	0	0	0	0	0
Aleppo	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
EL-Zara	600	600	600	600	600	600	600	600	600	600	600	600	600
TOTAL	5,070	4,956	4,896	4,896	4,766	4,481	4,326	3,526	2,926	2,926	2,746	2,566	2,566

Source : MOE

Table 3.4.2.-2 Expected Power Balance

As End of Jan. 1995

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1 Total Available Installed Capacity	3,556	3,803	4,116	5,436	5,773	5,811	5,809	5,826	5,758	5,721	5,776	5,421	5,274
2 Largest unit (MW)	180	180	180	300	300	300	300	300	300	300	300	300	300
3 Second Largest unit (MW)	155	155	200	200	200	200	200	200	200	200	200	200	200
4 Largest GTG unit	100	100	100	100	100	100	100	100	100	100	100	100	100
5 Total (2+3+4)	435	435	480	600	600	600	600	600	600	600	600	600	600
6 Available capacity-1 (1 - 5)	3,121	3,368	3,636	4,836	5,173	5,211	5,209	5,226	5,158	5,121	5,176	4,821	4,674
7 Guarantee capacity-1 (6 x 0.95)	2,965	3,200	3,454	4,594	4,914	4,950	4,949	4,965	4,900	4,865	4,917	4,580	4,440
8 Available capacity-2 (1 x 0.9)	3,200	3,423	3,704	4,892	5,196	5,230	5,228	5,243	5,182	5,149	5,198	4,879	4,747
9 Guarantee capacity-2 (8 x 0.9 = 1 x 0.9 x 0.9)	2,880	3,080	3,334	4,403	4,676	4,707	4,705	4,719	4,664	4,634	4,679	4,391	4,272
10 Peak load demand (MW)	2,725	2,970	3,238	3,529	3,847	4,193	4,486	4,800	5,136	5,496	5,881	6,233	6,607
11 Energy demand (GWH)	16,285	17,750	19,348	21,089	22,987	25,056	26,810	28,686	30,695	32,843	35,142	37,251	39,486
12 Populatio Number	14,269	14,741	15,229	15,734	16,254	16,792	17,348	17,922	18,516	19,128	19,762	20,416	21,091
13 Kwh per one person	1.141	1.204	1.270	1.340	1.414	1.492	1.545	1.601	1.658	1.717	1.778	1.825	1.872
14 Deficit - 1 (7-10)	240	229	217	1,065	1,068	758	462	164	-236	-631	-963	-1,653	-2,167
15 Deficit - 2 (9 - 10)	155	110	96	874	830	514	219	-81	-472	-862	-1,202	-1,842	-2,335
16 Reserve capacity												0	0
17 Spining capacity												0	0

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1 Total Available Installed Capacity	5,070	4,956	4,896	4896	4,766	4,481	4,326	3,526	2,926	2,926	2,746	2,566	2,566
2 Largest unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Second Largest unit (MW)	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Largest GTG unit	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Total (2+3+4)	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Available capacity-1 (1 - 5)	5,070	4,956	4,896	4,896	4,766	4,481	4,326	3,526	2,926	2,926	2,746	2,566	2,566
7 Guarantee capacity-1 (6 x 0.95)	4,817	4,708	4,651	4,651	4,528	4,257	4,110	3,350	2,780	2,780	2,609	2,438	2,438
8 Available capacity-2 (1 x 0.9)	4,563	4,460	4,406	4,406	4,289	4,033	3,893	3,173	2,633	2,633	2,471	2,309	2,309
9 Guarantee capacity-2 (8 x 0.9 = 1 x 0.9 x 0.9)	4,107	4,014	3,966	3,966	3,860	3,630	3,504	2,856	2,370	2,370	2,224	2,078	2,078
10 Peak load demand (MW)	7,004	7,424	7,870	8,342	8,842	9,373	9,935	10,531	11,163	11,833	12,543	13,295	14,093
11 Energy demand (GWH)	41,855	44,366	47,028	49,850	52,841	56,011	59,372	62,934	66,710	70,713	74,956	79,453	84,220
12 Populatio Number	21,790	22,511	23,256	24,026	24,821	25,643	26,491	27,368	28,274	29,210	30,177	31,176	32,208
13 Kwh per one person	1.921	1.971	2.022	2.075	2.129	2.184	2.241	2.300	2.359	2.421	2.484	2.549	2.615
14 Deficit - 1 (7-10)	-2,187	-2,716	-3,218	-3,690	-4,314	-5,116	-5,825	-7,181	-8,383	-9,053	-9,934	-10,858	-11,655
15 Deficit - 2 (9 - 10)	-2,897	-3,410	-3,904	-4,376	-4,982	-5,743	-6,431	-7,675	-8,793	-9,463	-10,319	-11,217	-12,015
16 Reserve capacity	600	600	600	600	600	600	600	600	600	600	600	600	600
17 Spining capacity	400	400	400	400	400	400	400	400	400	400	400	400	400

Source : MOE

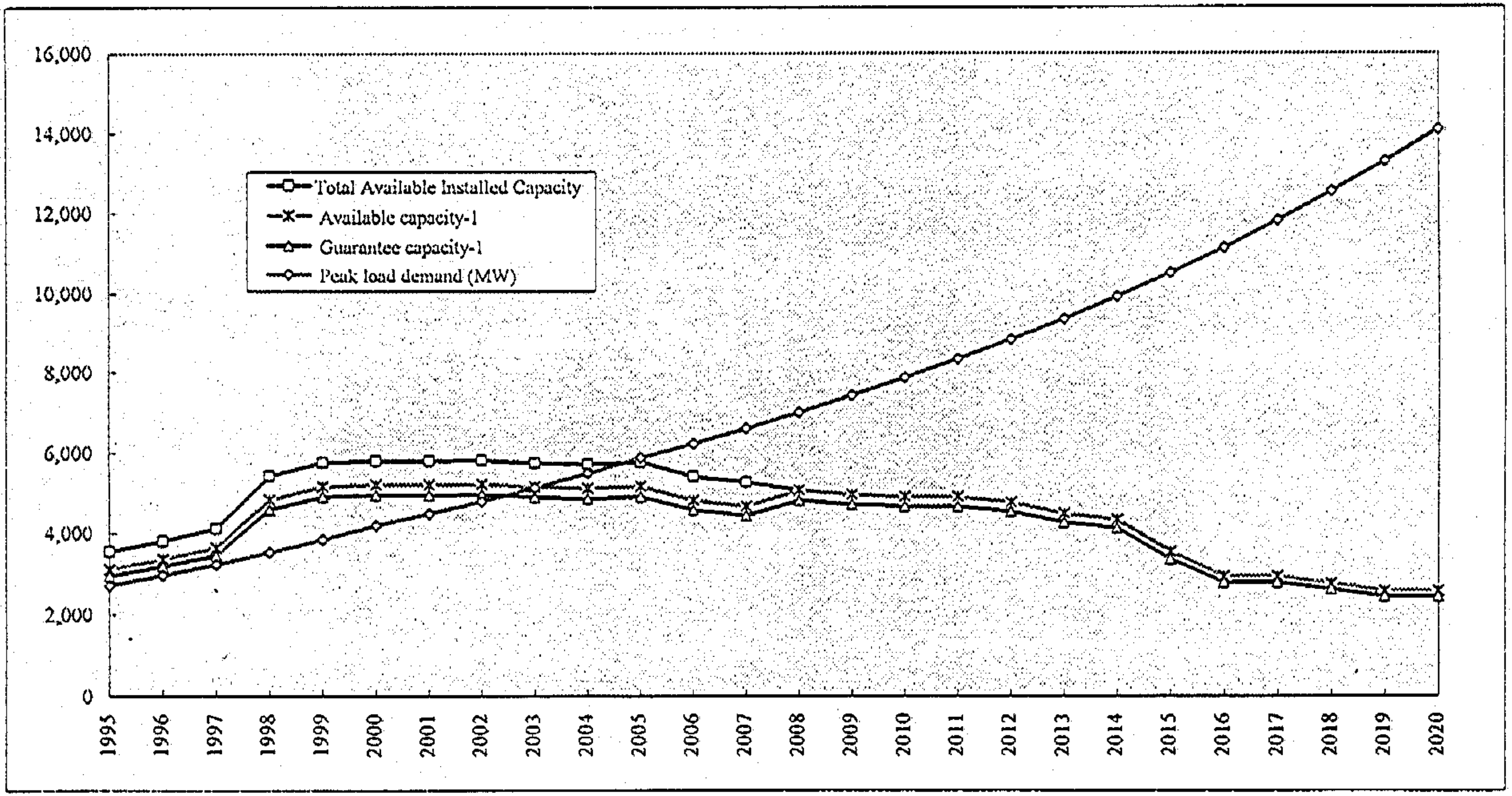


Fig 3.4.2-1 Power Balance (1)

