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

JULY, 1995

YACHIYO ENGINEERING CO.,LTD.

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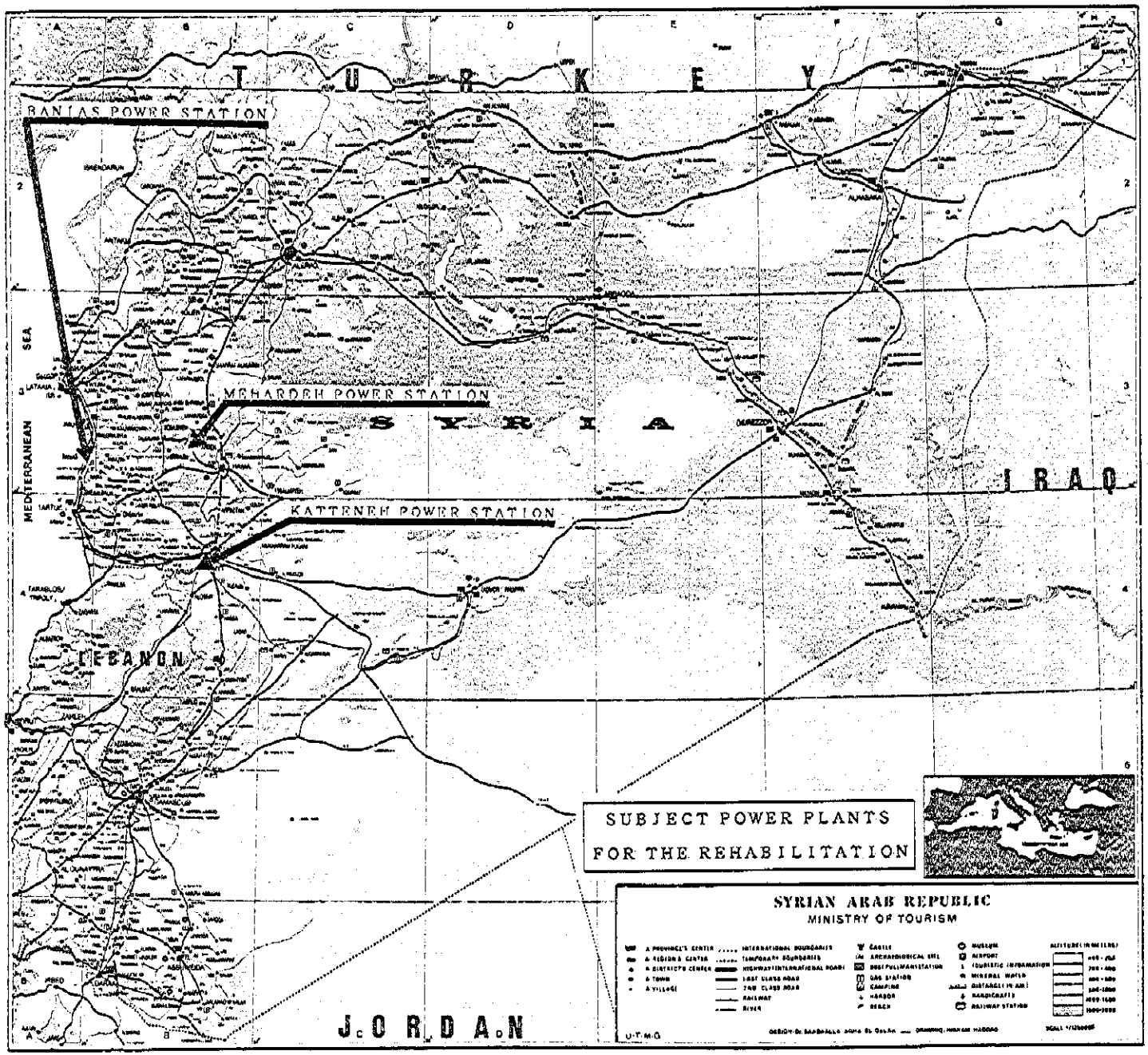
T U R K E Y
BANIAS POWER STATION
MEHARDEH POWER STATION
KATTENEH POWER STATION
S Y R I A
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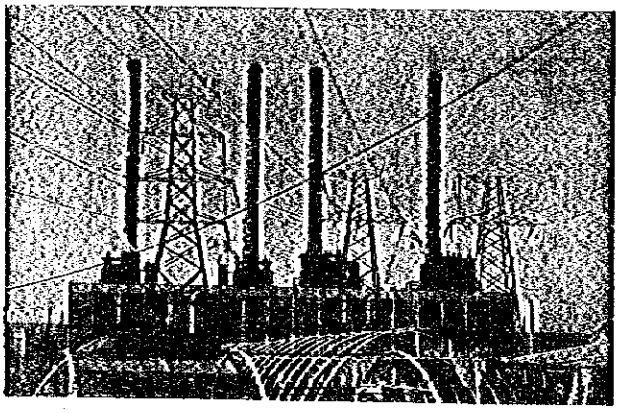
MEDITERRANEAN SEA
LEBANON
J O R D A N
SUBJECT POWER PLANTS
FOR THE REHABILITATION
SYRIAN ARAB REPUBLIC
MINISTRY OF TOURISM

BANIAS POWER STATION



◀ GENERAL VIEW

BOILER ▶

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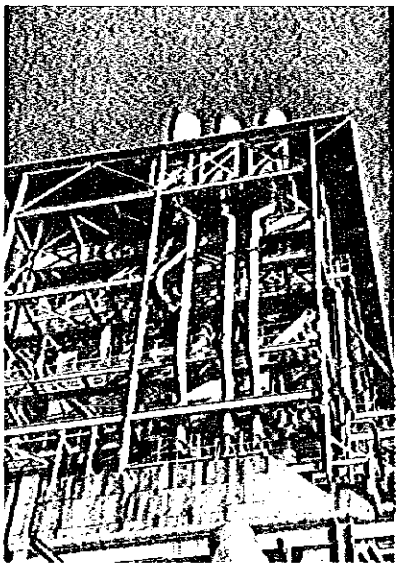
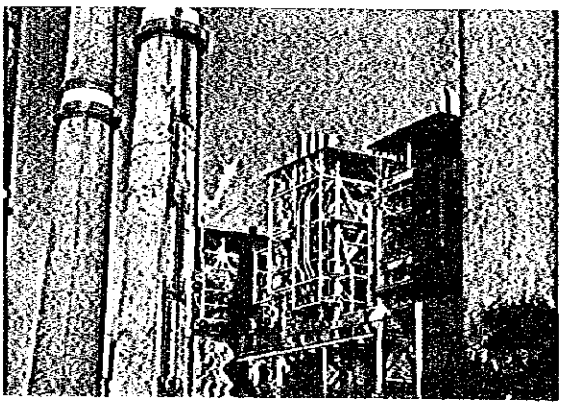
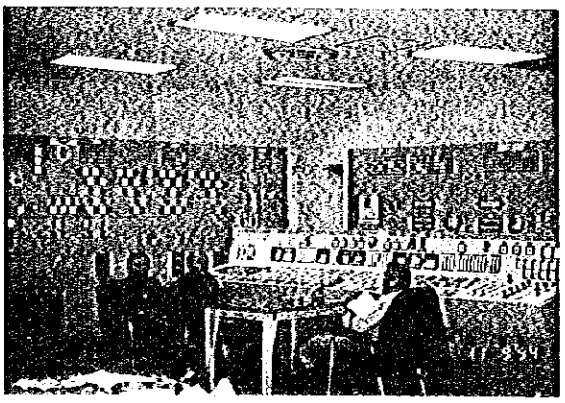
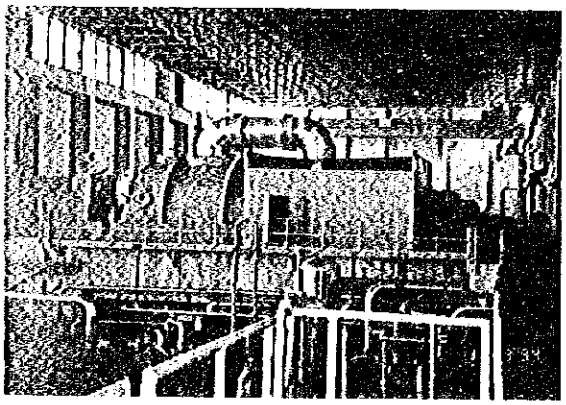




