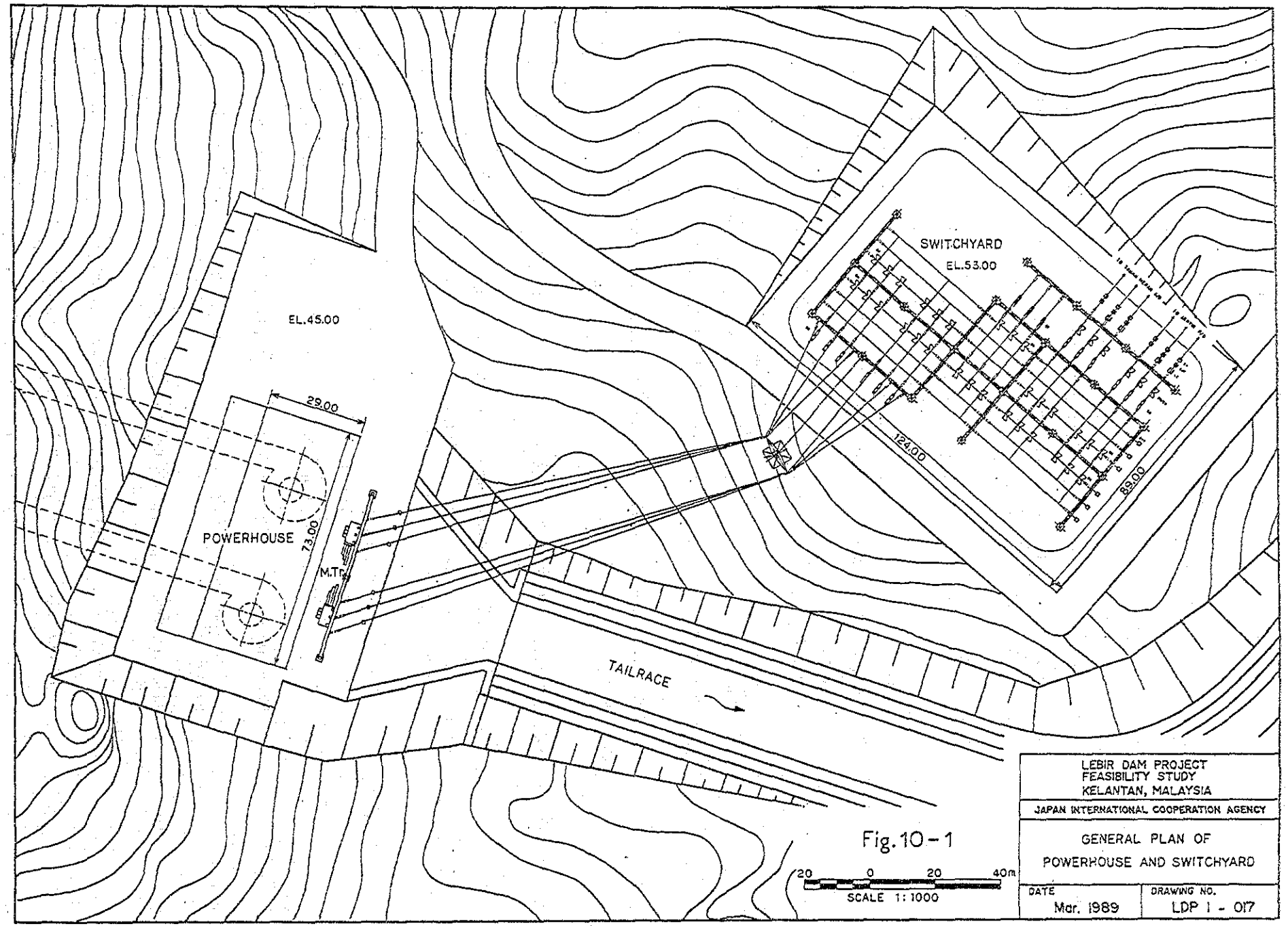
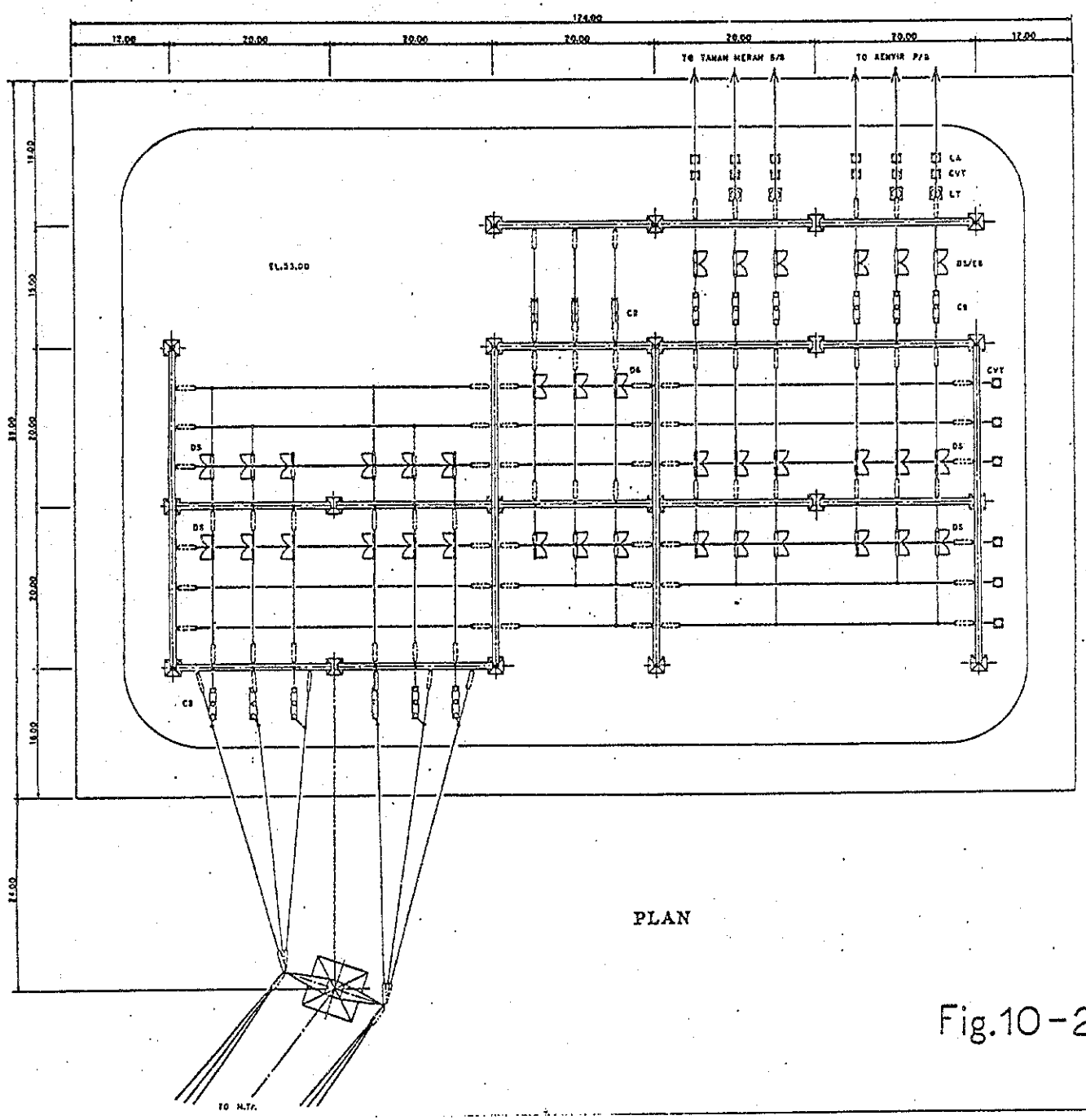

SWITCHYARD
EL.53.00
EL.45.00
29.00
POWERHOUSE
73.00
M.Tr.
124.00
89.00
TAILRACE
20 0 20 40m
SCALE 1:1000
LEBIR DAM PROJECT
FEASIBILITY STUDY
KELANTAN, MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY
GENERAL PLAN OF
POWERHOUSE AND SWITCHYARD
DATE
Mar. 1989
DRAWING NO.
LDP 1 - 017

Fig. 10-1



PLAN

Fig.10-2

LEBIR DAM PROJECT
FEASIBILITY STUDY
KELANTAN, MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

SWITCHYARD
PLAN

DATE	DRAWING NO.
Mar. 1989	LDP I - 018

SYMBOLS

- GENERATOR
- SPEED SIGNAL GENERATOR
- M.Tr. MAIN TRANSFORMER
- Ex.Tr. EXCITER TRANSFORMER
- GROUNDING
- CB CIRCUIT BREAKER
- DS DISCONNECTING SWITCH
- - Ditto - (WITH EARTHING SWITCH)
- DS/ES
- VT VOLTAGE TRANSFORMER
- CVT CAPACITOR VOLTAGE TRANSFORMER
- CVT - Ditto - (WITH TERTIARY WINDING)
- CT CURRENT TRANSFORMER
- BCT BUSHING CURRENT TRANSFORMER
- ZCT ZERO-SEQUENCE CURRENT TRANSFORMER
- METER OR INSTRUMENT SWITCH FOR VT CIRCUIT
- - Ditto - FOR CT CIRCUIT
- AMMETER SHUNT
- MAKE CONTACT
- THYRISTOR
- RECTIFIER
- NGR NEUTRAL GROUND RESISTOR
- LT LINE TRAP
- LA LIGHTNING ARRESTER
- SA SURGE ABSORBER
- AVR AUTOMATIC VOLTAGE REGULATOR
- GOV GOVERNOR
- CABLE HEAD
- I.P.B. (ISOLATED PHASE BUS)