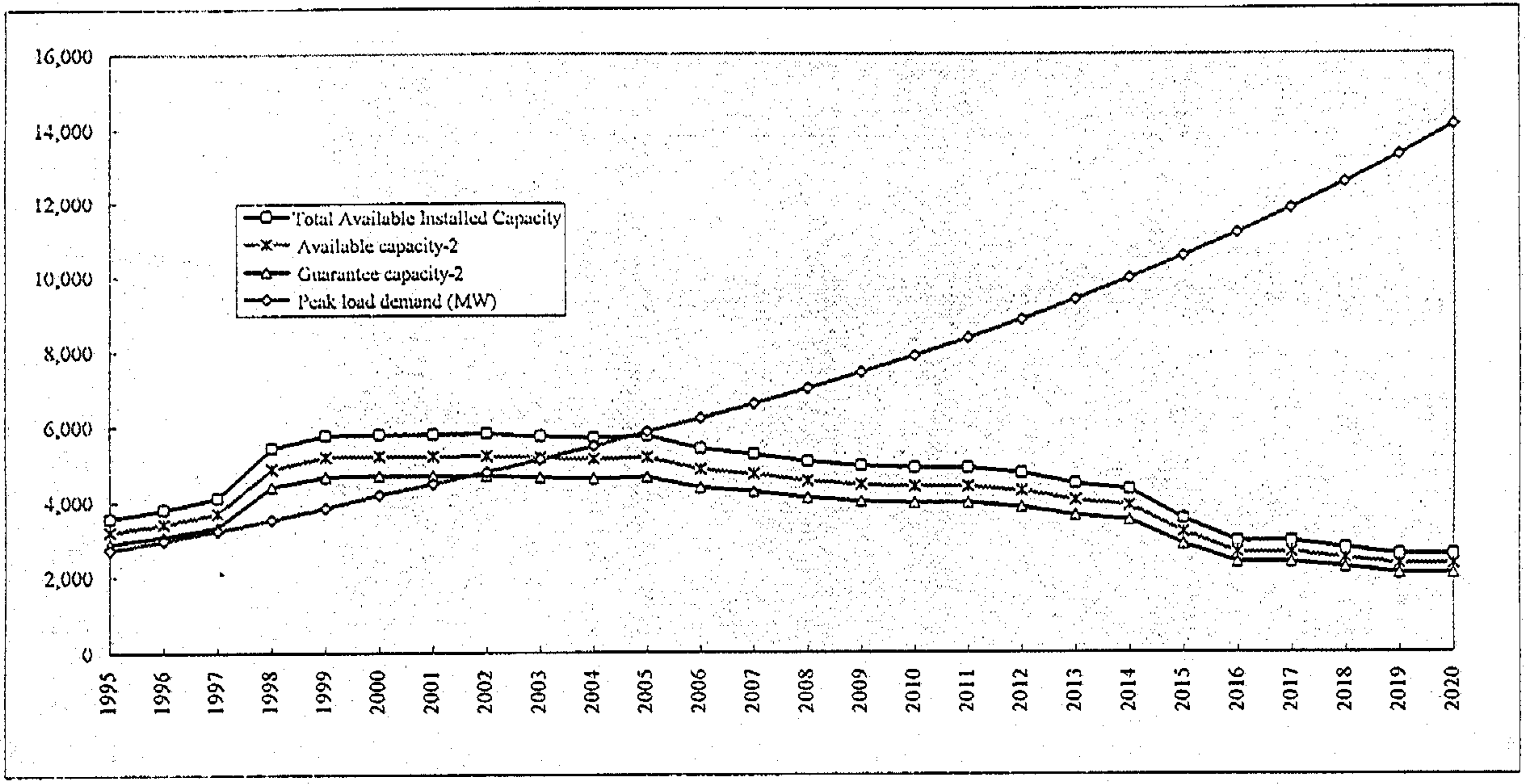


Fig 3.4.2-2 Power Balance (2)

It is therefore of the utmost importance to immediately implement in a planned fashion the Rehabilitation and Renovation Plan being proposed in this Study. It is considered that the materialization of this Plan will make a great contribution to improving the power supply situation and raising the reliability of the power supply within the Long-term Power Supply Plan for up to 2020.

3.4 Initial Environmental Examination (IEE)

3.4.1 Environmental Protection Policy

The ongoing industrial development is accompanied by increased pollution such as exhaust gas, waste water and noise, etc. associated with various plants, particularly in and around large cities. While emission gas and noise from automobiles cause environmental concern in such major cities as Damascus and Aleppo, exhaust gas and waste water from oil refineries, fertilizer plants and power plants, etc. are becoming causes for concern regarding their adverse impacts on the lives of the people of Homs, Syria's third largest city.

Despite increasing environmental concern, the Government of Syria did not adopt environmental protection measures until 1992 when it established the Ministry of Environment in response to a UN recommendation. At the same time, a committee was established within the Ministry to prepare environmental standards, mainly on air and water quality, and these standards are presently being discussed by the parliament with a view to their legislation. These standards, in fact, include standards on noise and vibration and stipulate the enforcement responsibilities of the administration, compliance obligations of state enterprises and penal provisions for violations, etc. The standards are a good example of the concrete commitment of the Government of Syria to the implementation of environmental protection.

Another move by the Ministry of Environment is the establishment of the National Research Center for Science and Environment in August, 1994. The Center is designed to improve the standard of environmental study, research and monitoring technologies from the viewpoint of environmental science and to train environmental experts while acting as an auxiliary organization to assist the environmental administration of the central government. It also acts as Syria's representative to cooperate with Arab countries and international organizations in the establishment of a regional environmental monitoring system.

3.4.2 Current Environmental Laws and Regulations

The Government of Syria has compiled environmental standards addressing the responsibilities of administrative bodies and state enterprises, etc. and has asked parliament to legislate these standards. There are, however, no environmental standards regulating the activities of private enterprises. The Government of Syria has started to examine the report and recommendations of the Second Round Table Conference to Make Recommendations on Environmental Impacts of Various Business (Industrial) Activities in Arab Countries and has also commenced preparation of environmental standards based on the report and recommendations. The Conference was held as part of the UN Environmental Programme and the said report and recommendations were compiled by the Arab University.

The report and recommendations, in fact, suggest guidelines for exhaust gas and waste water control vis-a-vis some 50 different types of business (industrial) activities based on environmental survey reports compiled by the WHO and organizations in the US, UK, Germany and Holland, etc. In particular, clear control subjects and exhaust gas guidelines are proposed for thermal power plants which use coal, oil or natural gas as fuel.

3.4.3 Current Conditions of Selected Plants Concerning Environmental Protection

(1) Current Environmental Protection Measures at Power Plants

Environmental considerations have been given, to some extent, to the waste water treatment, neutralization, oil separation etc., however no recent environmental protection facilities for air pollution (SO_x, NO_x dust collection) are not provided at all thermal power plants in Syria. This may be a reflection of the fact that no environmental protection laws or regulations are currently in force. The present reality is that it is impossible to check whether or not the exhaust gas is harmful because of the breakdown of most of the instruments used to measure the exhaust gas density and constituents at these power plants.

According to those PEEGT engineers who were interviewed, however, the new Aleppo Power Plant, the construction agreement for which was concluded in November, 1994, has installation space for an electric precipitator to collect dust from the smoke and similar arrangements to prevent pollution are planned for all new power plants to be constructed in the future.

3.5 Institutional Framework

3.5.1 Organization and Tasks of MOE

All power-related activities, from generation to distribution, in Syria are nationalised and are managed by the MOE. While the MOE supervises wide ranging subjects, from the preparation of the power demand forecast to the planning, design and work relating to power resources development, generation, transmission and distribution and further to the collection of electricity charges, the actual work is commissioned to the PEEGT (Public Establishment of Electricity for Generation and Transmission) and PEDEEE (Public Establishment for Distribution and Exploitation of Electric Energy) with ministerial approval.

At present, the MOE plans to implement the following 3 measures to improve the situation.

1st Step	:	Establishment of an appropriate maintenance system to increase the output of the existing power plants
2nd Step	:	Reduction of the distribution loss
3rd Step	:	Construction of new power plants

The MOE has a technical institute (mechanical and electrical training institutes) at 3 locations, i.e. Adra near Damascus, Lattakia and Aleppo, for the training of new maintenance staff and the re-education of existing engineers with the purpose of increasing the output of the existing power plants, which is considered to be the first stage in the overall improvement of the power sector. These attempts to improve and consolidate the skills of maintenance staff and engineers, however, have not quite achieved their objectives due to the lack of educational/training equipment and facilities, in turn caused by insufficient budgetary allocation under Syria's tight fiscal situation.

Regarding the second stage distribution loss, preparation of a master plan for the national transmission and distribution network through aid (grant aid) from the EU was started at the end of 1994. In addition to this, it is planned that the EU will reorganize the aforementioned Aleppo Technical Institute into a Transmission and Distribution Technology Training Center, and will provide equipment and materials and also dispatch specialists, with the aim of training and retraining of transmission and distribution staff or engineers. As for the works on the improvement, strengthening and expansion of the transmission and distribution network which are scheduled for implementation through loan aid from the EU, no specific plans have as yet been drawn up.

The construction of new power plants, believed to be the third stage of power sector improvement, has been making steady progress. The Tishreen Power Plant (ST 200 MW × 2 units + GT 100 MW × 2 units) constructed with Russian assistance commenced operation in early 1994 while the GT No.1 and No.2 Units of the Jandar Power Plant (C/C 300 MW × 2 units) are already in operation with the remaining units to be commissioned by the end of 1995. Furthermore, construction agreements for the Aleppo Thermal Power Plant (ST 200 MW × 5 units) and Tishreen Hydropower Plant (HT 100 MW × 6 units) have been concluded with a Japanese and Chinese contractor respectively, and these plants have now moved to the actual construction stage. In the case of the Al-Zara Thermal Power Plant, negotiations to secure a Japanese loan are progressing.

Fig. 3.6.1-1 shows the organizational structure of the MOE, the competent ministry for the power sector.

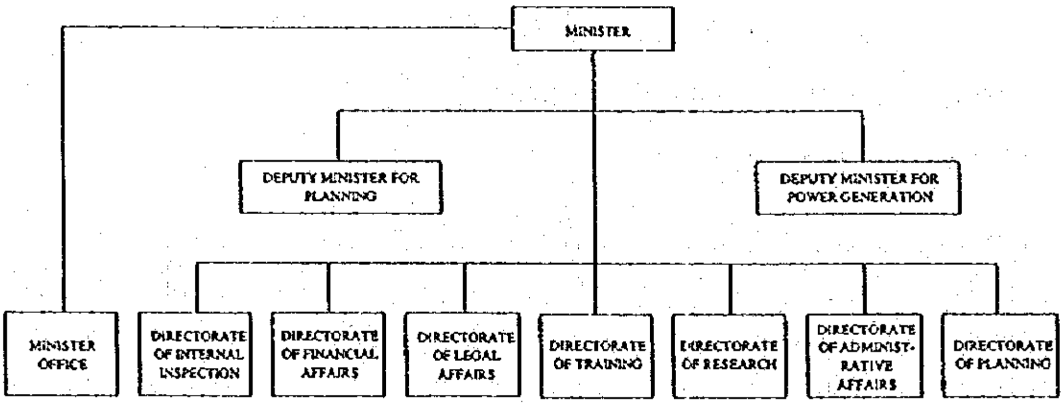


Fig. 3.6.1-1 Organizational Structure of Syrian Ministry of Electricity (MOE)

3.5.2 Organizations and Tasks of PEEGT

The PEEGT is in charge of the planning and execution of power resources development, generation and transmission.(≧66KV). It employs some 250 people at the Head Office in Damascus and some 5,000 people at the various power plants. The PEEGT is headed by the General Director who is assisted by 2 Deputy General Directors responsible for technical affairs and financial, legal and administrative affairs respectively. Each power plant is directly linked to the General Director. In the case of a technical problem, the Technical Department of the Head Office provides the plant management with appropriate advice. The Deputy General Director for Technical Issues supervises 9 departments while the Deputy

General Director for Financial, Legal and Administrative Affairs supervises 7 departments. Fig. 3.6.2-1 shows the PEEGT's organizational structure.