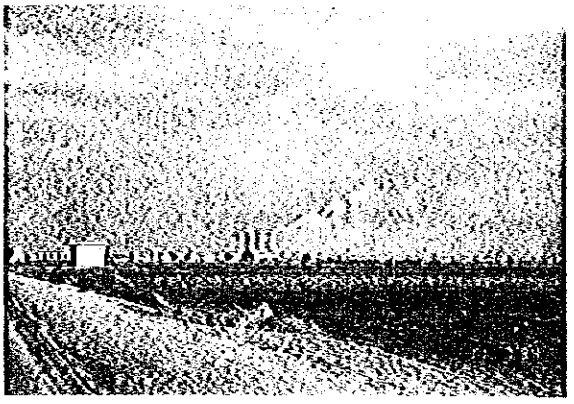


▲ CENTRAL CONTROL ROOM



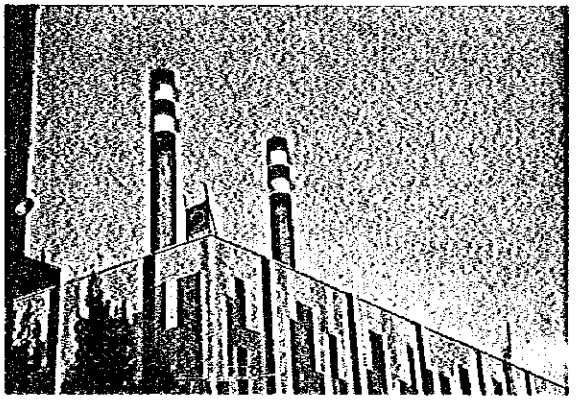
◀ TURBINE UNIT

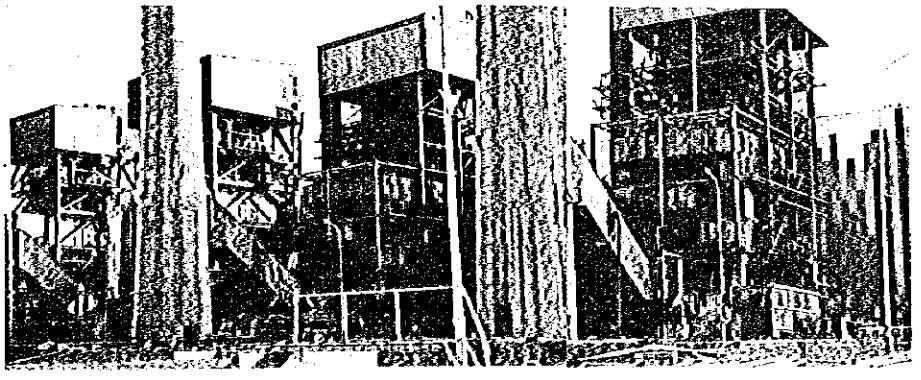
MEHARDEH POWER STATION



◀ GENERAL VIEW

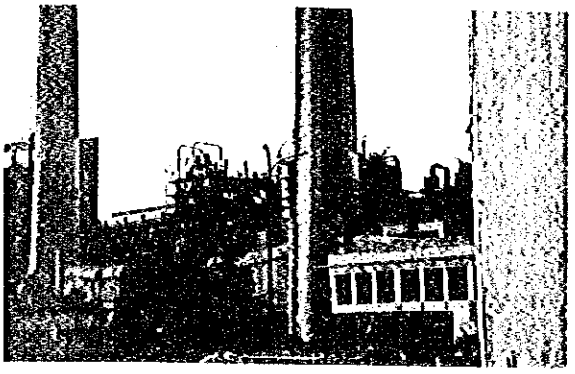
STACK ▶





▲ BOILERS (4 UNITS)

KATTENEH POWER STATION



◀ BOILERS

TURBINE HOUSE ▶

CANDIDATE SITE OF NEW TRAINING CENTER

(NEXT TO THE EXISTING JANDAR C/C POWER STATION)

PREFACE

In response to a request from the Government of the Syrian Arab Republic, the Government of Japan decided to conduct the Master Plan Study on Rehabilitation and Manpower Training for Power Plants in the Syrian Arab Republic and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Noritsune Chiba of Yachiyo Engineering Co., Ltd. to the Syrian Arab Republic four times from October 1994 to June 1995.

The team held discussions with the officials concerned of the Government of the Syrian Arab Republic, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

I with to express my sincere appreciation to the officials concerned of the Government of the Syrian Arab Republic for their close cooperation throughout the study.

July 1995

Kimio Fujita
President
Japan International Cooperation Agency

CONTENTS

APPENDICES

ABBREVIATIONS

APC	:	Automatic Plant Control
BTG	:	Boiler Turbine and Generator
C/C	:	Combined Cycle (Generating Plant)
CND	:	Conductivity
DO	:	Dissolved Oxygen Concentration
EU	:	European Union
FDF	:	Forced Draft Fun
GDP	:	Gross Domestic Product
GT	:	Gas Turbine
GTG	:	Gas Turbine Generating Plant
HT	:	Hydraulic Turbine
HFO	:	Heavy Fuel Oil
I&C	:	Instrument and Control
JICA	:	Japan International Cooperation Agency
LRMC	:	Long Run Marginal Cost
MOE	:	Ministry of Electricity (of Syria)
NCC	:	National Control Center (of Syria)
NG	:	Natural Gas
OECF	:	Overseas Economic Cooperation Fund (of Japan)
OJT	:	On the JOB Training
O&M	:	Operation and Maintenance
PEEGT	:	Public Establishment of Electricity for Generation and Transmission
PEDEEE	:	Public Establishment for Distribution and Exploitation of Electric Energy
SP	:	Syrian Pound
ST	:	Steam Turbine
SV	:	Supervisor

CHAPTER 1

OBJECTIVES AND BACKGROUND OF THE STUDY

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

Further details of each part are given below.

(1) [Part 1] Macro Framework Study for Master Plan

1) Phase 1: Data Collection and Site Surveys

① Study on socioeconomic structure and power demand

② Study on energy and environmental preservation policy

③ Study on existing power supply systems, including site surveys at existing power plants

④ Study on power development plan and investment programme

⑤ Study on institutional framework

2) Phase 2: Review and Analysis of the Following

① Review and analysis of power demand forecast

② Review and analysis of power supply expansion plan

③ Review and analysis of power development plan and investment programme

④ Review and analysis of power generation plan of each plant

⑤ Review and analysis of institutional framework

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

1) Phase 1: Identification of Target Power Plants

① Review of existing thermal power plants

② Pre-evaluation and examination of criteria to identify priorities

③ Selection of power plants requiring urgent rehabilitation

2) Phase 2: Detailed Study and Analysis for Rehabilitation and Renovation Alternatives

① Detailed study of selected power plants

② Preparation of alternatives for rehabilitation and renovation

③ Analysis of alternatives, including initial environmental examination

3) Phase 3: Preparation of Rehabilitation and Renovation Plan

① Conceptual design and cost estimate

② Economic and financial analyses

③ Preparation of recommendations

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

1) Phase 1: Study on Improvement of Operation and Maintenance System

① Review of operation and maintenance systems at existing power plants

② Analysis of improvement plan of operation and maintenance systems at existing power plants

2) Phase 2: Preparation of Manpower Training Concept

① Review of existing manpower training system of the Public Establishment of Electric for Generation and Transmission (PEEGT)