- A AMMETER
- V VOLTMETER
- W WATTMETER
- VAR VARMETER
- Hz FREQUENCY METER
- PF POWER FACTOR METER
- SPEED METER
- SYN SYNCHROSCOPE
- Hz FREQUENCY RECORDING METER
- V VOLT RECORDING METER
- Wh WATTHOUR METER
- VARh VARHOUR METER
- OSC AUTOMATIC OSCILLOGRAPH
- I CURRENT TRANSDUCER
- V VOLT TRANSDUCER
- W WATT TRANSDUCER
- VAR VAR TRANSDUCER

- 31 CONTACTOR FOR EXCITATION POWER SOURCE
- 41 FIELD-CIRCUIT BREAKER
- CARRIER RELAY
- LTU LINE TUNING UNIT
- PLC POWER LINE CARRIER

- 12 OVERSPEED DEVICE
- 14 SYNCHRONOUS SPEED DEVICE
- 15 UNDERSPEED DEVICE
- - Ditto - FOR DETECTING STANDSTILL
- 15 AUTOMATIC SPEED MATCHING DEVICE
- 25 SYNCHRONISM CHECK DEVICE
- 60 VB VOLTAGE BALANCE RELAY
- 27 AC UNDERVOLTAGE RELAY
- - Ditto - FOR PHASE SELECTION
- 40 LOSS-OF-FIELD RELAY
- 44S DIRECTIONAL DISTANCE RELAY FOR INTERNAL DIRECTION FAULT
- - Ditto - FOR EXTERNAL DIRECTION FAULT
- 44OS OUT-OF-STEP DISTANCE RELAY
- 44G GROUND DISTANCE RELAY
- 51 AC OVERCURRENT RELAY
- - Ditto - (NEUTRAL-POINT USE)
- - Ditto - (MAIN TRANSFORMER USE)
- - Ditto - (M.Tr. SECONDARY USE)
- - Ditto - (EXCITER TRANSFORMER)
- - Ditto - (GENERATOR USE)
- 51G GROUND OVERCURRENT RELAY (GENERATOR USE)
- - Ditto - (HIGH-SETTING)
- - Ditto - (LOW-SETTING)
- 87 AUTOMATIC CURRENT RELAY
- 59 AC OVERVOLTAGE RELAY (GENERATOR USE)
- 64B GROUND OVERVOLTAGE RELAY (BUSBAR USE)
- 64E - Ditto - (EXCITATION CIRCUIT USE)
- 64G VOLTAGE RELAY (GENERATOR USE)
- 64B - Ditto - (BUSBAR USE)
- 87 DIFFERENTIAL RELAY (MAIN TRANSFORMER USE)
- 87BB BUSBAR PROTECTION RELAY OF CURRENT DIFFERENTIAL TYPE FOR A-BUS ZONE OR B-BUS ZONE USE
- 87BT BUSBAR PROTECTION RELAY OF VOLTAGE DIFFERENTIAL TYPE FOR TOTAL ZONE USE
- 87G GROUND DIFFERENTIAL RELAY (GENERATOR USE)
- 32 POWER RELAY

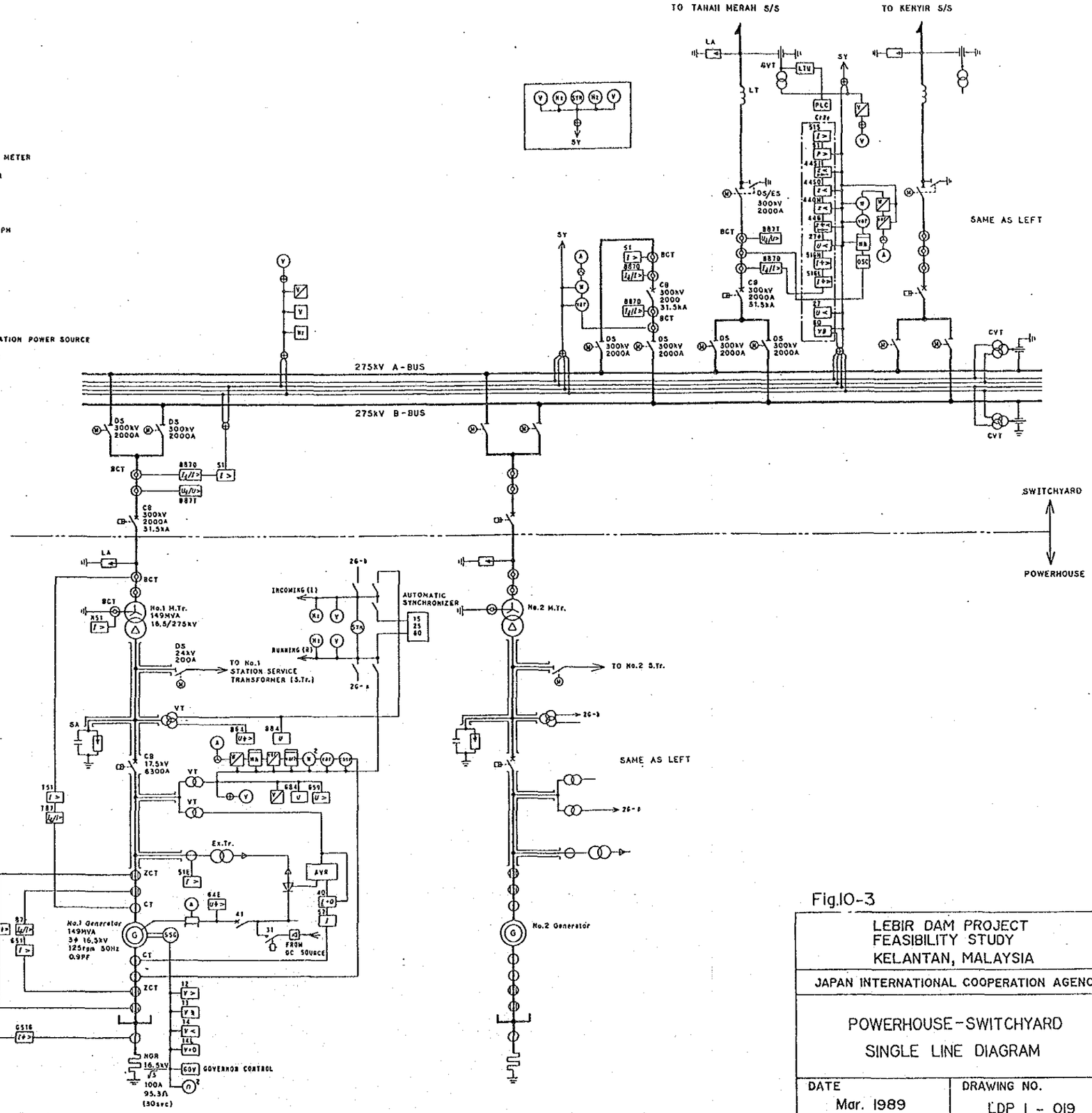
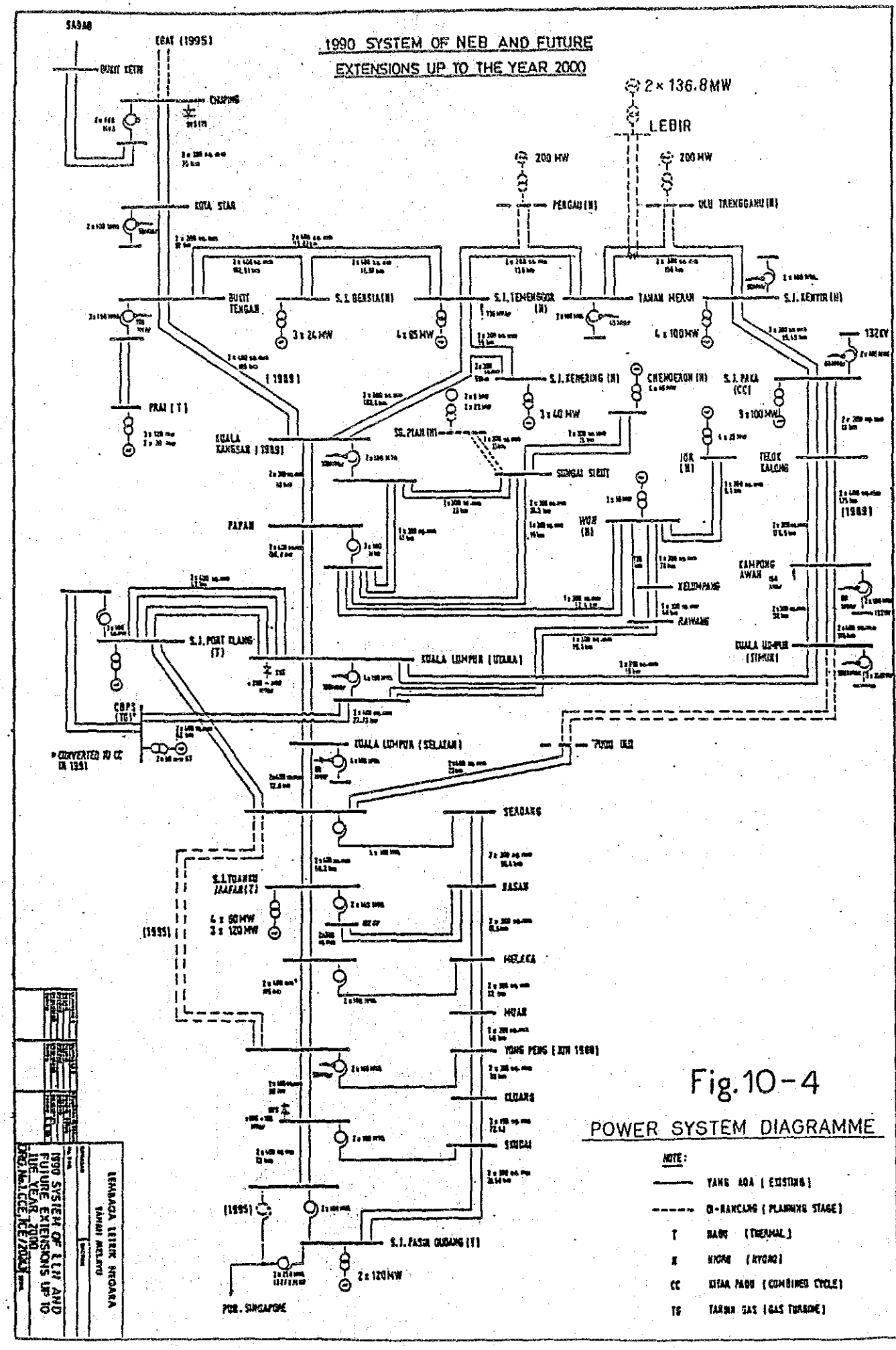