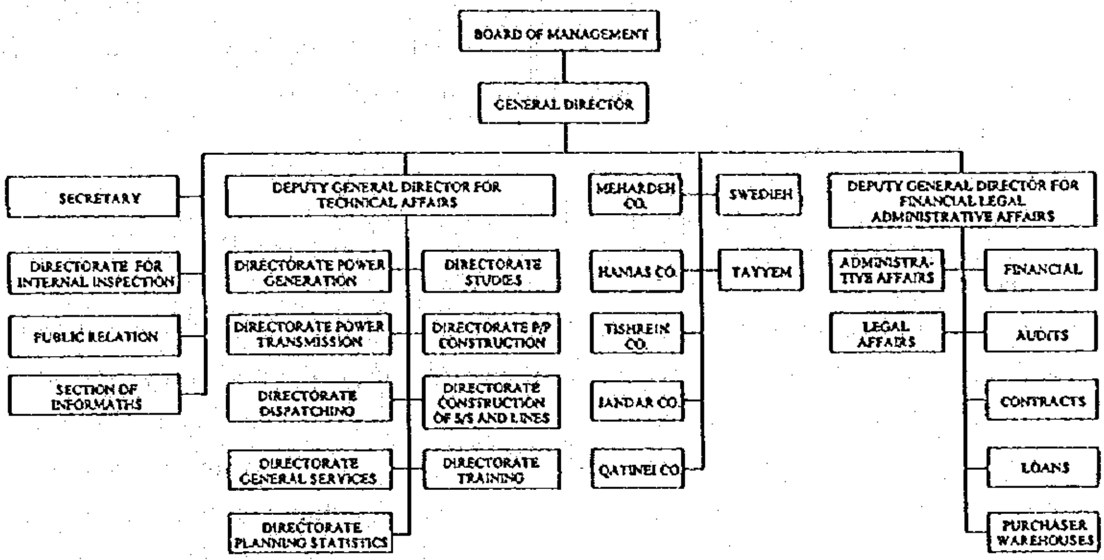


Fig. 3.6.2-1 Organizational Structure of PEEGT

3.5.3 Recommendations

(1) Operation and Maintenance Budget

While the power sector in Syria is run by the state, the collected electricity charges go to the Treasury. The MOE is operated on a budget, including a foreign currency portion, appropriated by the Ministry of Finance. This arrangement appears to strain the operation and maintenance budgets of the power plants to the point that some plants find it difficult to purchase the necessary spare parts. Although the immediate privatisation of the power sector in Syria appears impossible under the present circumstances, more freedom and independence should be granted to the power sector in that the necessary budget for the operation and maintenance of power facilities should be freely appropriated from the collected electricity charges with the approval of the central government.

(2) Electricity Charges

The electricity charges in Syria are revised every 1 - 3 years and present tariff is approx. 1 SP/KWh (average) as of December 1993. The charge level is fairly low and it appears impossible to recover investment in the power sector through the electricity charges alone. As electricity is an essential commodity for national life, the charge level should not be too high in order to protect low income earners. Nevertheless, a sensible charge level is required to ensure reasonable revenues to cover the operation and maintenance cost as well as the cost of investment in new facilities. Without a sensible charge level, development of the power sector is not feasible. Although under the present charge system, large users pay a higher charge than low income earners, the charge level for large users, including state-run enterprises, should further be reviewed to raise in an appropriate manner.

(3) Collaboration of PEEGT Head Office and Power Plants

Although efforts were made to gather as much information as possible on the operation and trouble records of the power plants, the information obtained was not sufficient. In addition to strengthening the regular monitoring and inspections and providing adequate operation and maintenance records, the management of each power plant must regularly submit such records to the Head Office.Through these records, the Head Office can properly understand the generation performance and conditions of troubles, etc. at each power plant and use such knowledge to prepare personnel assignment, repair, expansion and budgetary appropriation plans. This can also be linked to the construction plan for new power plants based on future demand forecast data.

(4) Personnel Plan for Power Plants

The number of people assigned to each power plant appears to be fairly large. Compared to a Japanese power plant of a similar scale, the manpower level at a Syrian power plant is 3 - 4 times large (although simple comparison ignoring the fact that Japanese power plants today are fully automated).

The technical level of staff working at Syrian power plants is not satisfactory. It is said that young workers with good skills tend to move to private companies or work abroad for higher pay. Consolidation of the training function of power sector is extremely necessary in order to improve the general technical level of staff through the fostering of young staff as well as re-training of existing staff. In addition, the working conditions, including wage level for technicians/engineers who have completed education and training, should be improved to make working at a power plant attractive for young technicians/engineers. If the number of highly capable technicians/engineers working at power plants increases due to higher wages etc., the total number of staff members can actually be reduced to pay for the improved wages.

CHAPTER 4 POWER PLANTS REHABILITATION PLAN

4.1 Selection of Subject Power Plants for Rehabilitation and/or Renovation Study

4.1.1 Selection Criteria

The following criteria were adopted to select the target power plants for rehabilitation and/or renovation under the this Study.

1) Selection Criteria Based on Equipment Conditions

- Deterioration of performance (output and efficiency)
- History of troubles and damages (records of troubles)
- Year of commissioning
- Total hours of operation
- Total number of starts and stops
- Recent operation status of main unit (in terms of vibration, noise and high temperature, etc.)
- Operating conditions of auxiliary equipment
- Storage conditions of spare parts and procurement problems
- Existence of manufacturer(s) of existing main equipment
- Maintenance of drawings (history of repairs)

2) Selection Criteria Based on Social and Environmental Conditions

- Importance of the plant (in terms of geographical area served and power grid efficiency)
- Generation capacity (number of beneficiaries in area served)
- Degree of pollution generation (smoke, oil and water, etc.)
- Fuel used
- Conditions of maintenance system and maintenance work in the plant (quality of staff and availability of maintenance materials and tools)

4.1.2 Selected Power Plants for Rehabilitation and/or Renovation

Following consultations with the Government of Syria, those units of the power plants listed below were selected as the subjects for rehabilitation and/or renovation based on the First Field Survey using the selection criteria described in (1) above.

1) Katteneh Power Plant: Unit No.3, Unit No.4, Unit No.5 and Unit No.6
2) Mehardeh Power Plant: Unit No.1 and Unit No.2
3) Banias Power Plant: Unit No.1 and Unit No.2

4.2 Power Plant Rehabilitation Proposals

4.2.1 Common Subjects for Rehabilitation

(1) Common Subjects for Selected Power Generation Plants

The common subjects for power generation plants in Syria are as follows.

1) Maintaining continuous output was treated as the highest priority issue at each of the power plants and units, and this meant that the repair of minor defects such as gas leakage was reluctantly postponed in deference to the continuation of operations.

   As a result of this, it is inferred that the minor defects were allowed to grow and eventually lead to major damage. For example, gas leaks would cause the corrosion of site instrumentation, transmitters, wiring and insulation cover plates.

2) Each of the units selected for rehabilitation and/or renovation has, until now, undergone overhaul involving the prior ordering and arrangement of materials and work. At Mehardeh Power Plant, for example, renewal work on the reheater, which had suffered damage from high temperature corrosion from the effects of vanadium, required the shut down of Unit No.1 and Unit No.2 for roughly seven weeks.

   This indicates that necessary repair work has been conducted only when it has become necessary.

   However, mere partial repair work has not led to the overall improvement or recovery of performance because sufficient maintenance work has not been carried out on other areas. Unless many defects which have occurred during operation are repaired simultaneously during the same shut down period, it will not be possible to restore declined output and thermal efficiency to original levels.

3) The fuel for the boiler, HFO, is a so-called low quality oil containing 4% sulfur, and if its soot is allowed to stick to tubes, it will cause tube corrosion.

4) Table 4.2.1-1 indicates the overhaul work involving long term shut down that has been conducted by each power palnt, however, this overhaul work differs from the general overhaul being proposed in this Report. It appears to have been directed at the repair of areas which have been damaged through troubles.

Table 4.2.1-1 PEEGT Examples of Implemented Overhaul Works which have Entailed Long Term Suspension of Operation

No.	Power Plant	Unit No.	Type of Overhaul	Implementation Period
①	Mehardeh P.S.	Unit No.2	Replacement of boiler reheater	April 3rd - May 23rd, 1986
②	Mehardeh P.S.	Unit No.1	Replacement of boiler reheater	September 2nd - October 19th, 1989
③	Mehardeh P.S.	Unit No.2	General overhaul of turbine and generator	November 8th, 1992 - January 22nd, 1993
④	Katteneh P.S.	Unit No.6	General overhaul of boiler and turbine	March 1st - May 31st, 1993
⑤	Banias P.S.	Unit No.2	General overhaul of turbine and generator	March 14th - August 30th, 1993
⑥	Katteneh P.S.	Unit No.6	General overhaul of generator and excitor	April 26th - July 23rd, 1994

Note 1) The replacement of the high temperature reheater in Unit No.1 and Unit No.2 at Mehardeh Power Plant is recorded as a typical case of reheater tube consecutive failure resulting from high temperature corrosion caused by Vanadium of HFO ash.
It is said that on this occasion, the wearing down of tube thickness from 6 mm to 2 mm resulted the failure.

2) In Banias Power Plant Unit No.1, an 800 m length of furnace tube and the first floor burner were replaced in 1993. In Unit No.2, the replacement of the first floor burner was made in 1994 and about 1,650 m length of furnace rear and side wall tubes were replaced in 1993.

5) Management and Control Conditions at the Power Plants

In 1994 at Banias Power Plant, a system was introduced whereby defects are picked up using work request cards and confirmed in meetings of related department members, following which the ordering and arrangement of materials and work is carried out and the relevant data is compiled into computer for use as reference in future work budget making and control. Judging from this, it can be expected that a basis for preventive maintenance is gradually being established.

At Mehardeh Power Plant, the work order format is used, though data processing by computer is not introduced yet, and it is hoped that the plant control situation will move in the same direction as that at Banias Power Plant.

(2) Common Items in the Rehabilitation and/or Renovation Proposals for Selected Power Plants

1) Countermeasures for Defect Potential

Fig. 4.2.1-1 indicates potential defects and countermeasures against them. It can be seen that many of these involve cleaning and the renewal of deteriorated parts and/or portions.

Good effects from these measures can be expected provided that within the general overhaul period, cleaning is performed carefully and also provided that the work is surely performed while receiving confirmation from original supplier supervisors and specialists. The Rehabilitation Proposals recommend that detailed inspections be carried out especially on boiler pressure retaining parts, which are capable of causing critical damage to units. This is because the long periods required in procuring and processing the necessary materials make it necessary to make arrangements for renewal before actual failure occurs.