② Identification of the necessity and scope of manpower training

③ Identification of training curriculum and management method

3) Phase 3: Preparation of Manpower Training Plan

① Conceptual design and cost estimate for training center

② Examination and Analysis of institutional framework

③ Preparation of recommendations

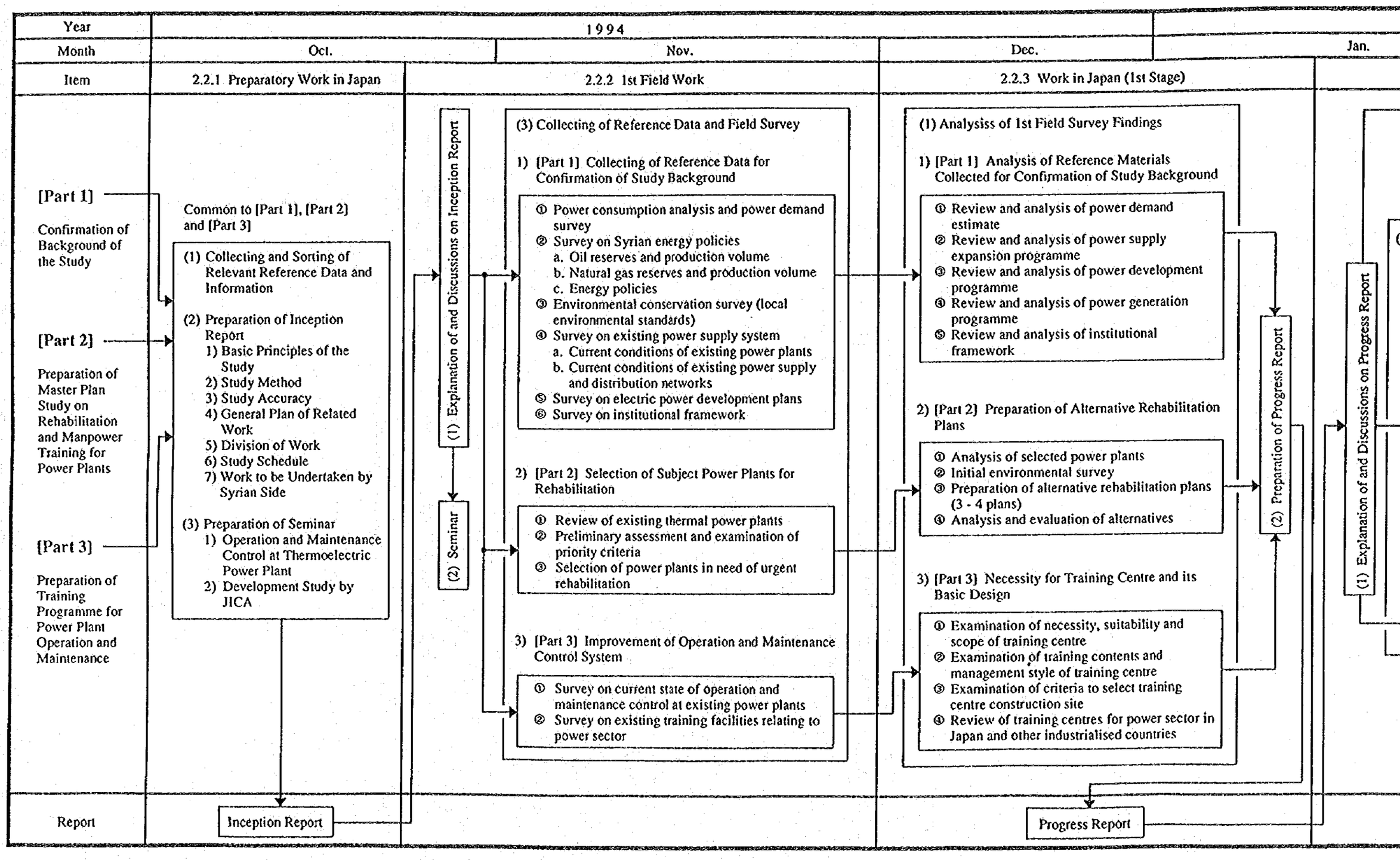
1.5 Study Implementation Schedule (Work Flow Diagram)

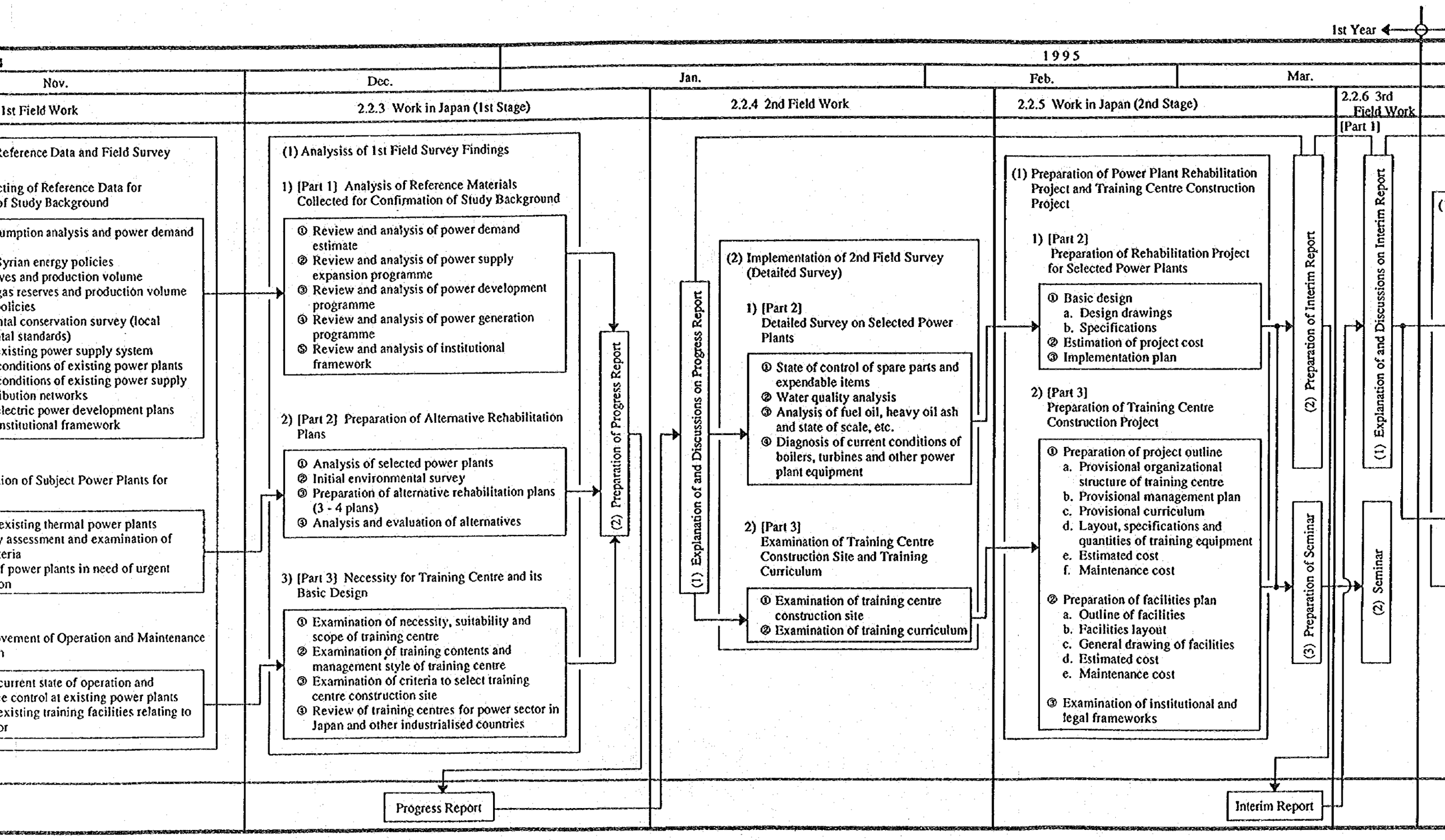
The overall implementation schedule of the Study is as illustrated in the work flow diagram (see Fig. 1.5-1).