Fig.10-3

LEBIR DAM PROJECT FEASIBILITY STUDY KELANTAN, MALAYSIA	
JAPAN INTERNATIONAL COOPERATION AGENCY	
POWERHOUSE-SWITCHYARD SINGLE LINE DIAGRAM	
DATE Mar. 1989	DRAWING NO. LDP I - 019


1990 SYSTEM OF NEB AND FUTURE
EXTENSIONS UP TO THE YEAR 2000
SABAH
GBAT (1995)
BUKIT KETRI
CHUPING
KOTA STAR
2 × 136.8MW
LEBIR
200 MW
200 MW
PERGAU (H)
ULU TRENGGANU (H)
BUKIT TENGAH
S.I. GERSIA (H)
S.I. TEMENGOR (H)
TANAH MERAH
S.I. KENTIR (H)
3 x 24 MW
4 x 65 MW
4 x 100MW
132 KV
(1988)
PRAI (T)
KUALA KANGSAR (1988)
S.I. KEMERING (H)
CHENDEROH (H)
S.I. PAKA (CC)
3 x 40 MW
9 x 100MW
SG. PIAH (H)
SUNGAI SIPUT
JOR (H)
TELOK KALONG
(1988)
PAPAN
WOH (H)
KAMPONG AWAN
KELUMPANG
RAWANG
S.I. PORT KLANG (T)
KUALA LUMPUR (UTARA)
KUALA LUMPUR (TIMUR)
CCPS (TG)*
* CONVERTED TO CC IN 1991
KUALA LUMPUR (SELATAN)
PUDU ULU
SEREMBAN
S.I. TUANKU JAAFAR (T)
SASAR
4 x 60 MW
3 x 120 MW
(1995)
MELAKA
MUAR
YONG PENG (JUN 1988)
KLUANG
SEDENAK
(1995)
S.I. PASIR GUDANG (T)
2 x 120 MW
PGB. SINGAPORE
LEMBAGA LETRIK NEGARA
1990 SYSTEM OF L.L.N. AND FUTURE EXTENSIONS UP TO THE YEAR 2000
DRG. No. LCCE/TCE/2000/1
Fig. 10-4
POWER SYSTEM DIAGRAMME
NOTE :
YANG ADA (EXISTING)
DI-RANCANG (PLANNING STAGE)
T THERMAL (THERMAL)
H HYDRO (HYDRO)
CC KITAR PADU (COMBINED CYCLE)
TG TARBIN GAS (GAS TURBINE)

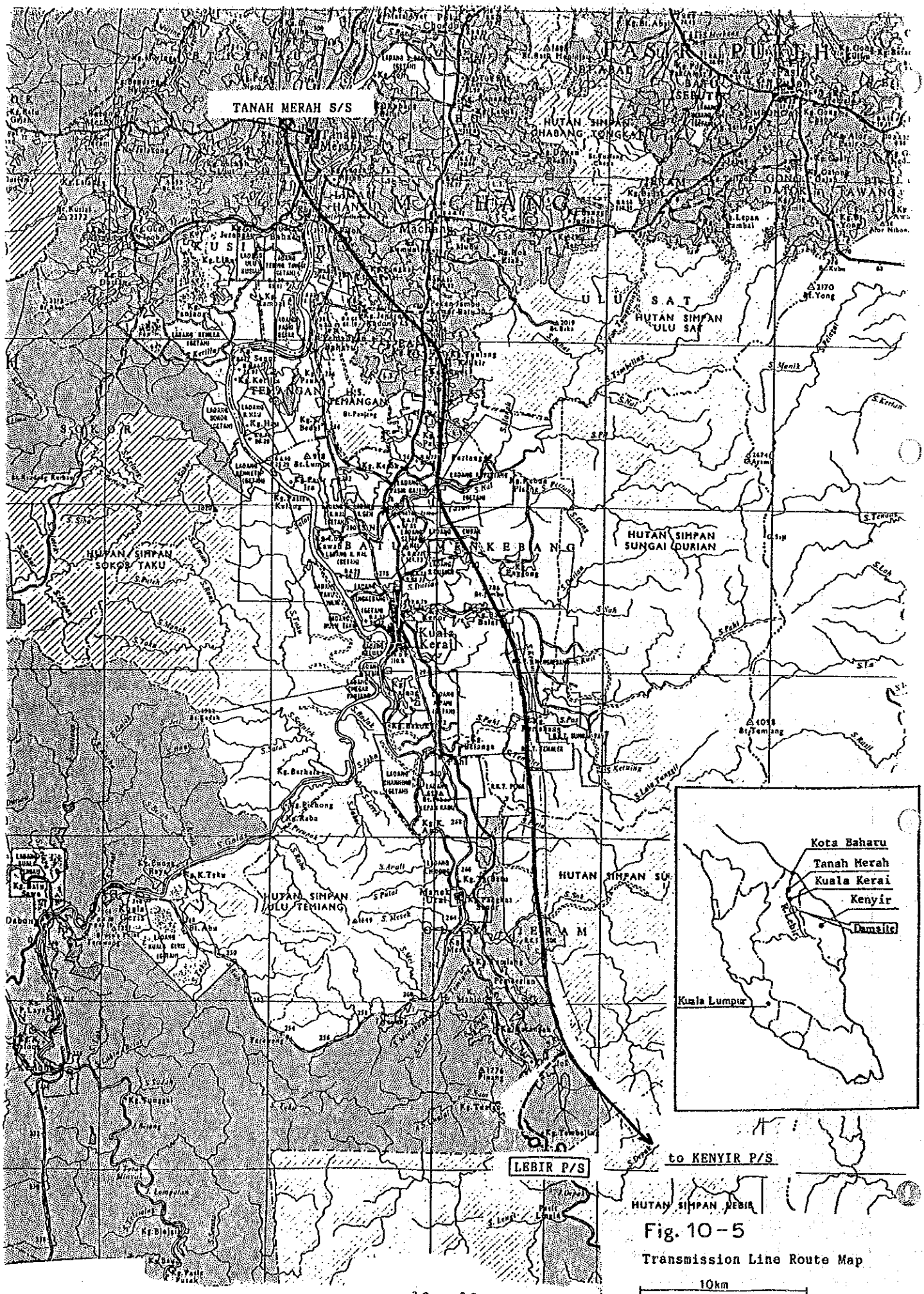
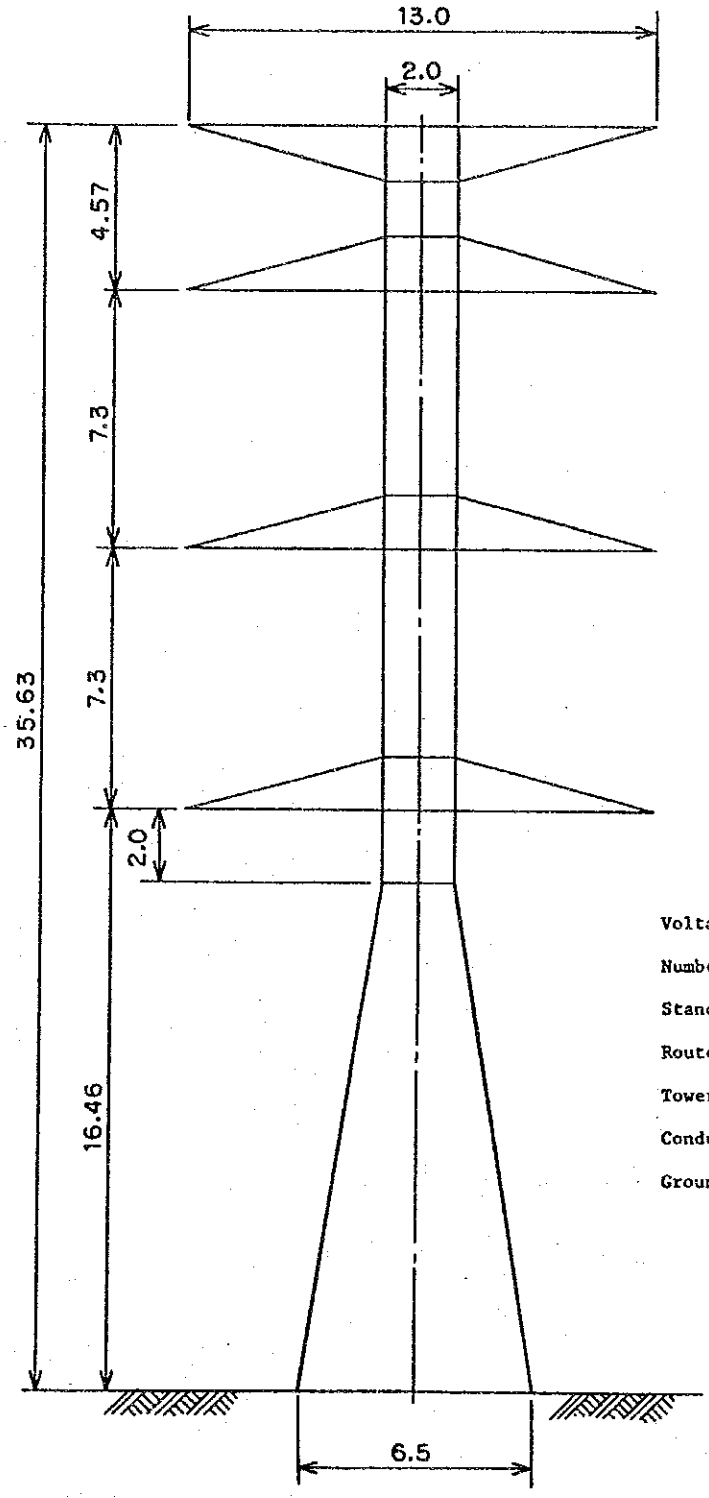