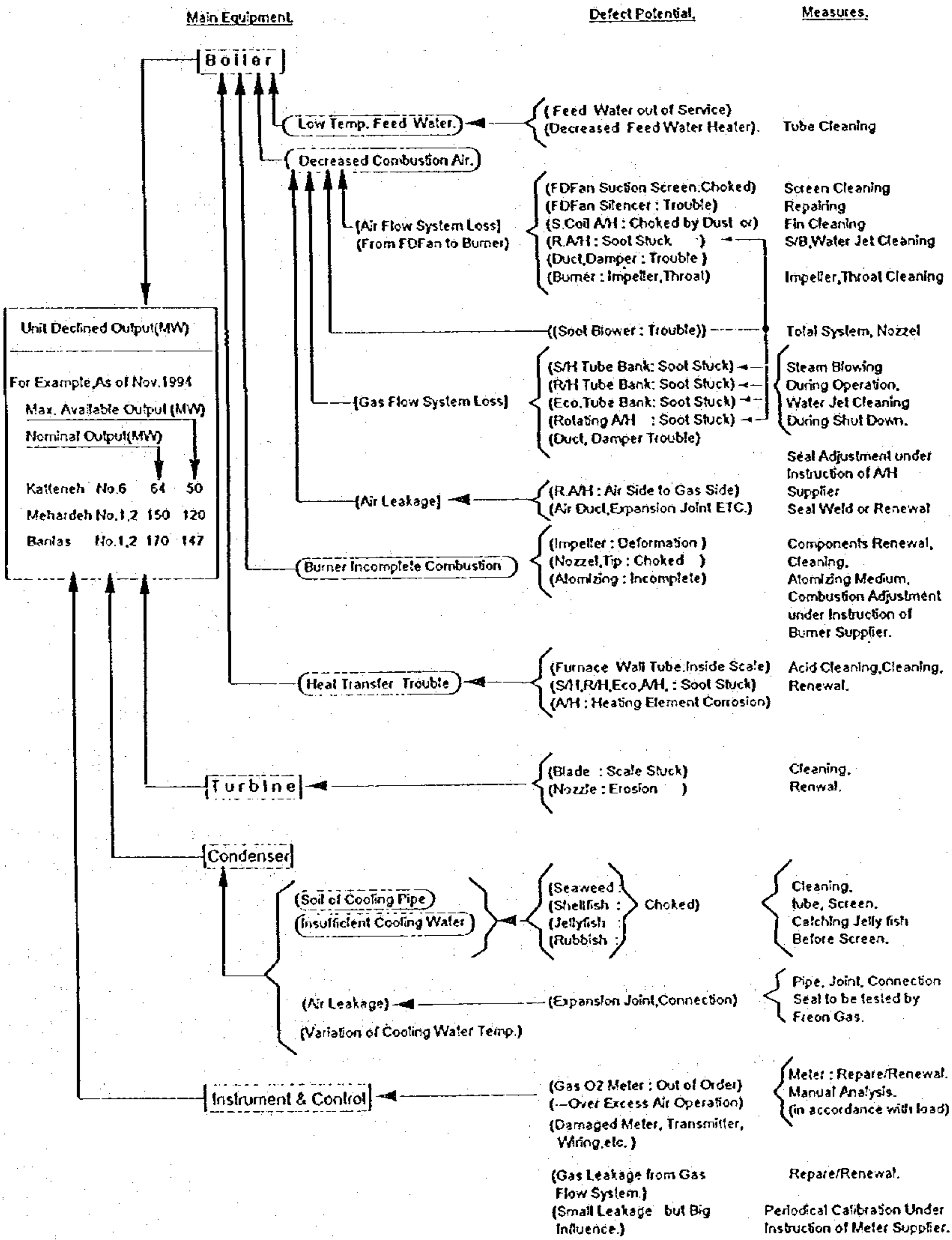
2) Common Items for Electrical Equipment and Instrumentation

① Basic Concept for Study

In principle, the idea of rehabilitation is not appropriate for electrical items and instruments.

Consequently, it has been decided that replacement/remodelling proposals will be made for aged electrical equipment and systems from the viewpoint of easy, safe and reliable handling/operation.

Fig. 4.2.1-1 Causes of Unit Declined Output, Declined Efficiency and Measures in HFO fired Unit



② Common Renewal Proposals

It is a common fact at all the power plants that many instruments have been left unrepaired or have not been replaced, regardless of the need for safe and easy operation. Because of the importance of safe, easy and reliable operation, all the rehabilitation proposals for each power plant include the replacement of instruments (detectors, switches and indicators, etc.)

3) Basic Concepts of Rehabiltation Proposals

The Rehabilitation Proposals shall be concluded with the following basic items.

a) Cleaning
b) Detailed inspection
c) The simultaneous implementation of all defect countermeasures during the same shut down periods

4.2.2 Banias Power Plant Unit 1 & 2, Mehardeh Unit 1 & 2 and Katteneh Power Plant Unit 6

(1) Examination of Rehabilitation Plan for Every Unit (Mechanical)

1) Implementation of the following measures is proposed to restore the declined output and declined thermal efficiency for all units.

① The gas O_2 % at both the air heater inlet and outlet will be measured to determine the rate of air leakage from the rotating air heater and also to check the thermal efficiency of the boiler.

② Thorough maintenance and the replacement of parts will be conducted for all the seal construction of the air heater to minimise air leakage from the rotating air heater.

③ In order to maximise the use of the heating surface of the rotating air heater, the units will be stopped for washing of the heating elements and recording of the corrosion loss. However, the renewal of heater elements is recommended, depending upon the results of the detailed inspection.

2) Detailed Inspection of All Parts for Every Unit

The detection of defects in boiler pressure retaining parts is relatively difficult. Therefore, the items and contents relating to these parts which should be included in the detailed inspection are proposed based upon the past experience of Study Team.

(2) Examination of Rehabilitation Plan for Every Unit (Electrical and Instrumentation)

1) Renewal of existing instrumentation system

The existing instrumentation system is based on the pneumatic mechanism and ageing of the system has resulted in such problems as air leakage and blockage by silica powder. Replacement of the entire system is more realistic than conducting piece-meal repairs to fundamentally solve all the problems. The electric system is the mainstay of power plant instrumentation systems today due to its easy operation and maintainability in addition to preventing the problems associated with the pneumatic mechanism. It is, therefore, proposed that the existing pneumatic system be replaced by the electric system for easy maintenance and repair as well as for the easy procurement of spare parts.

2) Replacement of instruments

Instruments should be replaced in accordance with the adoption of the electric instrumentation system described above, including those instruments of which the procurement of spare parts and readjustment are difficult or impossible due to the models being outdated.

(3) Proposal of Rehabilitation Plan for Every Unit (Mechanical)

1) Rehabilitation Master Time Schedule

Fig. 4.2.2-1 indicates the one example of rehabilitation master time schedule for Banias Power Plant Unit 1 & 2. It is proposed that the rehabilitation program consist of plant shut down to allow first stage general overhaul, second stage general overhaul and following that, periodic overhauls on a continuous basis.

First Stage General Overhaul

The proposed first stage general overhaul is of medium scale and is designed to identify all of the rehabilitation items to be simultaneously carried out in the second stage larger scale overhaul, which will be carried out 13 months later.

The first stage overhaul includes the following work.

① Detailed inspection planning (implementation plan)

② Detailed inspection implementation (Refer to Fig 4.2.2-2, Fig 4.2.3-2 and Fig 4.2.4-2)

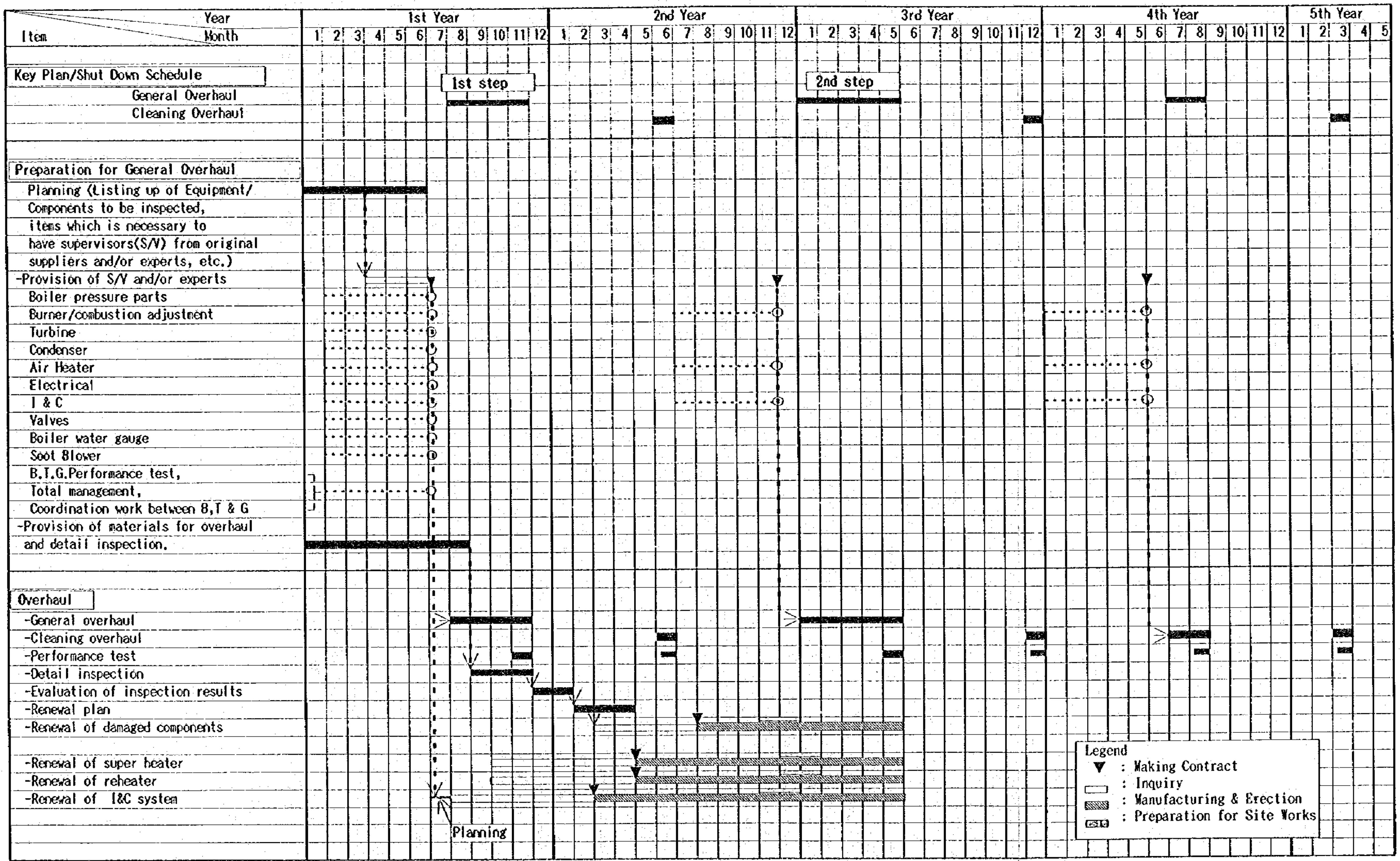
③ Invitation of the original supplier supervisor or specialist to have guidance for the following rehabilitation items and to confirm results

No.	Item	Supervisor or Specialist
a.	Detailed inspection of boiler parts	S/V from original supplier
b.	Inspection of pressure parts	Specialist
c.	Burner/combustion adjustment	S/V from original supplier
d.	Rotating air heater (seal adjustment and confirmation of air leakage ratio)	S/V from original supplier
e.	Instrumentation and control (meter calibration, control adjustment)	S/V from original supplier
f.	Turbines	S/V from original supplier
g.	Condenser (cleaning, air leakage check)	S/V from original supplier
h.	Performance test for boiler, turbine and generator, total management, coordination work between B, T & G	S/V from original supplier

The fundamental roles or responsibilities of the above mentioned supervisor or specialist are the confirmation and implementation of the detailed inspection items for each area, compilation of the inspection report and preparation of the damaged components renewal plan.