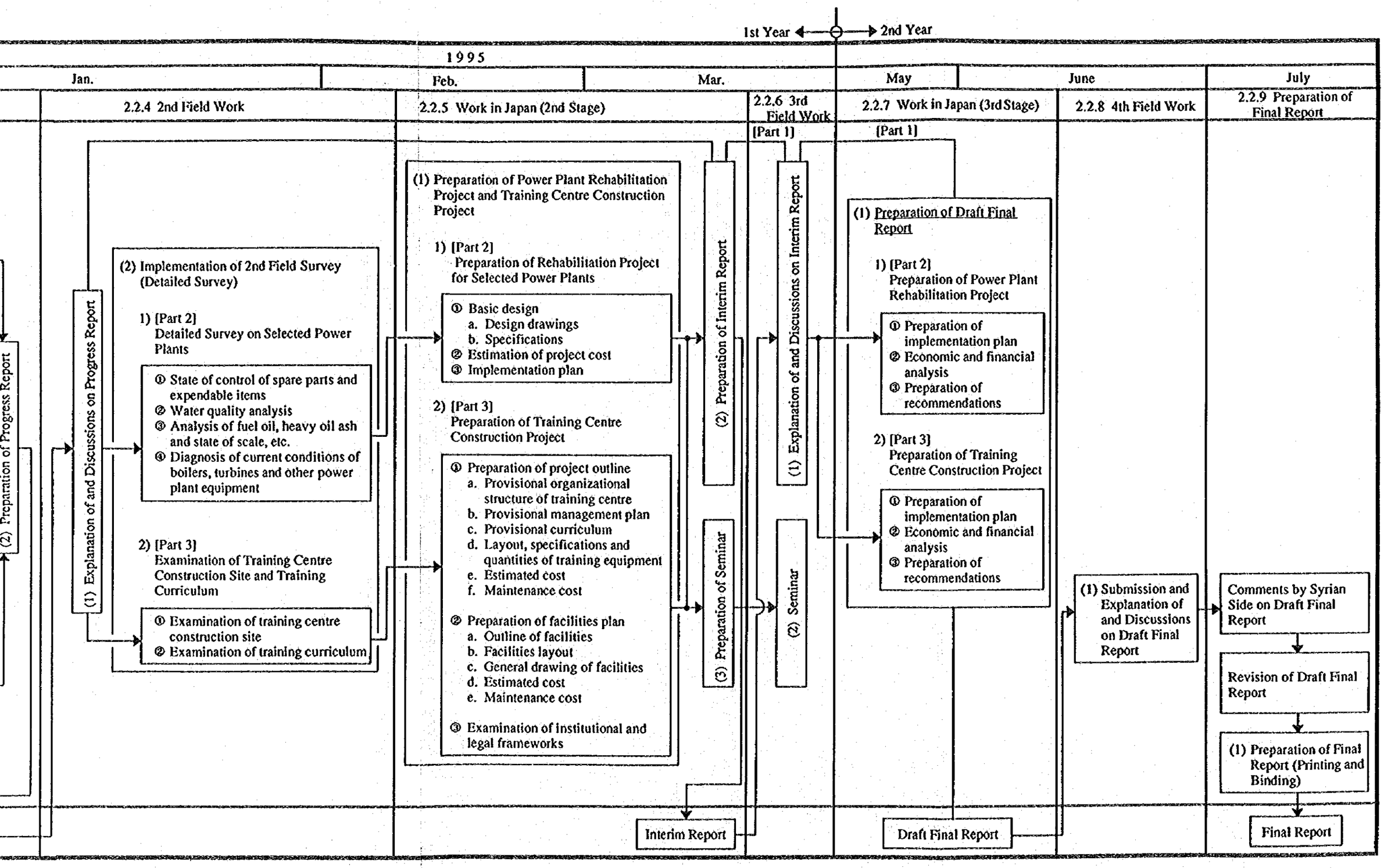
The field surveys were conducted over the following periods:

(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.
1st 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
[Part 1]
Reference Data and Field Survey
cting of Reference Data for
of Study Background
umption analysis and power demand
Syrian energy policies
ves and production volume
gas reserves and production volume
olicies
ntal conservation survey (local
tal standards)
existing power supply system
conditions of existing power plants
conditions of existing power supply
ibution networks
electric power development plans
nstitutional framework
ion of Subject Power Plants for
existing thermal power plants
assessment and examination of
teria
f power plants in need of urgent
on
vement of Operation and Maintenance
n
current state of operation and
e control at existing power plants
existing training facilities relating to
or
(1) Analysiss 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
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
Interim Report
(1) Explanation of and Discussions on Interim Report
(2) Seminar


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
[Part 1]
2.2.7 Work in Japan (3rd Stage)
[Part 1]
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
③ Analysis of fuel oil, heavy oil ash and state of scale, etc.
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② Examination of training curriculum
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③ Implementation plan
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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
(1) Explanation of and Discussions on Interim Report
(2) Seminar
(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
(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)
Interim Report
Draft Final Report
Final Report

CHAPTER 2

OUTLINE OF STUDY-IMPLEMENTATION

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 Preparatory Work in Japan

The preparatory work in Japan was carried out from the middle through to the end of October 1994 and the contents of the work were compiled in the Inception Report. The contents of the preparatory work were as follows.

(1) Collection and analysis of data and information relating to the Master Plan

(2) Preparation of the Field Survey schedule

(3) Preparation of the Field Survey Plan (compilation of data to be collected and items to be investigated)

(4) Preparation of criteria for the selection of power plants to undergo rehabilitation and renovation

(5) Preparation of Seminar Draft

The draft of the seminar was prepared, which was conducted at the time of the First Field Survey, "entitled Concerning the Operation and Maintenance of Thermal Power Plants in Japan."

2.2 First Field Survey

The First Field Survey was carried out from October 28th to December 2nd in order to confirm the background to the Master Plan and to collect basic data. The items surveyed in the course of the Survey and the items discussed and agreed upon with the Syrian side are as stated below. Details of the Survey are given in the Progress Report (presented and explained to the Syrian side at the time of the Second Field Survey).

2.2.1 Contents of the Survey

(1) Explanation and discussion of the Inception Report

(2) Holding of the seminar (See item 2.2.3)

(3) Field survey and collection of data

- Field survey and data collection for the confirmation of the background to the Master Plan Study
- Selection of the power plants to undergo rehabilitation and renovation
- Examination of operation and maintenance conditions at power plants and of power sector technical institutes.

2.2.2 Discussed and Agreed Items

(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) Necessity of Manpower Training

In addition, it was confirmed through this Study that absolute numbers and technical levels of staff involved in operation and maintenance at Syria's thermal power plants are lacking, and that there are insufficient facilities and equipment and also relatively low educational levels at existing power sector technical institutes. The necessity of the establishment of a New Training Center was thus recognized by both the Study Team and Syrian counterpart, and it was also agreed to locate the construction site of the Center within the area of the Jandar C/C Power Plant.

2.2.3 Seminar

A Seminar was held on November 4, 1994, regarding "Operation and Maintenance of Thermal Power Station in Japan" and about 30 engineers from Syrian Side attended.

2.2.4 Minutes of Discussions

The Minutes of Discussions held between the Study Team and the Syrian side during the First Field Survey are shown in Appendix 1-1 (A) and 1-1 (B).

2.3 Work in Japan (First Stage)

2.3.1 Work Contents

The first stage work in Japan was commenced immediately after the return to Japan of the First Field Survey Team and consisted of analysis of the data and information collected in the course of the First Field Survey and also the preparation of power plant rehabilitation and renovation alternative plans and the training center conceptual design. The major work contents and results are summarized below.

(1) Analysis of Data and Information to Confirm the Background of the Master Plan

- Review and analysis of power demand forecasts
- Review and analysis of power supply expansion plan
- Review and analysis of power development plan
- Review and analysis of the power generation plan
- Review and analysis of the institutional framework

(2) Preparation of Power Plant Rehabilitation and Renovation Alternative Plans

- Analysis of power plants selected to undergo rehabilitation and renovation
- Initial environmental examination
- Compilation and evaluation of power plant rehabilitation and renovation alternative plans

(3) Study on the Necessity of the Training Center and Conceptual Design

- Study on the necessity and scope of the Training Center
- Study on training curriculum and management system at the Training Center
- Selection of the Training Center construction site

(4) Review of power sector training centers in Japan and other advanced nations

2.3.2 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.

2.3.3 Preparation of Progress Report

Based upon the results of analysis of the information and data collected during the First Field Survey, the power plant rehabilitation alternative proposals and the necessity of the New Training Center were examined, and the conceptual design was prepared during the first work in Japan. At the same time, review was made for power sector training center examples in Japan and other advanced countries. The findings were compiled into the Progress Report and this was presented and explained to the Syrian side during the Second Field Survey.

2.4 Second Field Survey

2.4.1 Contents of the Survey

The Second Field Survey was conducted from January 12 to February 7, 1995. During this period, the detailed field surveys related to the subject power plants for rehabilitation and renovation and the New Training Center were carried out. The main study contents and discussed items are as follows.

(1) Explanation and discussion of the Progress Report

(2) Detailed survey of the selected power plants:
- Spare parts procurement and storage situation
- Survey of water quality, fuel oil, heavy oil ash and attached scale etc.
- Diagnosis of current state of boilers, turbines, generators and other equipment

(3) Detailed Survey of Matters Relating to the New Training Center
- Discussion and examination of candidate construction site
- Discussion and examination of training curriculums etc.

2.4.2 Survey Results and Discussion and Agreement Contents

(1) Cooling Water Analysis

As part of the Second Field Survey, analysis was carried out on the quality of cooling water used for condensers in the three power plants selected for rehabilitation and renovation.