Fig. 10-5

Transmission Line Route Map



(Unit : m)

Voltage	: 275 kV
Number of circuits	: 2
Standard span length	: 300 m
Route length	: Approx.7 km
Tower	: Steel tower
Conductor	: Batang (ACSR 323mm^2)x2
Ground wire	: Skunk (ACSR 63mm^2)

Fig.10-6

Typical Tower Assembly
(light angle type)

11. Environmental Problems

(Refer to Volume 2)

12. Construction Schedule and Project Implementation Programme

12. Construction Schedule and Project Implementation Programme

The implementation programme of the Lebir Dam Project is presented below and shown in bar chart in Fig.12-0-1.

The main activities to be carried out towards the completion of the Project are listed hereunder.

Year	Activities to be carried out
1989	Review of feasibility study report and decision on the implementation of the Project.
1990	Financial arrangements for the project costs, selection of the consultant for detailed design and relocation programme for the upstream farm lands to be submerged.
1991	Detail design and preparation of tender documents for the main works, design of the preparatory works and commencement of the preparatory arrangement for resettlement of the upstream farm lands to be submerged.
1992	Prequalification of tenderers and calling of tenders for the main works, and commencement of the preparatory works.
1993	Evaluation of tenders for the main works and contract negotiation, and implementation of the preparatory works.
1994	Commencement of the main works.
1995	Implementation of the main works.
1996	Implementation of the main works and construction of the relocation roads, and implementation of the environmental measures.
1997	Commencement of impoundment of the dam.
1998	Commencement of operation of the power plant and environmental monitoring.

12.1. Detail Design and Preparation of Tender Documents

Detail design and preparation of tender documents for the main works are scheduled to commence in January, 1991 and to be complete within 21 months. The main works include the following:

- Main dam (including spillway, diversion tunnel and quarry site)
- Saddle dams (Saddle Dam I and Saddle Dam II)
- Waterway, powerhouse and switchyard
- Electro-mechanical equipment
- Transmission line related works
- Penstock, gates and valves
- Hydrological telemetering and downstream discharge warning systems

For implementation of the above design works, the Malaysian authority appointed as implementation agency is recommended to employ foreign and local consultants having appropriate experience in these fields of work.

The time schedule for detail design and preparation of tender documents is shown in Fig.12-1.1. The following are the main works to be carried out.

- Field Investigation

  . Production of aerial survey map (410 km^2).
  The existing aerial survey map of 1979 is not sufficiently up-to-date, since land development after 1979 has been extensive. A new aerial survey map is required covering the land development of the submerged area.

  . Production of topographical map (1.0 km^2, 7 km)
  In terms of the main structures, mapping supplemental to that of the topographical map produced in 1987 is required to be produced. Additional survey works on transmission line route related to the project, shall also be included.

  . Drilling investigation (104 holes, 4,300 m) and adit investigation (7 adits, 360 m)
  To be carried out at the main dam, Saddle Dam I, and the quarry sites

. Laboratory testing

Various tests on the construction materials (rock, soil, cement, concrete, water, etc.)

. Hydraulic model tests

Hydraulic model tests on the water intake and spillway are to be carried out.

- Various Analyses

Structural, hydraulic, electrical, etc. analyses required for detail design are to be carried out.

- Preparation of detail design drawings.

- Preparation of bill of quantities and breakdown of the construction cost estimate.

- Implementation of the prequalification of tenderers.

- Preparation of tender documents
  . Instructions to tenderers
  . General conditions of contract
  . Particular conditions of contract
  . Technical specifications
  . Bill of quantities
  . Data and information on the field investigations

12.2. Preparatory Works

Preparatory works should be completed prior to the commencement of the main works. Design of preparatory works is planned to be carried out by the local consultant appointed by the implementing agency, with assistance from the foreign consultant for main works during the course of design.

The time schedule for preparatory works is shown in Fig.12-1-1 and its work items are as follows;

- Access road (from Tualang to the left bank of dam)	3 km
- Relocation of logging road	8 km
- Construction of power transmission line for construction use (from Kuala Kerai to the Site)	60 km
- Base camp facilities for the owner	2,500 m^2 (buildings inclusive)
- Communication facilities (in/outside the site)	1 unit

12.3. Procurement of Contracts

The main works contractors are planned to be selected by international tender. Thus, tender documents required for international tender are prepared in accordance with the method mentioned in Section 12.1. Since such contracts are for major works to be carried out in a project area which has complex geological and other site conditions, contractors must show that they have experience of similar work and conditions. On this basis, the prequalification will be carried out.

For the preparatory works and the environmental measures, local contractors are to be employed.

12.4. Construction Schedule of Main Works

The construction schedule for the main items of work is given in Fig.12-4-1. This is based on an April 1994 start of construction, and a period of 50 months from this date up to the date when the two generation units are brought into operation.

The following shows the main events during construction.

- April, 1994 : Commencement of the main works.
- September, 1995 (18th month) : Start of installation of steel liner in the waterway tunnel.
- February, 1996 (22nd month) : Start of river diversion.

- July, 1996 (27th month) : Commencement of the main dam embankment.
- October, 1996 (30th month) : Start of installation of the overhead travelling crane at the powerhouse.
- November, 1997 (44th month) : Start of reservoir impounding.
- April, 1998 (49th month) : Start of operation of Unit No.1.
- June, 1998 (50th month) : Start of operation of Unit No.2.

(1) Access road and temporary facility

If the preparatory works (ref. Section 12.2.) are completed prior to the commencement of the main works scheduled in April, 1994, there need be no delay to the main contractors who can immediately start their construction of on-site roads and temporary facilities required for the construction of the main works.

The main on-site roads include access roads to, the intake, outlet of the diversion tunnel, the quarry site, the intake from the powerhouse site, and the transportation roads to the dam from the quarry site and the borrow area.

Main temporary facilities include an aggregate plant, batching plant and assembling and repair workshop for machinery. These works are scheduled to be completed before February, 1995 (10th month).

(2) Development of quarry site

The proposed quarry site is located on the right bank of the Lebir River, and about 1.5 km north-east of the dam site. A logging road passes near EL.85 m and the highest elevation of the proposed quarry site is EL.230 m. A yield of 5 x $10^6 m^3$ of rock is expected to be available by developing about 16 ha (400 m x 400 m) up to the elevation of EL.115 m.

The bench height would be 15 m and there would be a maximum of 6 steps. The quarry area at the lowest foundation of EL.115 m would be 325 m wide and 300 m long.

Construction of the access road and the stripping and clearing are carried out within a period of two months. This work follows a mobilization period of one month after contract award.

During the next 5 months common excavation of 1,250,000 m^3 is carried out prior to quarrying, which is then planned to continue for the next 40 months.

5,000,000 m^3/40 months = 125,000 m^3/month
At the peak, 250,000 m^3/month is quarried.
Thus, an output of 10,000 m^3/day is required.

(3) Diversion tunnels

Two circular diversion tunnels each approx. 580 m long, of 14 m diameter, and 154 m^2 cross-section, are constructed in the right bank abutment of dam. Tunnels No.1 and No.2 are excavated simultaneously from the both ends (4 cut faces), to minimize the construction period for excavation. The excavation method envisaged is by a top heading and bench.

Tunnel excavation is started 5 months after the commencement of work on-site. The 5 months is made up of 1 month for mobilization, 1 month for construction of the access road, and 3 months for open excavation.

Upper-half tunnel excavation

The excavation involves the use of two 5-boom jumbos each having a capacity per round = 3.0 m. One is deployed upstream and one downstream. The single jumbo at each end serves both tunnels. Two blastings per day are carried out by each Jumbo unit.

Monthly progress : 75 m/cut face/month x 4 cut faces = 300 m/month

Daily progress : 3.0 m/cut face/day x 4 cut faces = 12m/day

Excavation period : 4 months

Lower half tunnel excavation

The same method as mentioned above is adopted. However, four blastings per day are carried out by each jumbo unit.

Monthly output : 150 m/cut face/month x 4 cut faces = 600 m/month

Daily output : 6 m/cut face/month x 4 cut faces = 24 m/month

Required period : 2 months

Concreting

Two units of 10 m shutter are used.

Concreting (453 m^3/shift)	15 hrs.
Curing	33 hrs.
Removal of form	1 day
Assembling of form	2 days
One cycle =	5 days

Monthly output : 60 m/shutter/month x 2 shutters = 120 m/month

Concreting period: 9.7 months

(4) Saddle dams

Saddle Dam I has an excavation volume of 870,000 m^3 and embankment volume of 1,400,000 m^3. Those for Saddle Dam II are 200,000 m^3 and 740,000 m^3 respectively. Diversion tunnels are not required for either of the dams. Excavation of Saddle Dam II starts from the 9th month after commencement of the main works when the diversion tunnel works of the main dam are fairly well under way. Excavation for Saddle Dam I is to start when the embankment of Saddle Dam II becomes possible, and the excavated soils can be incorporated in the embankment of Saddle Dam II. The embankments of both dams are scheduled to be completed before commencement of the main dam embankment.