④ Confirmation of general overhaul results through performance test

Fig.4.2.2-1 Rehabilitation Master Time Schedule for Unit Nos. 1&2 in Banias P.S.



2) Second Stage General Overhaul

Based upon the results of the detailed inspection conducted as part of the first stage general overhaul and following the cleaning overhaul which will be implemented six months after that, the large scale second stage general overhaul will be implemented 13 months after the first stage general overhaul. This will involve the renewal of instruments and control equipment, repair of the reheater and superheater in high temperature zones, where damage is forecast to occur, and renewal work in other areas.

On the other hand, the rehabilitation of rotating auxiliary equipment such as boiler feed water pump, combustion air fans, HFO pumps, valves, casing and ducts etc. which are not stated in the rehabilitation master time schedule will have to be carried out beforhand in the first stage general overhaul. It is absolutely necessary to carry out complete repairs of all defects in the second stage general overhaul without any remainders.

3) Subsequent Periodic Overhauls

It is proposed that cleaning overhauls are implemented every six months following the general overhaul work. (As HFO is a low quality fuel, the cleaning frequency will need to be increased). Moreover, data on tube thicknesses shall be recorded in every second periodic overhaul and upon comparing these with the tube thickness data recorded during the detailed inspection, they will be used as reference data in deciding the scope of next rehabilitation work.

FIG. 4.2.2-2

Inspection Items on Pressure Parts for Banias No. 1&2

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

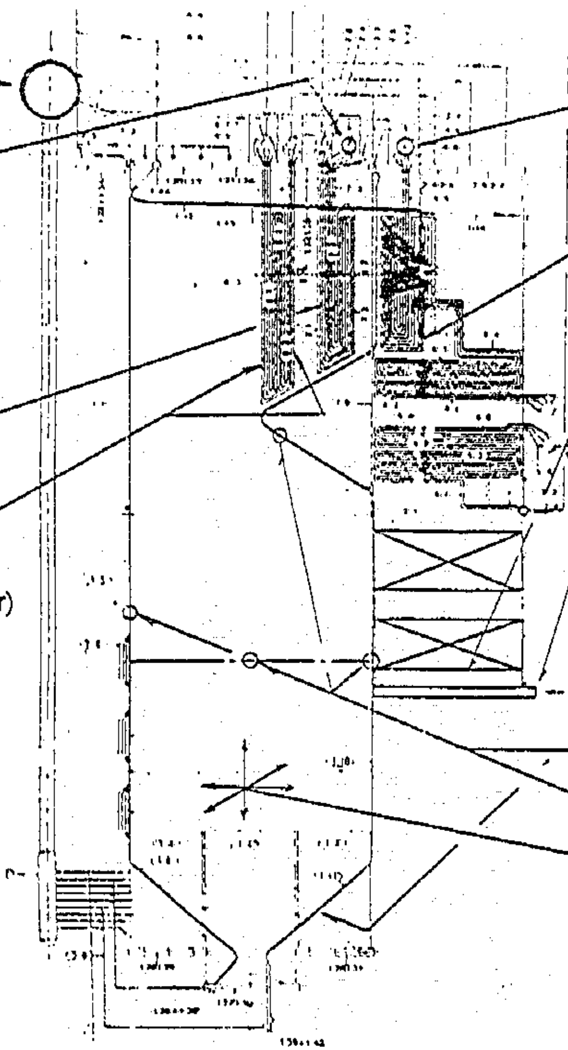
(SH-3) Outlet Header
(1) MT Of Weld Parts of Tube Stubs.
(2) MT Of Weld Parts of Drain Nozzle.
(3) ST Of Outside Surface of Welded Part of Outlet Nozzle.
(4) VI(Fiber-scope) Of Inside Surface of Outlet Nozzle.

Super Heater Tube (SH-3),— (7.1),(7.2),(7.3)
(1) Wall Thickness.(UT)
(2) MT Of Weld Parts of Lugs.
(3) Tube Sampling Investigation.

Super Heater Tube (SH-2),— (6.3:Element Front & Rear)
(1) Wall Thickness.(UT)
(2) MT Of Weld Parts of Lugs.

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

Hot Reheat Pipe
(1) MT Of Weld Parts of Support Lugs.
(2) VI(Fiber-scope) Of Internal Surface (for drain attack)



(SH-1) Inlet Header
(1) MT Of Weld Parts of Tube Stubs.
(2) MT Of Weld Parts of Drain Nozzle.

Reheater Outlet Header
(1) MT Of Weld Parts of Tube Stubs.
(2) MT Of Weld Parts of Drain Nozzle.
(3) ST Of Outside Surface of Welded Part of . Outlet Nozzle.

Reheater Tube (8.3),(8.4),(8.5)
(1) Wall Thickness.(UT)
(2) MT Of 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) Of Inside Surface of Tube Stubs.

Furnace W/W Tube
(1)VI & PT Of Weld Parts at Menbrane-bars for.
Each opening,such as Burner Throats,
A D openings and S B openings.
(2) PT Of Welded Connection of Tie-bars for Buckstay.
(3) VI Of Corner Condition of Buckstay.
(4) PT Of Weld Parts of lugs on side wall for Furnace Hopper Support Girders.
(5)Thickness Of 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
(7) All W/W Tube (UT with Transducer)

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

RH Attemperator
(1) PT Of Spray Nozzle for Fatigue Crack.
(2) VI (Fiber-scope) Of 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.

FIG. 4.2.3-2

Mehardeh P.S

Inspection Items on Pressure Parts for Mehardeh No. 1&2

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..

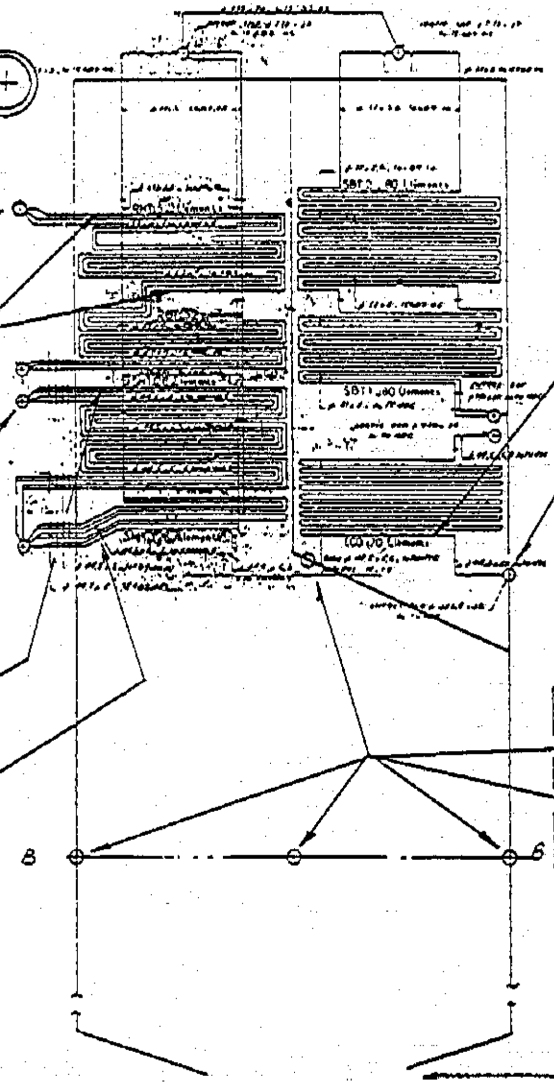
Reheater Outlet Header
(1) MT 0f Weld Parts of Tube Stubs.
(2) MT 0f Weld Parts of Drain Nozzle.
(3) ST 0f Outside Surface of Welded Part of Outlet Nozzle.

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

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

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



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

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

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.

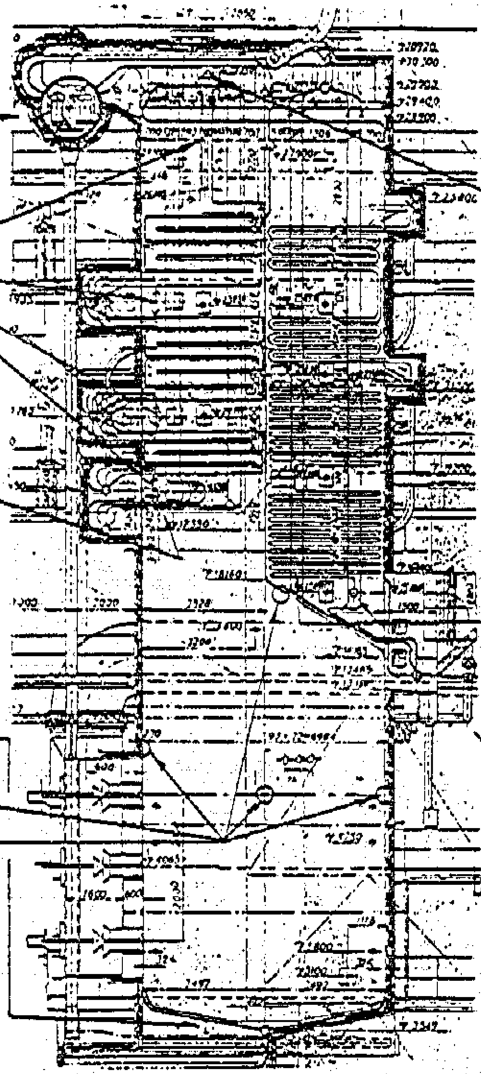
Furnace W/W Tube
(1)VI & PT 0f Weld Parts at Menbrane-bars for.
Each opening,such as Burner Throats,
AD openings and SB openings.
(2) PT 0f Welded Connection of Tie-bars for Buckstay.
(3) VI 0f Corner Condition of Buckstay.
(4) PT 0f Weld Parts of lugs on side wall for Furnace Hopper Support Girders.
(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

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

RH 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

Inspection Items on Pressure Parts for Katteneh No.6



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

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

Furnace W/W Tube
(1)VI & PT Of Weld Parts at Menbrane-bars for.
Each opening,such as Burner Throats,
AD openings and SB openings.
(2) PT Of Welded Connection of Tie-bars for Buckstay.
(3) VI Of Corner Condition of Buckstay.
(4) PT Of Weld Parts of lugs on side wall for
Furnace Hopper Support Girders.
(5)Thickness Of 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 Of Weld Parts of Support Lugs.
(2) VI(Fiber-scope) Of Internal Surface
(for drain attack)

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

Super Heater Tube
(1) Wall Thickness.(UT)
(2) MT Of 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) Of Inside Surface of Tube Stubs.