This analysis was carried out because of the reports that the poor quality of cooling water was causing the rapid deterioration of condenser tubes at three subject power plants and that large amounts of time and money were being consumed in the replacement of such tubes.

The Study Team, using a simple water analyzer, performed water analyses locally on those items that could be analyzed, in order to confirm the results of water analyses being performed by the staff at each power station. The measurement results of both sides did not show much of a difference, even taking into account the differing test methods and sampling times. The details of the measurement results are given in Chapter 4.1.3 (3).

(2) 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, however, comprehensive rehabilitation and renovation proposals are made through integrating the first rehabilitation alternatives. 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
Kalteneh 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
Kalteneh 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.		

(3) Training Curriculum, Management and Organization etc. of the New Training Center

Proposals for the training curriculum, management and organization of the New Training Center, which were prepared based upon the data and information collected in the course of the First Field Survey, 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. The details are described in Chapter 5.

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 is two to five months.

2) Necessary Syrian Instructors and Staff

The instructors and staff that are necessary for operating the New Training Center are 33 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

Since the Study Team and the Syrian side reached 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.

2.4.3 Minutes of Discussions

The Minutes of Meetings held between the Study Team and the Syrian side during the Second Field Survey are shown in Appendix 1-2.

2.5 Work in Japan (Second Stage)

The second stage work in Japan was commenced immediately after the return to Japan of the Second Field Survey and comprised the preparation of the Power Plants Rehabilitation Plan

and the New Training Center Establishment Plan, which were compiled in the Interim Report, based upon analysis of data and information collected in the course of the Second Field Survey. At the same time, preparation of the seminar scheduled to be held during the Third Field Survey was carried out. The main work contents are summarized as follows.

2.5.1 Preparation of Rehabilitation Plan for the Selected Power Plants

(1) Preparation of the Power Plant Rehabilitation Plan (equipment specifications, outline design etc.)

(2) Preparation of the Power Plant Rehabilitation Implementation Plan (main work schedules etc.)

(3) Rough Cost Estimation

2.5.2 Preparation of the New Training Center Construction Plan

(1) Preparation of the Overall Plan (curriculum, organization and management plan, equipment and materials plan, rough cost estimation etc.)

(2) Facilities plan (basic design, rough cost estimation, operation and maintenance costs etc.)

(3) Examination of the institutional framework and related legislation etc.

2.5.3 Preparation of Interim Report

The Selected Power Plants Rehabilitation Plan and the New Training Center Establishment Plan which were prepared during the second work in Japan were compiled into the Interim Report.

2.5.4 Seminar Preparation

Seminar materials were prepared based upon the results of the site surveys and the Rehabilitation Plan prepared by the Study Team. The seminar title was "Rehabilitation and Maintenance Proposals for the Selected Power Plants".

2.6 Third Field Survey

The Third Field Survey was implemented from March 10 to March 24, 1995. During this period, the Interim Report, which was compiled during the second work in Japan, was

presented and explained, and discussions were held with the Syria side. The discussed and agreed items are as follows.

2.6.1 Explanation and Discussion of Interim Report

The Selected Power Plants Rehabilitation Plan and the New Training Center Establishment Plan in the Interim Report were explained and discussions were held. Explanation was also made for the Syrian side undertakings in case the New Training Center is constructed under Japan's Grant Aid.

2.6.2 Discussed and Agreed Items

(1) Outline of the Rehabilitation Plans for each Power Plant

A detailed description is given in Chapter 4, however, the outline of the rehabilitation plans for subject power plants are as follows.

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

① First Stage Overhaul (Required Time: approximately 4 months)

This will be a medium-size overhaul designed to determine all of the regions and parts actually requiring rehabilitation. The following work items shall be implemented:

- Preparation of a detailed inspection implementation plan,
- Detailed inspection implementation,
- Request for dispatch of specialists from original equipment suppliers,
- Rehabilitation of equipment (pumps, fans and valves etc.) and ducts confirmed as being faulty during the detailed inspection,
- Confirmation of output and efficiency etc., through performance tests after the overhaul.

② Second Stage Overhaul (Required Time: approximately 5 months)

- Renewal of control and instrumentation systems,
- Renovation of reheaters and superheaters where damage is forecast to occur,
- Rehabilitation of equipment and ducts etc. where the rehabilitation of damage has not been completed during the first stage overhaul,

- Confirmation of output and efficiency etc., through performance tests after the overhaul.

③ Cleaning Overhaul (Required Time: approximately 1 month)

Even following the completion of rehabilitation work, since the heavy fuel oil (HFO) is low quality oil, soot and dust easily attach to the surface of vaious tubes and the inside of the boiler, and this leads to lower efficiency and shorter useful life of the boiler. Therefore, cleaning overhauls shall be periodically carried out (every six months).

During this cleaning overhauls, equipment data shall also be measured and used as reference in deciding the items and scope of future overhauls.

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

① First Stage Overhaul (Required Time: approximately 4 months)

This will be a medium-size overhaul designed to determine all of the regions and parts actually requiring rehabilitation. The following work items shall be implemented:

- Preparation of a detailed inspection implementation plan,
- Detailed inspection implementation,
- Request for dispatch of specialists from original equipment suppliers,
- Rehabilitation of equipment (pumps, fans and valves etc.) and ducts confirmed as being faulty during the detailed inspection,
- Confirmation of output and efficiency etc., through performance tests after the overhaul.

② Second Stage Overhaul (Required Time: approximately 5 months)

- Renewal of control and instrumentation systems,
- Renovation of reheaters and superheaters where damage is forecast to occur,
- Rehabilitation of equipment and ducts etc. where the rehabilitation of damage has not been completed during the first stage overhaul,
- Confirmation of output and efficiency etc., through performance tests after the overhaul.

③ Cleaning Overhaul (Required Time: approximately 1 month)

Even following the completion of rehabilitation work, since the heavy fuel oil (HFO) is low quality oil, soot and dust easily attach to the surfaces of various tubes and the inside of the boiler, and this leads to lower efficiency and shorter useful life of the boiler. Therefore, cleaning overhauls shall be periodically carried out (every six months).

During this cleaning overhauls, equipment data shall also be measured and used as reference in deciding the items and scope of future overhauls.

3) Katteneh Power Plant Unit No.6

① First Stage Overhaul (Required Time: approximately 3 months)

This will be a medium-size overhaul designed to determine all the regions and parts actually requiring rehabilitation. The following work items shall be implemented:

- Preparation of a detailed inspection implementation plan,
- Detailed inspection implementation,
- Request for dispatch of specialists from original equipment suppliers,
- Rehabilitation of equipment (pumps, fans and valves etc.) and ducts confirmed as being faulty during the detailed inspection,
- Confirmation of output and efficiency etc., through performance tests after the overhaul.

② Second Stage Overhaul (Required Time: approximately 5 months)

- Renewal of control and instrumentation systems,
- Renovation of reheater and superheater where damage is forecast to occur,
- Rehabilitation of equipment and ducts etc. where the rehabilitation of damage has not been completed during the first stage overhaul,
- Confirmation of output and efficiency etc., through performance tests after the overhaul.

③ Cleaning Overhaul (Required Time: approximately 1 month)

Even following the completion of rehabilitation work, since the heavy fuel oil (HFO) is low quality oil, soot and dust easily attach to the surfaces of various tubes and the inside of the boiler, and this leads to lower efficiency and shorter

useful life of the boiler. Therefore, cleaning overhauls shall be periodically carried out (every six months).

During this cleaning overhauls, equipment data shall also be measured and used as reference in deciding the items and scope of future overhauls.

4) Katteneh Power Plant Unit No.3, Unit No.4 and Unit No.5

① Approximately 25 years has passed since the start of operations in these units, and they were also subject to damage during the Middle East War of 1973. The extent of defects in the units is thus so great that output and heat efficiency levels cannot be restored to original levels. For this reason, it is proposed to install a new 200 MW unit that uses HFO and/or NG as fuel in place of the existing units.

(2) New Training Center Establishment Plan

Regarding the New Training Center Establishment Plan, the training courses, training schedules, training curriculums, organization and operation system etc. which were proposed in the Progress Report and Interim Report were confirmed and agreed by the Syria side.

Moreover, the Syria side agreed to the operation and maintenance expenses, the securing of instructors and other necessary staff, and the construction of the necessary facilities etc. which were indicated in the Interim Report, and the Syria side expressed its strong desire to have the New Training Center through Japan's grant aid in accordance with the proposals of the Study Team.