Excavation of Saddle Dam II

Total volume	:	V = 195,100 m^3
Monthly output	:	2,800 m^3/month
Required period	:	7 months

Excavation of Saddle Dam I and embankment of Saddle Dam II

Total volume	:	V = 868,100 m^3
Monthly output	:	79,000 m^3/month
Daily output	:	3,200 m^3/day
Required period	:	11 months

Embankment of Saddle Dam I

Total volume	:	V = 1,395,500 m^3
Monthly output	:	140,000 m^3/month
Daily output	:	5,600 m^3/day
Required period	:	10 months

(5) Main dam

The upstream cofferdam is to be included as a part of the main dam and has an excavation volume of 130,000 m^3, and embankment volume of 500,000 m^3. Besides, those for the downstream are 50,000 m^3 and 150,000 m^3 respectively.

These works shall start on February, 1996 (22nd month) when the river is diverted into the tunnels, and are to be completed within 5 months (during dry season).

Excavation of the main dam starts 1.5 months later, after diversion of the river. Within 3.5 months thereafter, its volume is to reach 360,000 m^3 in order that embanking may be commenced.

Excavation

Total volume	:	V = 356,200 m^3
Monthly output	:	100,000 m^3/month
Daily output	:	4,000 m^3/day
Required period	:	3.5 months

Embankment

. Core

Total volume	:	V = 391,600 m^3
Monthly output	:	27,000 m^3/month
Daily output	:	1,100 m^3/day
Required period	:	14.5 months

. Filter

Total volume	:	V = 321,200 m^3
Monthly output	:	19,500 m^3/month
Daily output	:	800 m^3/day

. Rock

Total volume	:	V = 1,649,200 m^3
Monthly output	:	100,000 m^3/month
Daily output	:	4,000 m^3/day

(6) Waterway and powerhouse

Initially, excavations of 240,000 m^3 at the powerhouse and 1,040,000 m^3 in front of power intake are carried out. After completion of the excavation at the front of the power intake, two waterway tunnels will be excavated simultaneously from the upstream side. The upper tunnels have a total length of 370 m in the two lines. When the powerhouse excavation has reached EL.17.4 m, excavations of two lower tunnels having a total length of 33 m will be commenced. Thereafter, two inclined tunnels of 101 m total length will be excavated and this completes the excavation of the waterway tunnels.

Excavation of upper and lower tunnels (403 m long in total)

A 5-boom jumbo unit used in the excavation of the diversion tunnels will be improved and adapted for use in the waterway tunnels excavation. 0.5 months is allowed for the jumbo modification.

Progress per round of 3 m is expected in each tunnel.

Monthly output : 75 m/cut face/month x 2 cut faces = 150 m

Daily output : 3 m/cut face/month x 2 cut faces = 6 m

Required period : 3 months

Excavation of inclined shafts (101 m long in total)

Pilot shaft : 0.5 months

Enlargement of shaft: 0.5 months

Excavation of gate shafts (88 m long in total)

Pilot shaft : 0.5 months
Enlargement of shaft: 0.5 months

Using crawler drills, a daily progress of 3 m/cut face is expected, and two shafts are simultaneously excavated.

Installation of steel liners

Lower horizontal portions	33 m
Bending liners	70 m
Inclined shafts	31 m
Upper horizontal portions	7 m
Total length for two liners	141 m

Installation and concrete back-filling works will be carried out independently of the powerhouse excavation, work proceeding in an upstream direction.

Monthly output : 26 m/month
Required period : 5.5 months

Concreting of tunnels

Total length of concrete lining for two tunnels is 245 m.

Two units of 6 m shutter will be used, and cycle time of 5 days is estimated.

245 m/6 m x 5 days/(2 tunnels x 25 days) = 4.1 months

Excavation of powerhouse

Common	:	73,700 m^3
Rock	:	161,300 m^3
Total	:	235,000 m^3
Monthly output	:	14,000 m^3/month
Daily output	:	553 m^3/day
Required period	:	17 months

- Common excavation

Monthly output	:	66,000 m^3/month
(8 hrs x 330 m^3/hr x 25 days = 66,000 m^3/month)		
Required period	:	2 months

- Rock excavation

Monthly output	:	18,000 m^3/month
Required period	:	9 months (Float : 6 months)

Concreting of powerhouse

Of the 56,000 m^3 total volume of concrete, 74,000 m^3 is in concrete up to crane girder beam level.

Monthly output	:	4,700 m^3/month
Daily output	:	190 m^3/day

Within 12 months, concreting work up to the crane girder beam will be completed.

(7) Installation of electro-mechanical equipment
(Electro-mechanical facilities of the powerhouse)

Upon completion of the powerhouse building, after installation of the draft tubes, the overhead travelling

crane will be installed. Transportation and installation of the spiral casings inside the powerhouse then become possible by use of the crane.

After installation of the spiral casings, concreting up to the level of powerhouse foundation will be carried out followed by assembly of the turbines. The stator and rotor of generators are first fixed together at the assembling bay, and then installed and set in their correct positions. Thereafter, the generators are assembled. During this time, the main transformers and 275 kV outdoor equipment will be installed, and finally after adjustment and test operation, the installation of electro-mechanical equipment is completed.

For installation of the above equipment, two months is estimated for the overhead travelling crane, and 18 months from the commencement of spiral casing installation for Unit No.1 to the taking over of No.2 Unit.

(275 kV transmission line)

A 275 kV double-circuit transmission line with a total length of about 7 km will be constructed, and π connection will be adopted at the nearest existing 275 kV transmission line.

7 months are required for the construction at site.

(8) Installation of gates and valves

Intake gate

For installation, 6 months are required before reservoir impounding begins.

Draft gate

6 months are required before test operation of the turbine without water.

Bottom outlet facility

No.1 Diversion Tunnel will be shut down in the dry season using stop-logs, and the installation will be carried out within a period of 8 months before reservoir impounding.

(9) Impounding and test operation

With an impounding date at the middle of November, it will take about 3.5 months for the reservoir to reach a level suitable for test operation with water. In the average year, a water level of EL.77.0 m is expected by this time. By the middle of April (5th month), the water level is expected to be at the high water level of EL.80 m.

12.5. Construction Supervision

The scope of construction supervision includes the activities required after evaluation of tenders for the main works. Construction drawings are scheduled to be prepared within a period of 16 months following the opening of tenders.

The construction supervision is planned to be executed by the foreign and local consultants appointed by the implementing authority. The time schedule from the opening of tenders to the signing of contracts is shown on Fig.12-1-1. Fig.12-4-1 refers to the construction schedule from commencement of the main works.

Main work items of construction supervision are as follows.

- Preparation of the tender evaluation report
- Assistance in the contract negotiation
- Preparation of construction drawings
- Preparation of monthly progress certificates
- Preparation of monthly reports on progress management
- Preparation of quarterly reports on cost control
- Preparation of monthly reports on quality control
- Witnessing factory and site tests
- Design changes at the site

12.6. Measures on Environmental Problems

This project involves a number of environmental problems including the inundated farm lands upstream, and proper measures to deal with these problems are considered necessary. Basically, the implementing authority will mainly perform these measures in cooperation or association with the other authorities concerned. The employment of a local or foreign consultant specialized in the field of environmental measures might provide a very useful expansion of available experience in this field.

The following outlines a preliminary approach to settling the main environmental problems.

(1) Resettlement of the inundated farm lands in the upstream area

The inundated farm land to be resettled should be measured by carrying out a detailed survey using the newly produced topographical map of the reservoir.

After a survey of the particular site for relocation, an implementation programme of resettlement should be established.

The programme should be implemented soon after getting approval from the authorities concerned. Since the cultivation of farm lands requires many years, 7 years are estimated for implementation.

Therefore, it is necessary to ascertain the authority for implementing cultivations.

(2) Development of aquaculture industry

The development of aquaculture industry using the reservoir should be designed at an early stage after impounding, to minimize the impact on the people to be relocated due to impounding.

An implementation programme should be prepared by an appointed specialist, and upon approval of the programme, the training of fishermen, and a pilot project should be carried out under the jurisdiction of the authority selected for implementation.

If it is anticipated that fluctuations of the water level in the reservoir will cause problems, these must be studied and small dams constructed in the upstream tributaries.

(3) Training on environmental measures

Training for imparting knowledge and providing techniques related to the preservation of environment should be implemented for the people related to this project. For this objective, local and foreign experts should be invited. It is also recommended to have training at the authority responsible for implementation.

(4) Detail survey of fauna and flora in the inundation area

For implementation of the detail survey, a local specialist should be appointed.

(5) Felling and clearing of the forest within the reservoir

Based on the newly produced topographical map of the reservoir, felling and clearing plans of timber in the unlogged forest within the inundated area should be prepared and implemented under jurisdiction of the Forestry Department of the Kelantan State. At the same time, clearing of non-valuable and non-commercial trees within the reservoir area should be planned and carried out.

(6) Afforestation of the reservoir bank

An afforestation programme should be established followed by determination of the locations of the forest reserve extending along the reservoir bank, and the locations to be afforested. Thereafter, an agency for implementation should be selected and properly authorized to proceed.

(7) Monitoring of water quality

For water quality monitoring, the agency for implementation should be selected, and monitoring executed before commencement of the construction works. The monitoring should be continuous even after completion of the project, and recommendations given to the project owner and other authorities concerned.

(8) Detailed investigation of the siltation problem

A local specialist should be employed to produce a detailed survey on land erosion in the upstream area of the reservoir, together with conclusions regarding reservoir siltation and any posible countermeasures.