SH Attemperator
(1) PT Of Spray Nozzle for Fatigue Crack.
(2) VI (Fiber-scope) Of 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.

(4) Proposal of Rehabilitation Plan for Every Unit (Electrical and Instrumentation)

1) Renewal of Existing Instrumentation Systems

Based upon the factors described in 4.2.2(2), the existing instrumentation systems (pneumatic) shall be remodeled to electrical systems.

2) Instrument Renewal

- Renewal of deteriorated instruments shall be carried out:
- Based upon the results of the first stage inspection overhaul, renewal and repair of instruments and equipment shall be conrreced out.

3) Calibration of Instruments

Whether instruments are renewed, rehabilitated or left as they are, calibration shall be carried out on all instruments and meters.

4) Renewal of deteriorated electrical equipment (For Katteneh)

- Renewal of D.C systems
- Renewal of 380V Switchgear

4.2.3 Proposal of Rehabilitation Plan for Katteneh Power Plant Unit No.3, Unit No.4 and Unit No.5

Unit No.3, Unit No.4 and Unit No.5 were manufactured in the former Czechoslovakia and originally commissioned in the sixties. Deterioration of the units has progressed so far that it is thought that there is little hope of restoring declining output and thermal efficiency levels and, moreover, when one considers the short remaining service life of the plant itself, the rehabilitation of the units now cannot be described as a wise policy. It is therefore proposed that, instead of carrying out rehabilitation of the existing units, a new installation of NG and/or HFO fired 200 MW unit (steam or gas turbine) is proposed.

As for the existing Unit No.3, Unit No.4 and Unit No.5, it is desirable to continue the implementation of partial repair work and also to carry out cleaning overhauls on each units (every one to one and a half months) in an effort to extend the remaining service lives of the units and utilize their remaining capacity to the fullest degree. These three units shall be used as short term operation reserve units.

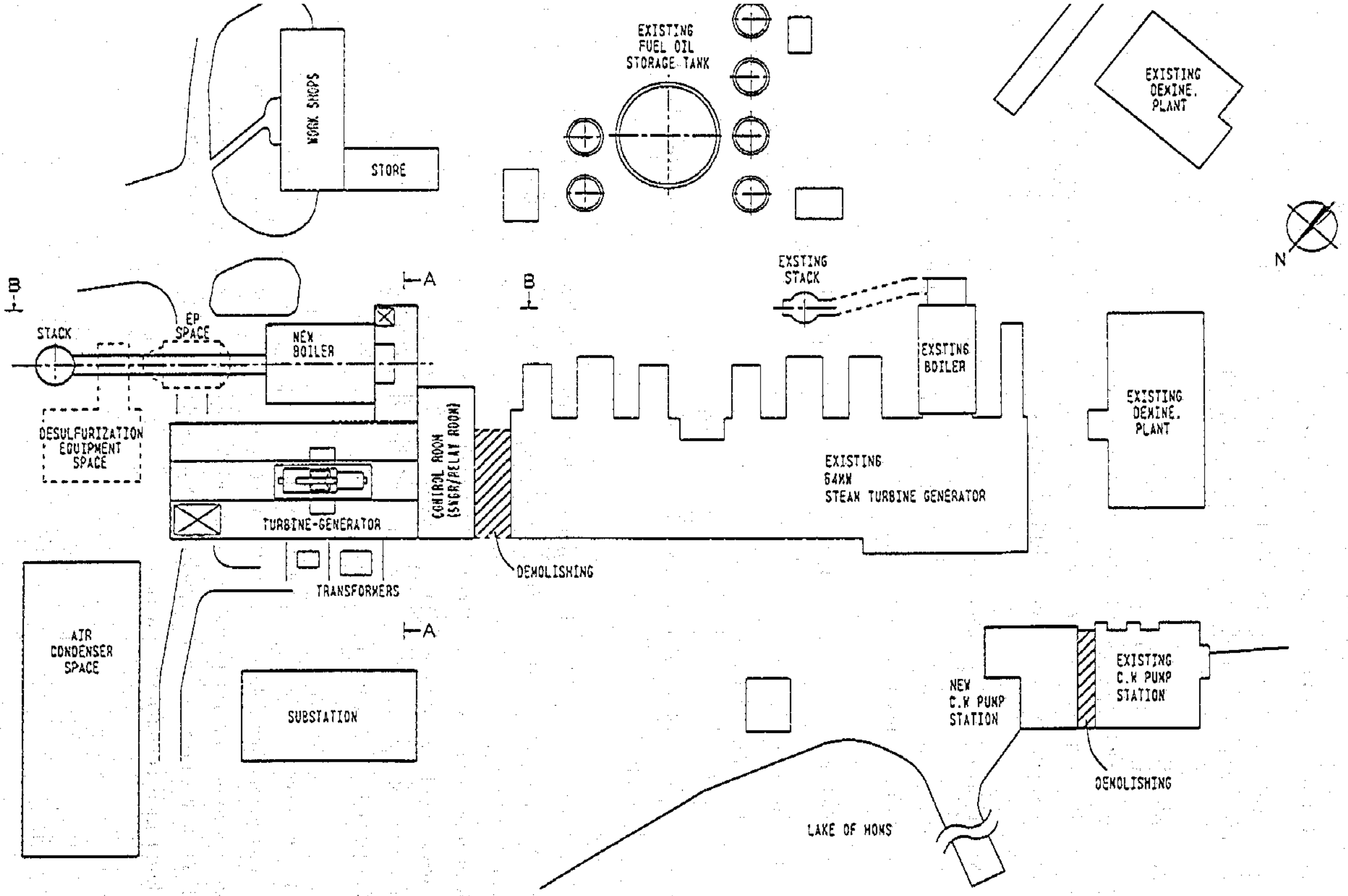
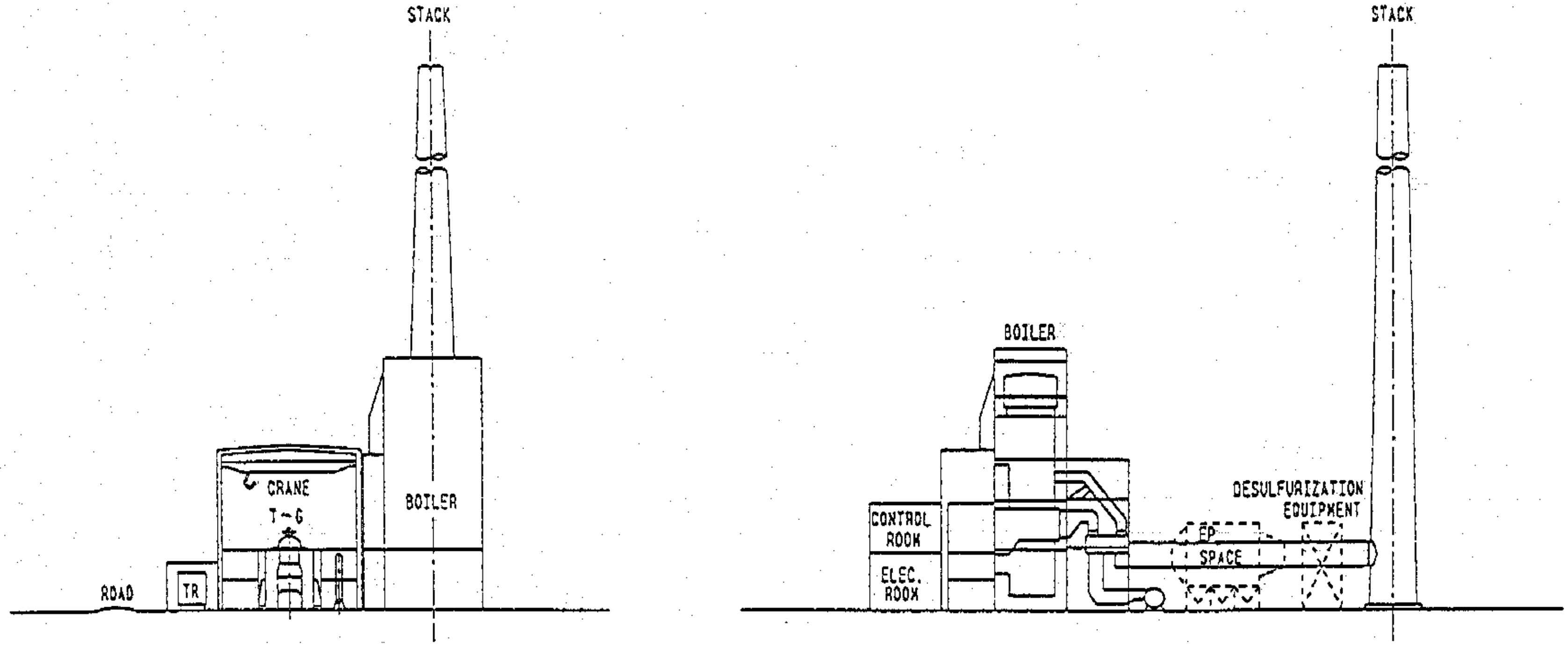