2.6.3 Seminar

A seminar, which was entitled "Rehabilitation and Maintenance Proposals for the Selected Power Plants" and was prepared based upon the rehabilitation proposals prepared by the Study Team from its Second Field Survey findings, was staged and about 20 officials and engineers from the Syria side attended.

2.6.4 Minutes of Discussions

The Minutes of Discussions held between the Study Team and the Syria side during the Third Field Survey are shown in Appendix 1-3.

2.7 Work in Japan (Third Stage)

In the third work in Japan, a Draft Final Report was prepared based upon the discusseion and agreed items with the Syria side during the Third Field Survey. The following sections describe the contents of the third work in Japan.

2.7.1 Preparation of Rehabilitation Plans for the Selected Power Plants

(1) Preparation of implementation plan

(2) Economic and financial analyses

(3) Preparation of recommendations : Integration of the study results relating to the Rehabilitation Plan

2.7.2 Preparation of the Training Center Establishment Plan

(1) Preparation of implementation plan

(2) Economic and financial analyses

(3) Preparation of recommendations : Integration of the study results relating to the Training Center Establishment Plan

2.7.3 Preparation of Draft Final Report

The Draft Final Report, consisting of Rehabilitation Plan for the Selected Power Plants and the New Training Center Establishment Plan, was prepared during the third stage work in Japan.

2.8 Fourth Field Survey

2.8.1 Contents of the Survey

The Fourth Field Survey was conducted from June 6 to June 20, 1995. During this period, the Draft Final Report, which was prepared during the third work in Japan, was presented and explained to the Syria side.

2.8.2 Minutes of Discussions

The Minutes of Discussions held between the Study Team and the Syria side during the Fourth Field Survey are indicated in Appendix 1-4.

2.9 Final Report Preparation

The Final Report is prepared based upon the results of the discussions held with the Syria side concerning the Draft Final Report during the Fourth Field Survey and upon the making of any necessary revisions. The Final Report is scheduled to be presented to the Syria side in the middle of August 1995.

CHAPTER 3

CONFIRMATION OF THE STUDY BACKGROUND

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, as is summarised in Table 3.1.1-1. The economic development during this period was inevitably affected by the political situation.

Table 3.1.1-1 5-Year National Economic and Social Development Plans, 1960 - 1990

5-Year Plan	Period	Summary
1st	1960 - 1965	During the period of federation with Egypt designed to consolidate the social infrastructure, the nationalisation of major banks and enterprises led to a much lower level of private sector investment than initially hoped for. The establishment of the Baath Party administration in 1963 established the power basis for subsequent governments but economic development stagnated with the investment performance remaining at 60% of the planned level.
2nd	1966 - 1970	Under the guidance of then East Germany, the plan was formulated based on the East European model. Due to the shortage of foreign currency and the break-out of the third Middle East War, etc., the investment performance remained at 70% of the planned level.
3rd	1971 - 1975	Due to the fourth Middle East War, the plan was temporarily suspended. With increased financial aid from other Arab countries, the resulting investment during the plan period totalled 12.7 billion Syrian pounds instead of the originally planned 8 billion pounds. The GDP growth rate achieved 10.7%, far exceeding the target 8.2%.
4th	1976 - 1980	Syria's military involvement in Lebanon in 1976 antagonised Persian Gulf countries, resulting in a drastic decline of the foreign currency reserves. The GDP growth rate during this period of 5.8% was low compared to the target 12%.
5th	1981 - 1985	The worsening international balance of payments, violent surge of Islamic Brotherhood and Israeli invasion of Lebanon deteriorated the political situation surrounding Syria. The GDP growth rate remained at 2.2% against the target 7.7%. The economic recession was particularly underlined by the negative growth of such key industries as agriculture, mining and manufacturing.
6th	1986 - 1990	Due to funding and other difficulties, the plan components stayed at the draft stage even in the final year of the plan period. The growing seriousness of the power supply and goods shortage made the investment plan for the public sector focus on these 2 aspects. Specific attention was also paid to the possibility of new oil field development to improve the international balance of payments.

Source: JICA Country Data on Syria in Fiscal 1993

(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. Table 3.1.1-2 indicates the target GDP growth rates in the Sixth 5-Year Development Plan.

Table 3.1.1-2 Target GDP Growth Rates of 6th 5-Year Plan (1985 prices)

(Unit: million Syrian pounds)

Sector	1985	Ratio (%)	1990	Ratio (%)	Proposed Growth Under 6th Plan (%)
Agriculture	17,309	19.59	24,585	20.98	7.30
Mining	6,008	6.80	9,580	8.17	9.80
Manufacturing	13,309	15.07	18,845	16.08	7.20
Power/Water	1,236	1.40	2,615	2.23	16.20
Construction	6,365	7.20	880	0.75	6.90
Commerce	18,861	21.35	25,980	22.17	6.60
Transportation/Communications	5,642	6.39	8,710	7.43	9.10
Finance/Insurance	4,515	5.11	5,810	4.96	5.20
Services	15,097	17.09	20,205	17.24	6.00
Total	88,342	100.00	117,210	100.00	8.26

Source: JICA Country Data on Syria in Fiscal 1993

(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.

Table 3.1.3-1 Gross Domestic Product at Market Prices by Sector, 1970 - 1992

(at current price and in million Syrian Pounds)

	1970	1975	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992*
Agriculture	1,382	3,706	10,369	13,854	15,627	14,805	17,463	23,816	32,479	56,575	49,548	76,514	94,367	110,587
Mining & Manufacturing	1,494	4,012	8,373	11,609	12,013	12,035	12,521	15,554	18,094	30,228	41,381	54,067	63,144	61,498
Building & Construction	202	963	3,574	4,327	4,460	5,006	5,693	6,692	6,692	7,177	8,172	10,128	12,163	14,132
Wholesale & Retail trade	1,396	4,604	12,693	16,846	17,813	17,702	18,509	20,045	31,716	45,690	52,845	60,875	66,251	87,816
Transport & Communication	732	2,407	3,555	5,513	5,968	6,254	8,196	9,883	11,770	16,830	21,974	25,542	29,819	33,723
Finance & Insurance	731	1,480	3,266	4,328	4,202	4,402	4,180	4,883	5,912	6,616	7,810	9,996	10,984	12,308
Social & Personal Services	116	279	926	1,407	1,468	1,818	2,195	2,734	3,168	3,861	3,891	4,986	6,024	6,973
Government Services	729	3,127	8,430	10,861	11,693	13,268	14,408	16,260	17,808	18,987	23,176	26,127	33,334	43,788
Private non-profit Services	18	19	34	43	47	52	60	66	73	83	95	103	118	135
Total	6,800	20,597	51,270	68,788	73,291	75,342	83,225	99,933	127,712	186,047	208,892	268,328	316,204	370,990

* Provisional

Source: Statistical Abstract 1993 Forty Sixth Year, Central Bureau of Statistics

Table 3.1.3-2 GDP Growth, 1970 - 1992

(at constant price of 1985, 1985=100)

	1970	1975	1980	1985	1990	1991	1992*
Agriculture	40	64	100	100	128	133	146
Mining & Manufacturing	38	61	77	100	149	158	167
Building & Construction	15	33	75	100	41	45	48
Wholesale & Retail trade	34	64	90	100	87	96	110
Transport & Communication	33	57	74	100	124	127	138
Finance & Insurance	49	78	114	100	94	99	108
Social & Personal Services	23	32	69	100	75	87	92
Government Services	27	60	86	100	76	87	95
Private non-profit Services	47	42	66	100	138	149	161
Total	33	58	84	100	108	116	125