(9) Medico-ecological monitoring

For a medico-ecological monitoring, the agency for implementation should be selected, and the monitoring should be executed before commencement of the construction works. Continuous monitoring should be carried out even after completion of the project, and recommendations given to the project owner and the authority concerned.

(10) Compensation for inundation

A list of quantities and numbers of property, houses and farm lands, etc. should be prepared, based on the result of detail survey, by the project owner in cooperation with the authority concerned. Unit rates to be applied for compensation should be determined. Monetary compensation should be kept to a minimum, with goods and agricultural plantations, etc. used in preference as compensation. The project owner with assistance from the authority concerned should also assist to provide new employment opportunities for the people who loses their jobs by the inundation. The necessary job training should also be given.

(11) Construction of relocation roads

Based on the redevelopment programmes of the forest and agricultural plantations in the upstream reservoir area, a relocation road plan should be established by the project owner in cooperation with the authority concerned. For the construction of relocation roads, the local consultant appointed by the implementation agency will be involved in the design and construction supervision.

(12) Installation of fish ladder

For installation of a fish ladder, the local expert appointed by the project owner will be involved in the design and construction supervision.

(13) Construction of re-regulating pondage

For the construction of re-regulating pondage, the local consultant appointed by the project owner will be involved in the design and construction supervision.

Fig. 12-0-1 Lebir Dam Project Implimentation Programme

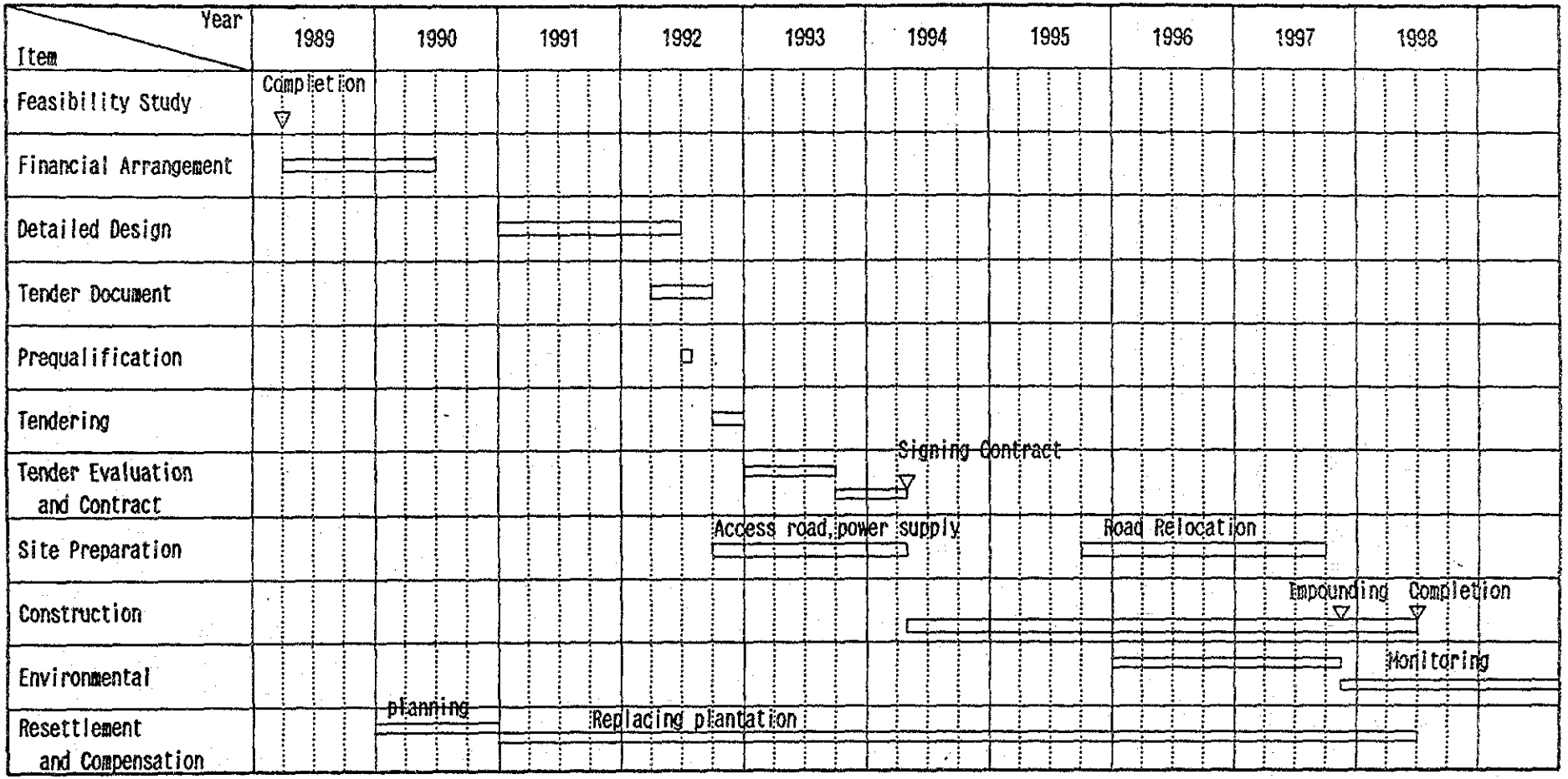


Fig. 12-1-1 Time Schedule for Detail Design and Preparation of Tender Document for Lebir Dam Project

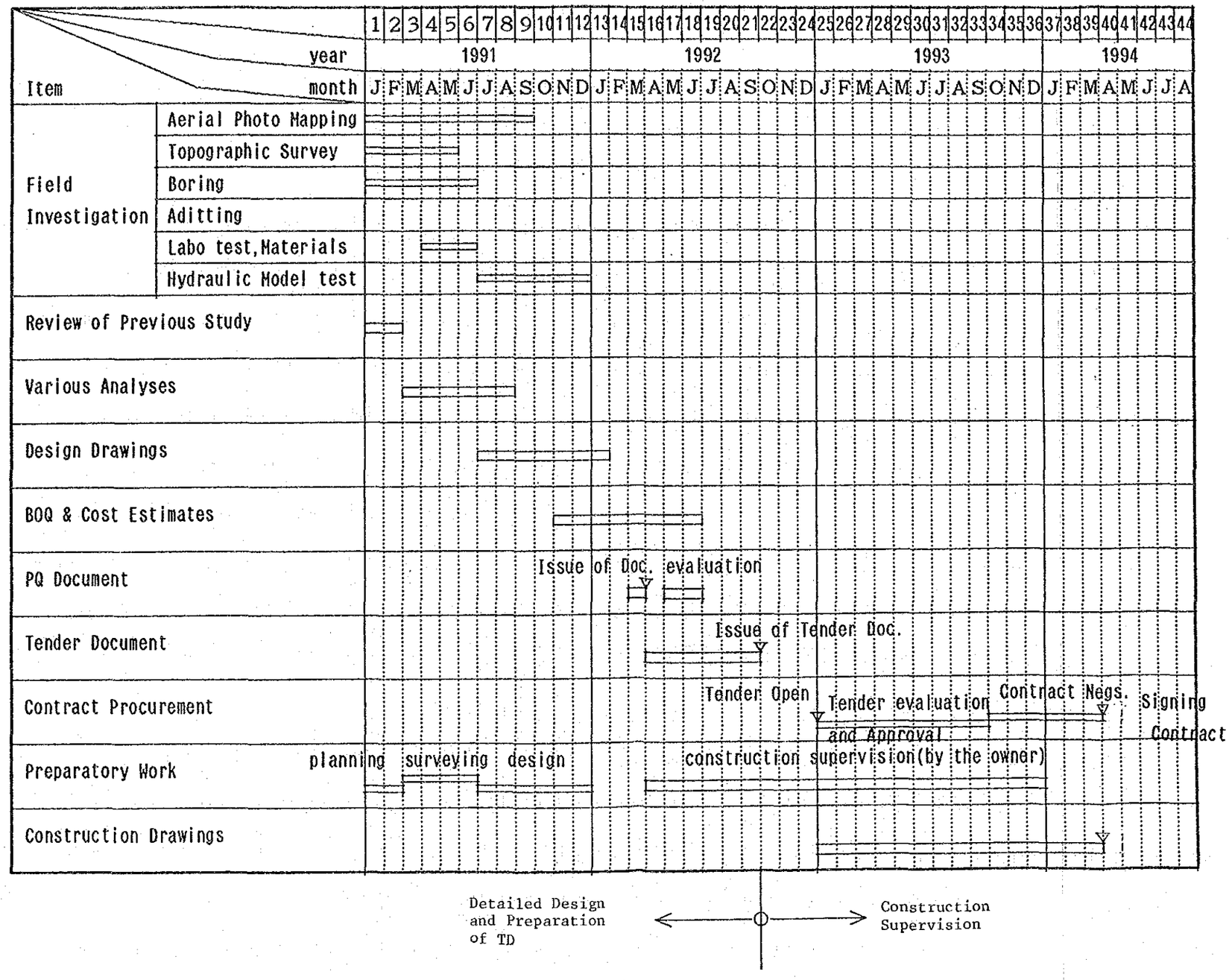
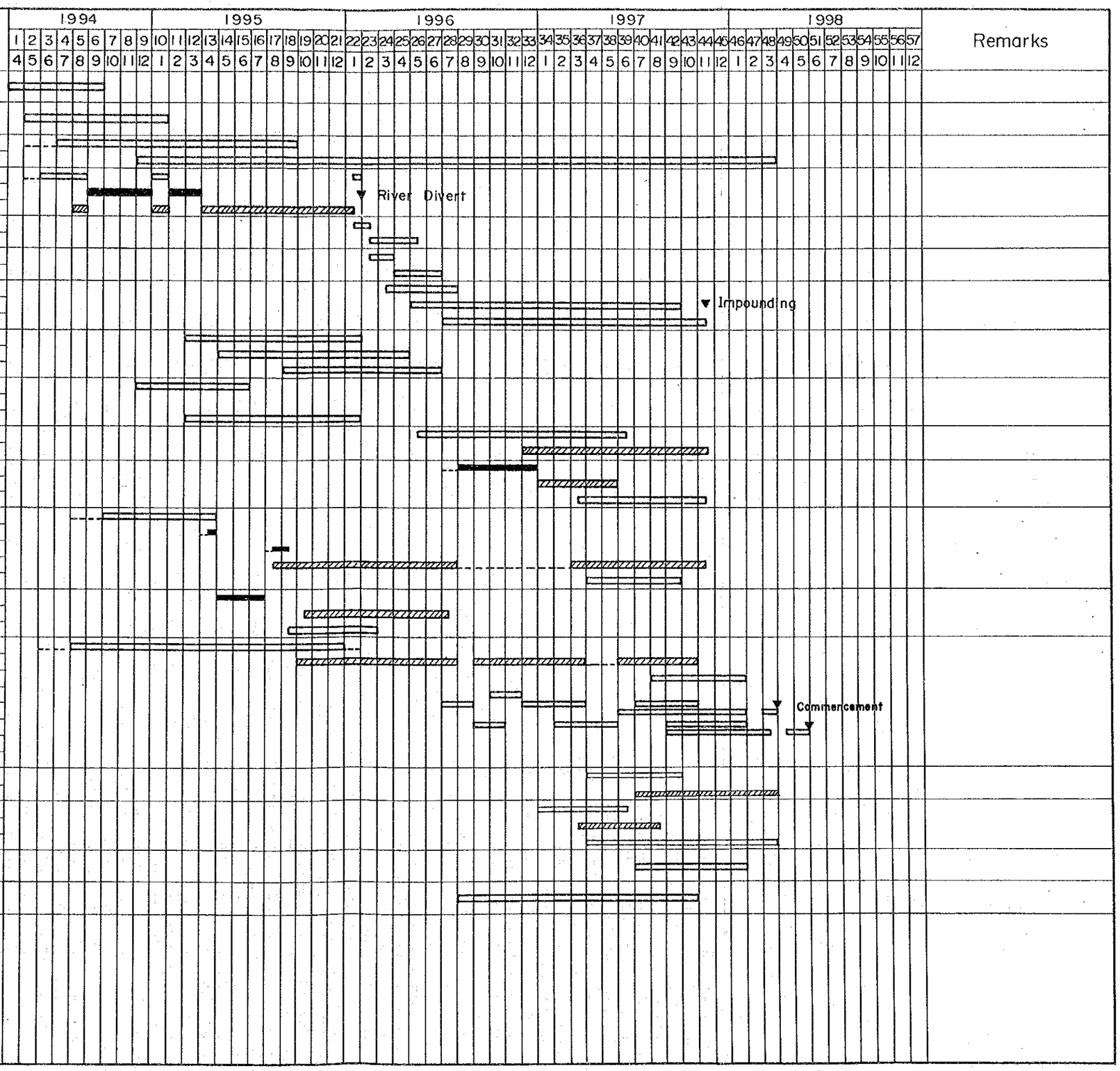