FIG. 4.2.4-4

PLAN
200MW S.T.G UNIT EXTENSION
IN KATTENEH P/S



VIEW AT A-A

VIEW AT B-B

FIG. 4.2.4-5

SECTIONS
200MW S.T.G UNIT EXTENSION
IN KATTENEH P/S

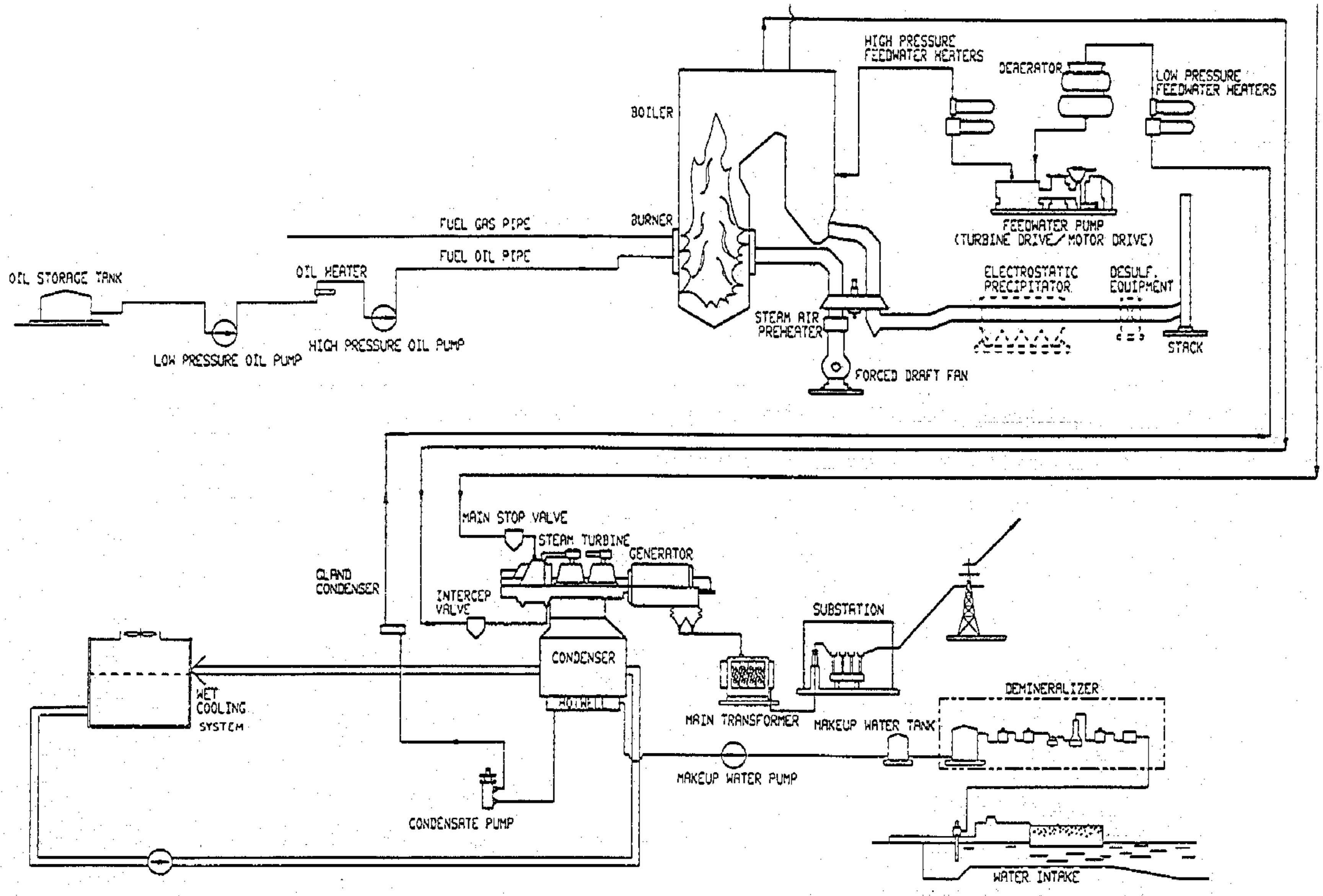


FIG. 4.2.4-6 SYSTEM FLOW DIAGRAM
200MW S.T.G UNIT EXTENSION
IN KATTENEH P/S

The main specifications of the new steam turbine generaing units are described below and the layout will be as indicated in Fig. 4.2.4-4, 5 and 6.

Capacity	:	200 MW class
Fuel	:	NG or HFO
Burner	:	low NOx burner

Furthermore, the completion of the above unit should be aimed at the year 2000 and the introduction of a flue gas desulphurisation system should be taken into consideration as a future environmental preservation measure.

4.3 Implementation Schedule and Cost Estimation

4.3.1 Implementation 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 in such a way to ensure that all rehabilitation and renovation work is completed between 1988 and 2000.

In addition, an alternative MASTER TIME 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.

Fig.4.3.1-1 Rehabilitation Master Schedule

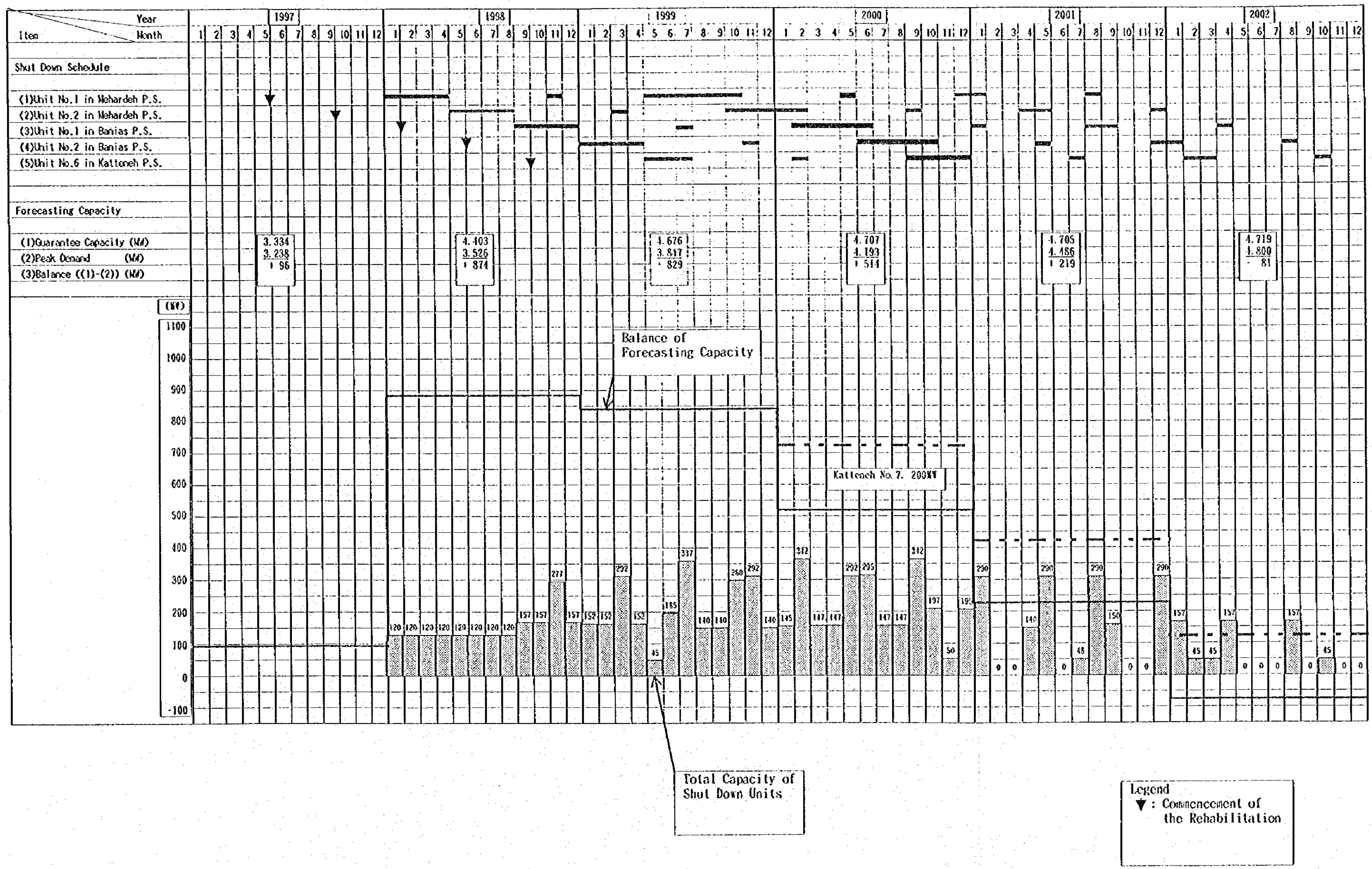
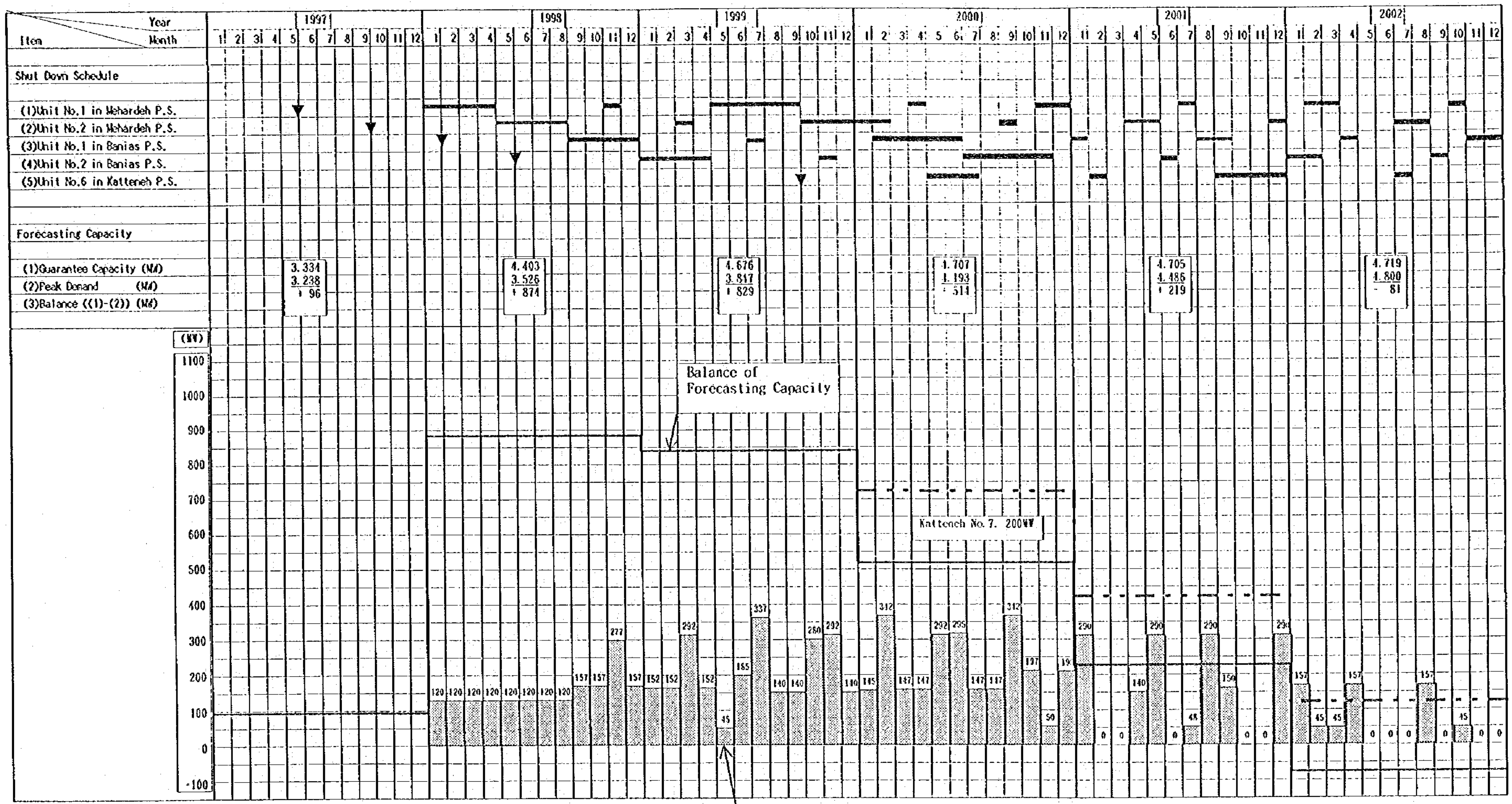


Fig.4.3.1-2 An Alternative Rehabilitation Master Schedule



(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

Total Capacity of
Shut Down Units

Legend
▼ : Commencement of the Rehabilitation

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 based upon data from past work cases experienced by the Study Team.