* Provisional

Source: Statistical Abstract 1993 Forty Sixth Year, Central Bureau of Statistics

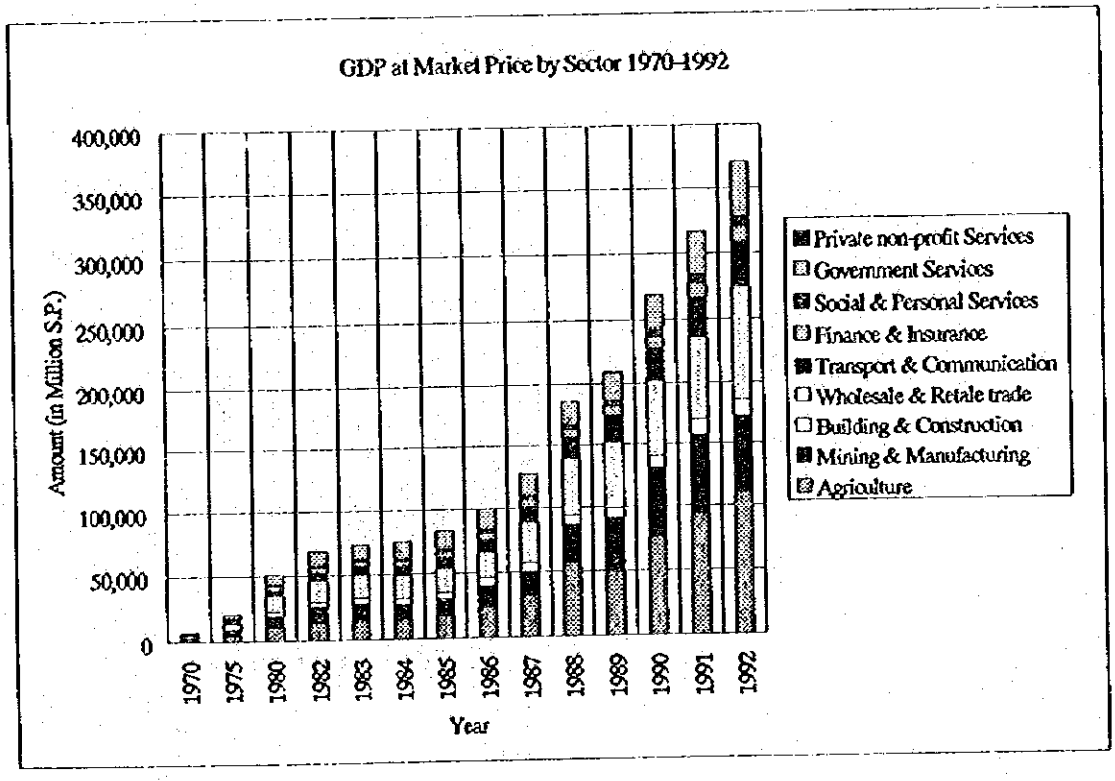


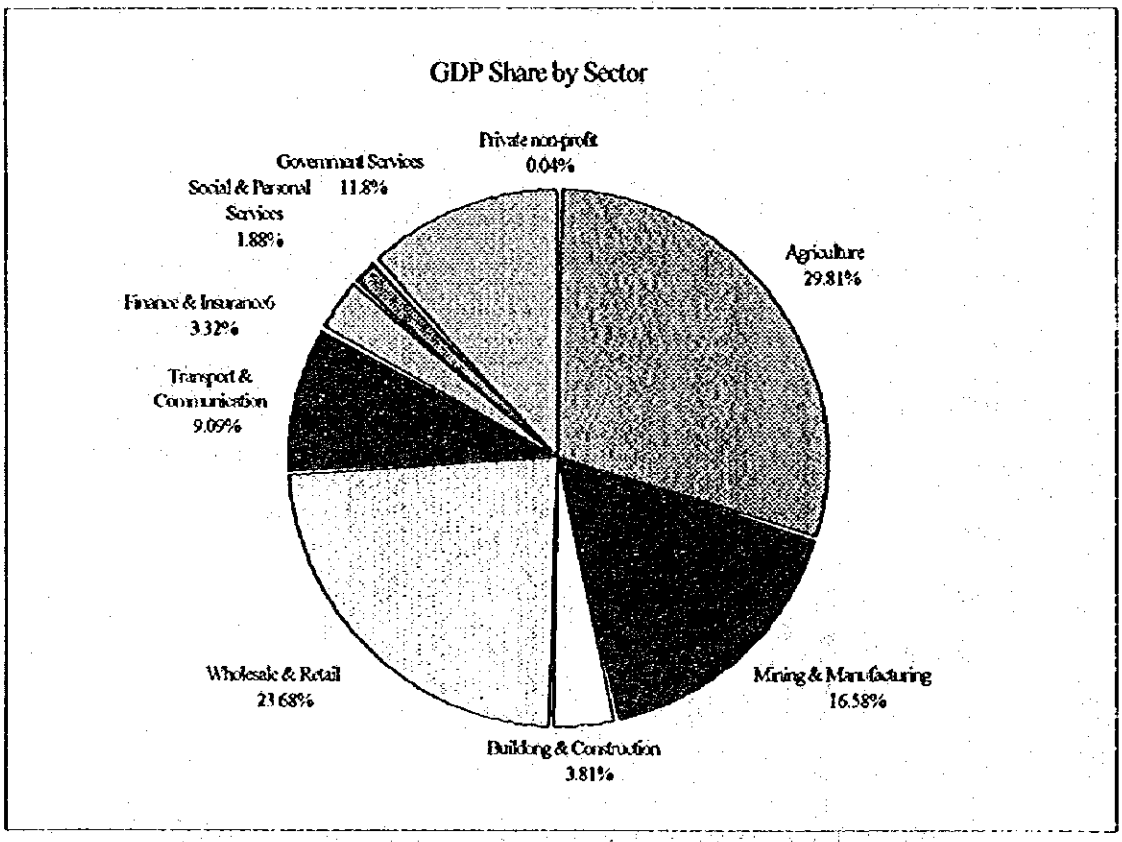
Fig. 3.1.3-1 GDP at Market Prices by Sector, 1970 - 1992

Table 3.1.3-3 Gross Domestic Product at Market prices by Sector, 1970 - 1992

(at current prices and in million Syrian pounds)

	1980	Share	1985	Share	1992	Share
Agriculture	10,369	20.22%	17,463	20.98%	110,587	29.81%
Mining & Manufacturing	8,373	16.33%	12,521	15.04%	61,498	16.58%
Building & Construction	3,574	6.97%	5,693	6.84%	14,132	3.81%
Wholesale & Retail Trade	12,693	24.76%	18,509	22.24%	87,846	23.68%
Transport & Communications	3,555	6.93%	8,196	9.85%	33,723	9.09%
Finance & Insurance	3,266	6.37%	4,180	5.02%	12,308	3.32%
Social & Personal Services	926	1.81%	2,195	2.64%	6,973	1.88%
Government Services	8,480	16.54%	14,408	17.31%	43,788	11.80%
Private Non-Profit Services	34	0.07%	60	0.07%	135	0.04%
Total	51,270	100.00%	83,225	100.00%	370,990	100.00%

Source: Statistical Abstract 1993 Forty Sixth Year, Central Bureau of Statistics



Source: Statistical Abstract 1993 Forty Sixth Year, Central Bureau of Statistics

Fig. 3.1.3-2 GDP Share by Sector, 1992

Table 3.1.3-4 GDP Per Capita, 1980 - 1992

Item	1980	1985	1990	1992
Population at Mid Year	8,704,000	10,267,000	12,116,000	12,956,000
GDP at Market Price (M.S.P.)	51,270	83,225	268,328	370,990
GDP Per Capita in S.P.	5,890	8,106	22,147	28,630
Exchange Rate per US$	3.93	—	11.23	11.23
GDP Per Capita in US$	1,501	—	1,973	2,551

Source: Statistical Abstract 1993 Forty Sixth Year, Central Bureau of Statistics

3.1.4 Power Demand Forecast

The power demand is usually forecast by the following methods.

(1) Accumulation of the demand by sector and application based on fact-finding survey results (short-term forecast).

(2) Forecasting by extending the power demand trend in the past to the future (short-term forecast).

(3) Using the almost proportional correlation between the power demand and unit price of power as well as the GDP index, forecasting of the likely demand based on the unit price of power and GDP index (medium-term forecast).

(4) Macroeconomic forecast taking the income elasticity as well as price elasticity of the power demand into consideration (long-term 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. As a result, it was impossible to reliably forecast the power demand using the above methods.