Fig. 12-4-1 Construction Schedule of Main Works

Item		Quantity
Mobilization		
Site Installation		
Quarry	Common	1 250,500 m³
	Rock Product	5 000,000 m³
Diversion Tunnel	Open Ex.	141,200 m³
	Tunnel Ex.	189,100 m³
	Con.	79,500 m³
Upstream Cofferdam	Ex	127,300 m³
	Em.	503,500 m³
Downstream Cofferdam	Ex.	45,700 m³
	Em.	154,000 m³
Main Dam	Ex.	356,200 m³
	Grouting	13,050 m
	Em.	2 362,000 m³
Saddle Dam I	Ex.	868,100 m³
	Grouting	8,820 m
	Em.	1 395,500 m³
Saddle Dam II	Ex.	195,100 m³
	—	—
	Em.	741,700 m³
Spillway	Ex.	1 318,800 m³
	Con.	121,600 m³
Bottom Outlet	Tunnel Ex.	3,600 m³
	Con.	1,500 m³
	Facility Inst.	
Power Intake	Open Ex.	1 042,100 m³
	Tunnel Ex.	2,600 m³
	Shaft Ex.	14,700 m³
	Con.	12,270 m³
	Gate & Screen	
Penstock Tunnel	Tunnel Ex.	31,100 m³
	Con.	8,100 m³
	Steel Liner	920 m³
Power house	Ex.	238,000 m³
	Con.	74,000 m³
	Draft Gate	
	Over Head Crane	—
	Unit # 1	—
	# 2	—
	M.T. # 1	—
	# 2	—
Tailrace	Ex.	437,300 m³
	Con.	12,300 m³
Switchyard	Ex.	74,900 m³
	Con.	4,000 m³
	E / M	—
Transmission Line		
Hydrological Telemetering & Downstream Warning System		



13. Cost Estimate for the Project

13. Cost Estimates for the Project

13.1. Items of Cost Estimates

Cost estimates for the Project comprise the following items:

(1) Preliminaries
(2) Civil and metal works
(3) Electro-mechanical work
(4) Compensation for resettlement
(5) Others

Breakdown of each item is as follows:

13.1.1. Preliminaries

(1) Site Preparation

Preparatory work necessary to implement the main construction work, such as civil and metal works and electro-mechanical work. Examples are, the construction of access and bypass roads, power transmission and telecommunication facilities for the construction purpose, site offices and lodging facilities.

(a) Access Road

Construction of an access road from Tualang to the dam site on the left bank of the Lebir River, extending for some 3 km.

(b) Bypass Road for Logging

Construction of a bypass logging road for construction of the Saddle Dam I on the right bank of the Lebir River, extending for some 8 km.

(c) Construction Power Transmission Line

Installation of a 33 kV power transmission line from Kuala Kerai to the dam site over the distance of some 60 km, and construction of the associated substation.

(d) Telecommunication Facilities

Installation of telecommunication facilities for the purpose of construction, including intra-project telecommunication systems.

(e) Base Camp and Facilities

Construction of site offices and lodging facilities for the use of NEB and engineering consultants.

(2) Road Relocation

Relocation of the existing roads due to impounding in the reservoir, extending for some 75 km for the projected highest reservoir water level of EL. 88.1 m.

(3) Environmental Protection

(a) Installation of a set of hydro-telemetering and down-stream discharge alarm systems

(b) Relocation of animals

(c) Felling and clearing in the proposed reservoir

(d) Construction of a fish ladder

(e) Construction of a regulating reservoir

(f) Others (afforestation, water quality monitoring, etc.)

13.1.2. Civil and Metal Works

Civil and metal works include the construction of the following facilities:

(1) Dam
(2) Waterway
(3) Powerhouse and switchyard
(4) Metal works

13.1.3. Electro-Mechanical Work
(including erection of equipment)

(1) Turbines
(2) Generators
(3) Main transformer and switchgear
(4) Associated transmission line

13.1.4. Compensation for Resettlement

Compensation for relocation of houses, plantations, public installations, etc. to be submerged by impounding in the reservoir.

13.1.5. Others

Engineering consultancy services required for investigation, detailed engineering and field design, bidding, and construction supervision.

Administrative work to be done by NEB themselves in implementing the Project.

(1) Engineering Consultancy Services

(a) Field investigation, detailed engineering and design

- Field investigation
- Various analyses
- Design and preparation of drawings
- Preparation of prequalification documents
- Preparation of tender documents
- Design of preparatory works

(b) Construction Supervision

- Evaluation of bids and assistance in contract negotiations
- Preparation of erection and construction drawings
- Construction supervision for a period of 50 months

(c) Administrative Work to be done by NEB themselves

Administrative work indispensable for implementation of the Project.

Examples are investigation of loss of properties to be submerged under water, establishment of criteria for compensation, planning of relocation of plantations, and administration for implementing environmental protection measures.

(d) Interest during Construction

Not included in the cost estimates.

(e) Contingencies

Contingencies are included in the cost estimates of each work item. There are appropriated not for price fluctuation, but for possible physical changes in the construction work.

13.2. Criteria and Method for Cost Estimates

13.2.1. Criteria for Estimating Costs

(1) Price base year : 1987

(2) Local procurement:

- Labourers
- Construction materials
  (Cement, reinforcing bars, lumber, powder, fuel for power, etc.)
- Field services
  (Surveys, tests, investigations, etc.)
- Light vehicles

(3) Procurement from abroad:

- Foreign supervisors
- Heavy construction equipment
- Special equipment and materials

13.2.2. Method for Estimating Cost for Civil Work

The contract price of the civil work is composed of the elements as given in Table 13-2-1. It is made up of direct cost, indirect cost and general administration expenses (markups). The direct cost is determined by summing up cost

estimates for each of the main elements of the construction work. The indirect cost and markups are obtained by multiplying the direct cost by certain factors determined on the basis of the past data. The factors used for estimating cost for the civil work are as follows.