(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	2,500,000
1.2	Second stage general overhaul	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	2,500,000
2.2	Second stage general overhaul	38,500,000
	(2. Total)	41,000,000
3.	Rehabilitation of Katteneh Power Plant Unit No.6	
3.1	First stage general overhaul	1,000,000
3.2	Second stage general overhaul	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.

4.4.2 Economic Examination

(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.

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) 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.

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		

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.

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. 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.

(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

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. 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.)

In each plant, the average age of long-serving engineers is going up. Finding more young and skilled engineers for positions in the operation and maintenance sections is vital.

c) Current Operation and Maintenance Conditions

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.

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.

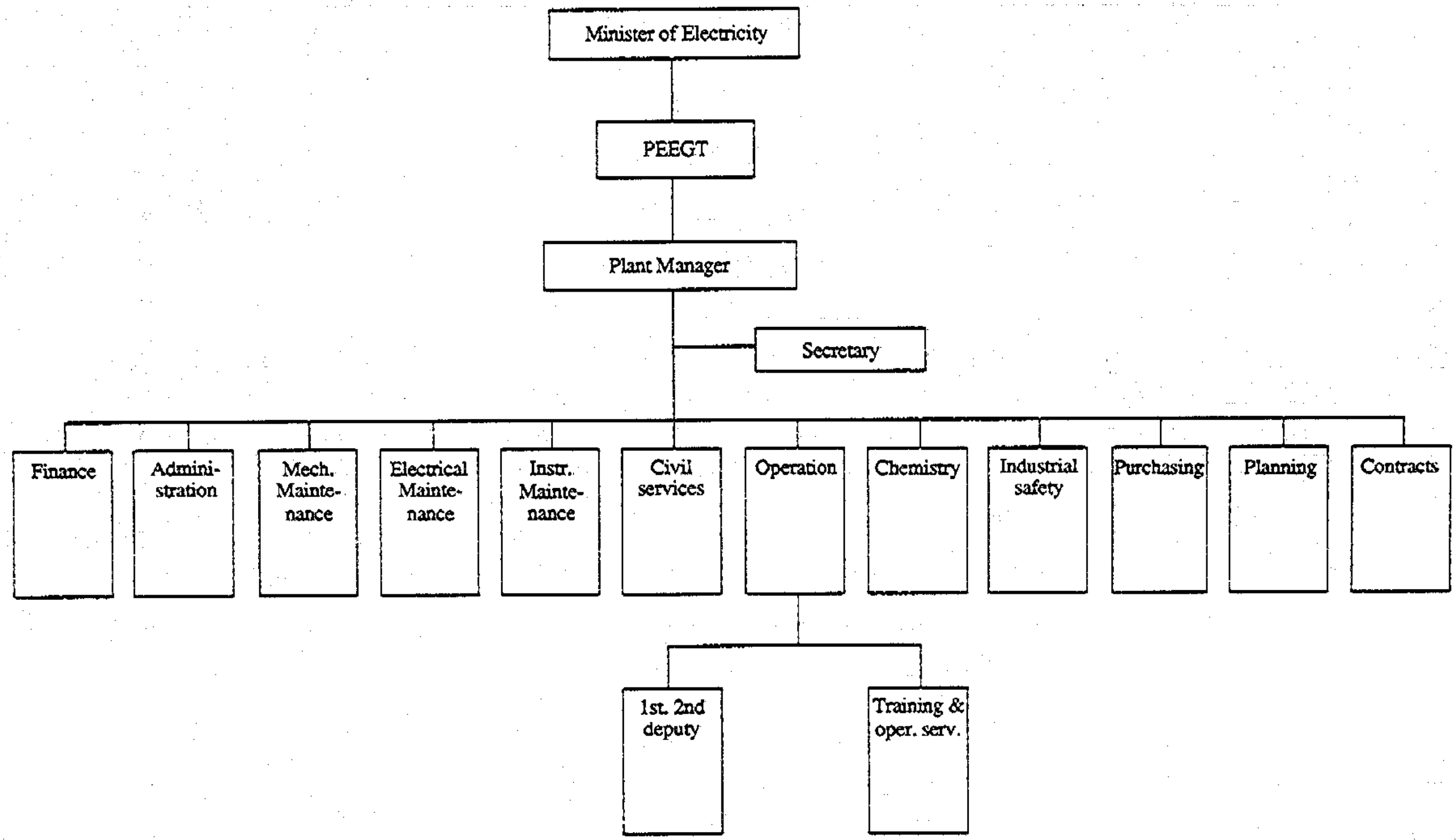


Fig. 5.1.1-1 Organization of the Each Plant

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.

(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.

Grooming a staff with a high level of technical expertise and morale, is necessary to ensure efficient operation of the plant.

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.

(3) Spare Parts for Operation and Maintenance

1) Storage Conditions

Most of the spare parts at each power plant are small items, and each plant stores its parts well and orderly in a manner that allows immediate and easy access.

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.

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.

Improvements of the system are required to make the procurement of parts from overseas more efficient.

5.1.2 Present Situation of Existing Technical Institutes (As of Nov. 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

2) Courses

Electric Power Course
Electronic Course
Control Course
Mechanical Course

3) Number of Staff: 32

4) Annual Budget

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

5) 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.

(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) Courses

Distribution Course

Electronic Course

Control Course

3) Number of Staff: 35

4) Annual Budget

- 14,500,000 Syrian pounds (S.P.)

5) Assessment

Only 69 students have enrolled so far which is far few for an institute that is planned for 1000 students. 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) Courses

Transmission Course

Distribution Course

Steam Generation Course

3) Number of Staff 62

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

5) Assessment

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.

5.1.3 Necessity and Urgency of the New Training Center

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

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.

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

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

It has been made clear 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.

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.

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. 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

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.

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

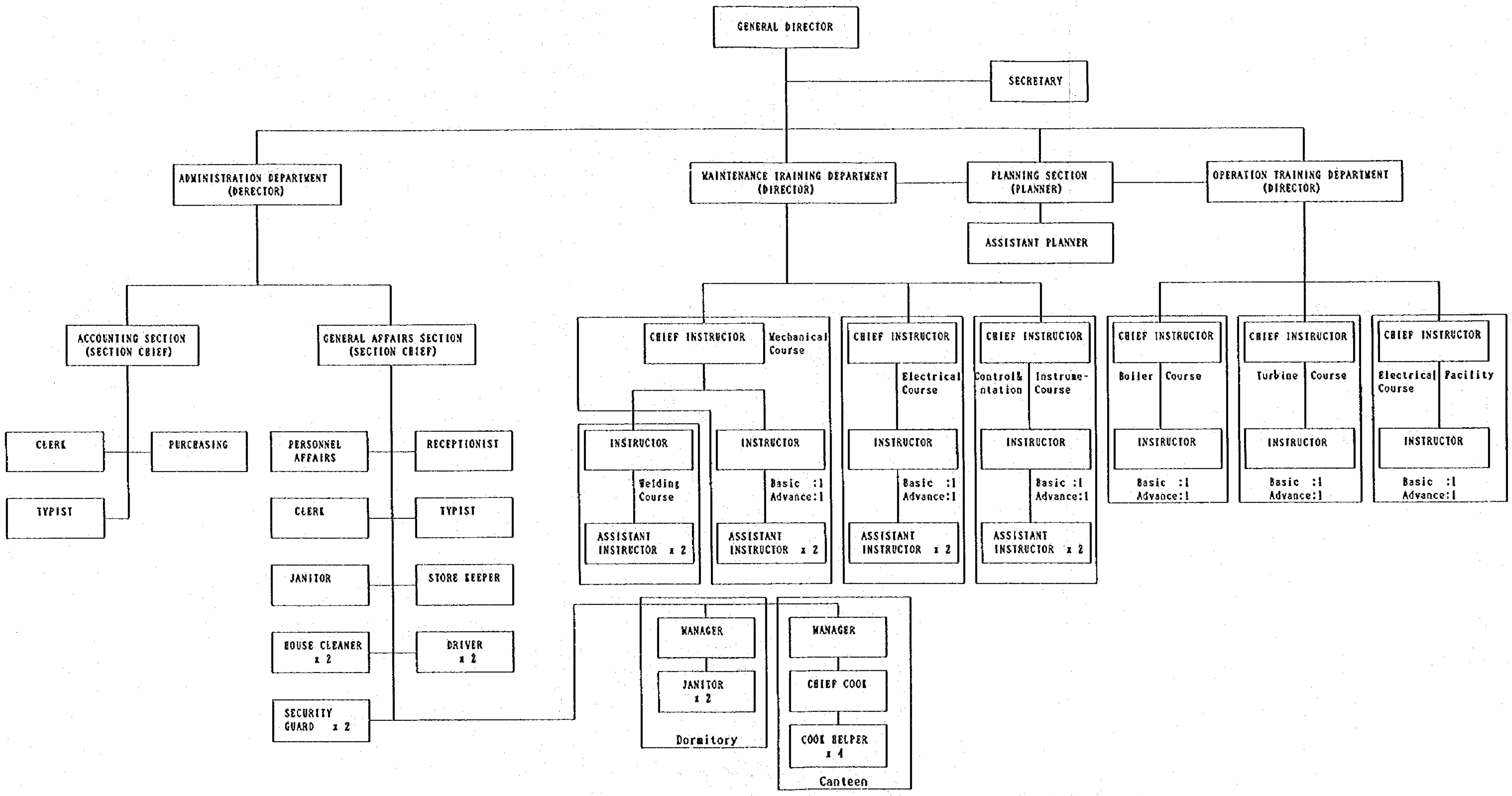


Table 5.2.1-1 Summary of Necessary Instructors in Accordance with Training Courses (Syrian Staff)

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			

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

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.

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.

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.

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.

(2) Training Curriculum

Based upon the above mentioned training concept and training objectives, the curriculums for each course have been compiled. (Details deleted)

(3) Training Schedules

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

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. (Details deleted)

(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.

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.

(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