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 (see Table 3.1.4-2) 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

Table 3.1.4-2 Power Demand in Last 30 Years

Year	Installed Capacity (MW)	Peak Load (MW)	Peak Load (%)	Power Demand (GWH)	Power Demand (%)
1964	0	0	–	370	–
1965	171	0	–	415	12.2
1966	180	0	–	443	6.7
1967	175	0	–	450	1.6
1968	173	0	–	498	10.7
1969	264	0	–	593	19.1
1970	267	174	–	777	31
1971	269	175	0.6	914	17.6
1972	285	190	8.6	1,051	15
1973	274	192	1.1	1,010	3.9
Average (1964 - 1973)			3.4		12.2
1974	675	255	–	1,132	–
1975	755	292	14.5	1,353	19.5
1976	984	302	3.4	1,628	20.3
1977	1,134	390	29.1	2,009	23.4
1978	1,502	511	31	2,440	21.5
1979	1,673	635	24.3	3,114	27.6
1980	1,727	770	21.3	3,637	16.8
1981	1,722	876	13.8	4,378	20.4
1982	1,887	1,090	24.4	5,315	21.4
1983	2,052	1,132	3.9	6,219	17
Average (1974 - 1983)			18.4		20.9
1984	2,050	1,318	–	6,755	–
1985	2,050	1,420	7.7	7,513	11.2
1986	2,050	1,460	2.8	8,250	9.8
1987	2,100	1,550	6.2	8,500	3.0
1988	2,100	1,650	6.5	9,100	7.1
1989	2,160	1,870	13.3	10,300	13.2
1990	2,220	1,928	3.1	10,907	5.9
1991	2,193	2,028	5.2	11,663	6.9
1992	2,193	1,982	2.3	12,055	3.4
1993	2,375	2,032	2.5	12,071	0.1
Average (1984 - 1993)			5.0		6.7

3.2 Power Supply System Improvement Plan

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 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

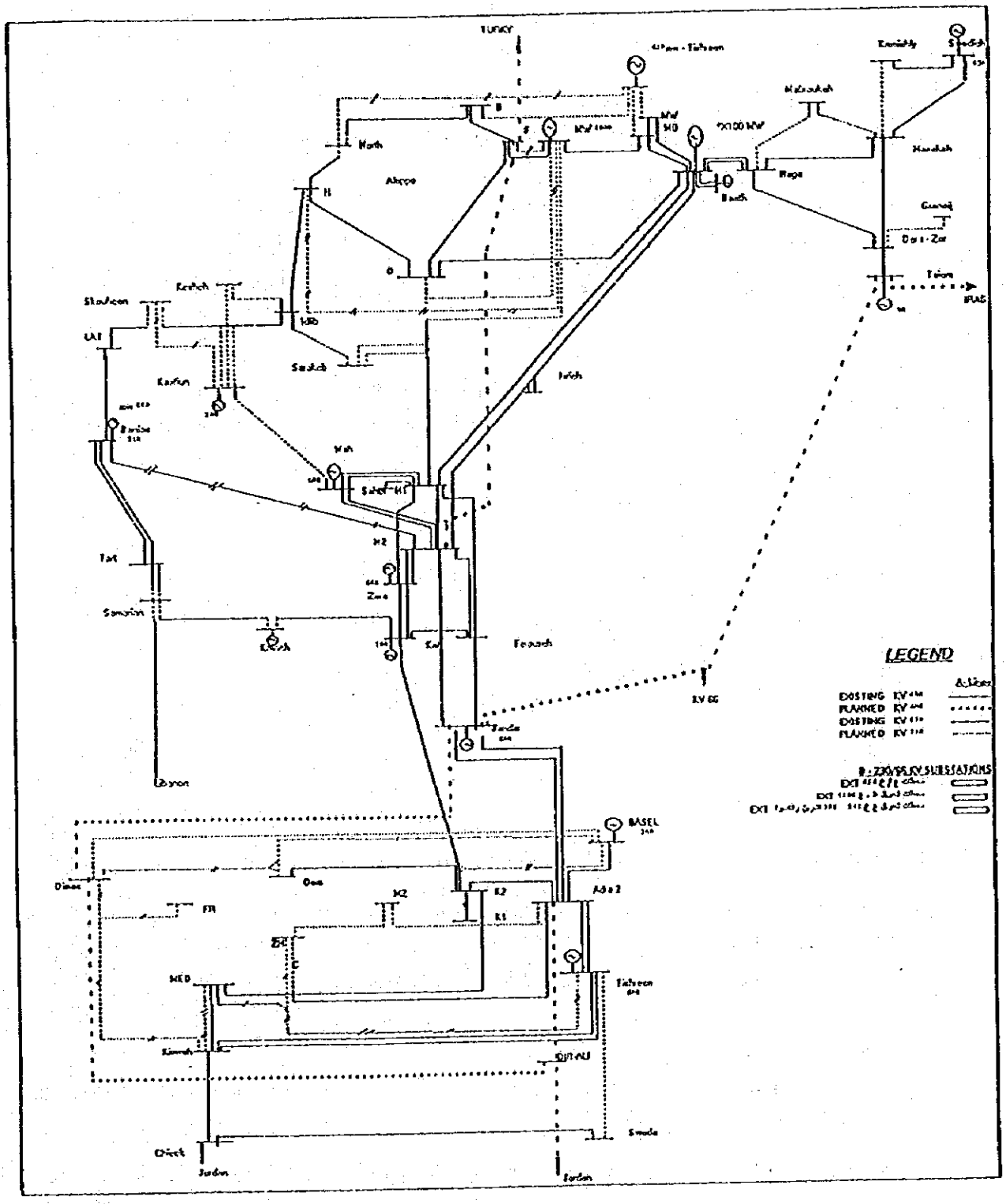
HFO: Heavy Fuel Oil NG: Natural Gas DO: Distillate Oil

The main power plants are the Thawa Hydropower Plant (8 × 100 MW), Mehardeh Thermal Power Plant (2 × 150 MW + 2 × 165 MW), Banias Thermal Power Plant (4 × 170 MW), Katteneh Thermal Power Plant (154 MW), Swedieh Gas Turbine Power Plant (5 × 30 MW) and Tayem Gas Turbine Power Plant (3 × 30 MW), both of which were commissioned in the period between 1988 and 1990, and Tishreen Thermal Power Plant (2ST × 200 MW + 2GT × 100 MW) commissioned in 1993. These 7 plants account for approximately 80% of the nominal capacity. The respective shares of hydro and thermal power generation are 25.1% for the former and 74.9% for the latter.

(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. The transmission grids are shown in Fig. 3.2.1-1.

Fig. 3.2.1-1 Power Transmission Grids in Syria



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

(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. (The Banias Power Plant is said to be an exception where the technical training of operation staff is actively conducted through OJT. However, the scope of training for maintenance staff is said to be limited.)

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 Plant Development Plan

3.3.1 New Power Plant Construction Plan

As already referred to in 3.2, the PEEGT plans to expand the nominal generation capacity by 3,430 MW by the end of 1997. 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 and work has begun.

3.3.2 Financial Plan

The current construction of the Jandar Combined Cycle Power Plant is being advanced through funding from the Overseas Economic Cooperation Fund (OECF) of Japan, while work on the Aleppo Thermal Power Plant is being advanced through a loan from Saudi Arabia.

It is considered difficult for Syria to cover the costs of construction of other power plants through its own finances, and it is in the situation where it must rely on foreign loans when compiling construction plans.

At present, talks are being advanced on the construction of the Al-Zara Thermal Power Plant (two 300 MW turbines), which is currently in the planning stage, through the provision of OECF funds. Currently, the OECF is studying this, however, no final decision has yet been made.

3.3.3 Relationship Between New Plants and Rehabilitated Plants

The construction of the planned new power plants is proceeding smoothly, and as was mentioned previously, construction of the Jandar Power Plant (600 MW) is scheduled to be completed by the end of 1995. Moreover, work on Aleppo Thermal Power Plant (1,000 MW) and the Tishreen Dam Hydropower Plant (630 MW) is expected to commence soon, and these two plants are scheduled for completion some time in 1997 or 1998.

The completion of these new power plants will provide a surplus nominal power generation capacity in Syria and will greatly help the operation of the existing power plants. To be more precise, the failure in the past to increase the nominal generation capacity in line with the demand increase meant that major power plants could not conduct the necessary shut-down for periodic inspection and maintenance purposes, resulting in de-rating of the generation facilities of these power plants. With the availability of a surplus generation capacity in the near future, the existing power plants will be able to shut-down and receive inspection and maintenance.

The systematic shut-down of the existing major power plants for thorough inspection, repair and rehabilitation purposes means a recovery of the rated generation capacity of these power plants which will in turn create the opportunity for the new power plants to also shut-down their operations to conduct proper periodic inspection and maintenance work. The end result of this virtuous cycle will be the improved reliability of the entire power supply system in Syria.