General site installation cost:
9% of the direct cost

General site expenses:
13.2% of the net construction cost

Markups:
9.3% of the construction cost

In sum, the contract price of the civil work carries a 35% increase over the direct cost, and it breaks down by element of cost to:

Direct cost	:	74.1 %
General site installation cost	:	6.7 %
General site expenses	:	10.7 %
Subtotal	:	91.5 %
Markups	:	8.5 %
Total	:	100 %

13.2.3. Unit Price of Principal Construction Materials

The unit price of principal construction materials used for estimating cost for the civil work is as given below:

Labourers:

	Man-day (M$)	Per hour (M$)
Foreman	73.00	10.01
Carpenter	43.00	5.91
Electrician	38.00	5.23
Pneumatic driller	38.00	5.23
Ganger	35.00	4.81
Truck lorry driver	25.00	3.44
Steel bar bender	24.00	3.30
General labourer	18.00	2.48

Materials:

	(M$)
Cement (40 kg/bag)	9.10
Cement (bulk)	178.00/ton
Steel bar	901.00/ton
Dynamite	14.58/kg
An-Fo	0.96/kg
Detonator	1.70/pc.
Electricity	0.20/kWh

Construction equipment:

Expenditure for construction equipment to be used for the civil work is obtained by estimating the standard ownership cost from the base (acquisition) value of the respective equipment in consideration of the past performance data.

The base value of equipment of similar sort to that used for the civil work is as shown in Table 13-2-2.

13.2.4. Unit Cost of Civil Work

Shown in Table 13-2-3 is the cost (including markups) per unit amount of work for the 27 principal civil work items. The breakdown of such work items is as given in Appendix Table 13-1.

13.2.5. Unit Cost of Metal Work

Shown in Table 13-2-4 is the cost per unit amount of work (ton) for the principal metal work items.

13.2.6. Cost for Electro-Mechanical Work

Refer to the preceding Section 10.9.

13.2.7. Cost for Preliminaries

Table 11-13-8 refers to the cost of relocation of roads in the upstream reach of the projected reservoir.

Section 11.14 refers to the cost of environmental protection. Given in Table 13-2-5 is the cost for the site preparation.

13.2.8. Compensation for Resettlement

Refer to Section 11.13.2.

13.2.9. Cost for Engineering Consultancy Services

Cost for engineering consultancy services (excluding contingency) by item and currency is as shown below:

(M$ 1,000)

	Foreign Currency	Local Currency	Total
Field investigation	-	4,886	4,886
Detailed engineering and design	5,980	1,149	7,129
Construction supervision	32,182	6,651	38,833
Total	38,162	12,686	50,848

13.2.10. NEB Administration Cost

An amount corresponding to 2.25% of the total project cost of M$565,726,000 (without contingencies) is added as the NEB administration cost.

13.2.11. Contingencies

An amount corresponding to 5 to 15% of the individual work cost as shown below is added as physical contingencies:

10% of the cost for preliminaries
15% of the cost for civil work
10% of the cost for metal work
5% of the cost for electro-mechanical work
10% of the compensation for resettlement
10% of the cost for engineering consultancy services
10% of the NEB administration cost

13.3. Estimated Cost of the Project

13.3.1. Estimated Cost by Item

The estimated cost with and without contingencies by work item is as summarized below:

		(M$ 1,000,000) Without Contingencies	With Contingencies
(1)	Preliminaries	54.1	59.5
(2)	Civil Work	218.7	251.5
(3)	Metal Work	19.6	21.6
(4)	Electro-Mechanical Work	141.8	148.9
(5)	Compensation for Resettlement	80.7	88.7
(6)	Engineering Consultancy Services	50.8	55.9
(7)	NEB Administration	12.7	14.0
	Total	578.4	640.1

Breakdown of the estimated cost by item is as tabulated in Table 13-3-1. Also tabulated in Table 13-3-2 is further breakdown of the estimated cost for the civil and metal works.

13.3.2. Estimated Cost by Currency

Table 13-3-3 shows the ratio of foreign and local currency costs by work item. In calculating the cost by currency, the exchange rate of US$ 1 = M$ (Ringgit) 2.5 (as of March, 1987) was used.

The estimated cost of the Project by currency is as summarized below:

	(M$ 1,000,000) Without Contingencies	With Contingencies
Local Currency Cost	290.7	325.2
Foreign Currency Cost	287.7	314.9
Total	578.4	640.1

Breakdown of the estimated cost by currency and item is given in Table 13-3-1.

13.3.3. Estimated Cost by Purpose

The estimated cost of the project by purpose is as summarized below:

Purpose	Without Contingencies 10^6M$	With Contingencies 10^6M$
Dam	210.4	238.9
Power	241.7	262.2
Environment	126.3	139.0
Total	578.4	640.1

Breakdown of the estimated cost by purpose is given in Table 13-3-4.

Although it is not the purpose of this study to figure out an amount of the allocation of the project cost to each beneficiary sector, i.e. power, flood mitigation and agriculture irrigation, nor within the scope of the study, a preliminary indication of such cost allocation is presented in Attachment 13-1 of Appendix, for reference, to demonstrate one of methods applicable.

13.4. Annual Disbursement Schedule

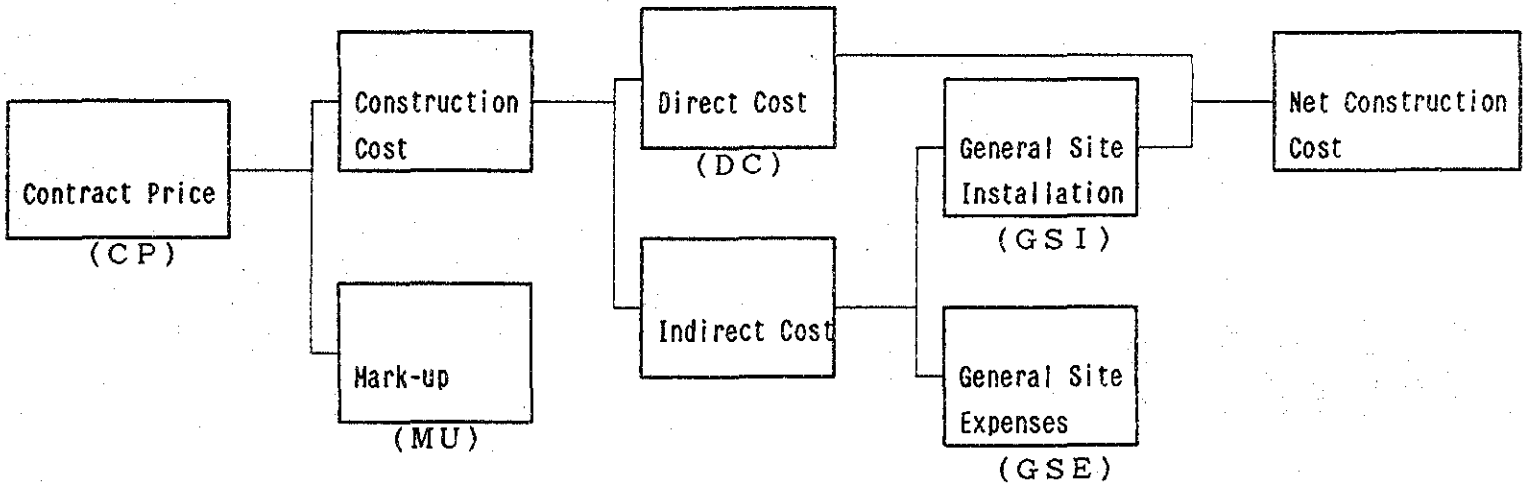
The annual disbursement schedule is prepared based on the progress rate of construction by year estimated from Fig. 12-0-1 Implementation Program, Fig. 12-1-1 Time Schedule for Detailed Design and Preparation of Tender Documents, and Fig. 12-4-1 Construction Schedule of Main Works of the preceding Chapter 12.

The annual progress rate of construction is given in Table 13-4-1. The annual disbursements by work item and currency are tabulated in Table 13-4-2. Shown below is a summary of the annual disbursements (including contingencies) by currency:

(M$ 1,000,000)

Year	Event	Foreign Currency Cost	Local Currency Cost	Total
1990	To work out a plantation relocation program	0	2.05	2.05
1991	To start detailed engineering and design	9.23	12.65	21.88
1992	To carry out bidding and start the preparatory work	2.52	18.92	21.44
1993	To implement the plantation relocation program	2.10	20.83	22.93
1994	To start the main construction work	26.52	49.25	75.77
1995		58.35	55.41	113.76
1996		56.65	65.02	121.67
1997	To start impounding in the reservoir	104.48	73.35	177.83
1998	To start the plant operation	46.51	19.79	66.30
1999		8.60	7.91	16.51
	Total	314.96	325.18	640.14

Table 13-2-1 Breakdown of Contract Price of Civil Work



Direct cost ---- labour, material, construction plant, fuel/power

General Site Installation ---- mobil/demobilization, temporary facilities, equipment

General Site Expenses ---- site management, supervision miscellaneous expenditure

Mark-up ---- head office management, construction design, financial charges, contingencies

Estimation of GSI, GSE & MU

$GSI = 0.09 \times DC$

$GSE = 0.132 \times (1+0.09) \times DC = 0.14388\ DC$

$MU = 0.093 \times (1+0.09+0.14388) \times DC$
$= 0.11475\ DC$

$CP = (1+0.09+0.14388+0.11475) \times DC$
$= 1.34863\ DC \fallingdotseq 1.35\ DC$

Table 13-2-2 Base Price of Major Construction Equipment

	Description	Base price (Ringgit)
1.	Bulldozer D 8	498,600
2.	Tractor Shovel 988 B	719,400
3.	Dump Truck 769 B	333,300
4.	Tractor Shovel 915 H	356,900
5.	Crawler Drill	110,600
6.	Compressor	113,500
7.	Truck Crane 25 ton	404,200
8.	Boring Machine 5.5 kW	30,200
9.	Grouting Machine	15,300

Table 13-2-3 Unit Price for main works

1.	Quarry rock extraction	m^3	4.62
2.	Aggregate production	ton	4.33
		m^3	8.66
3.	Cement (bulk)	ton	202.66
4.	Cement (bag)	ton	229.98
5.	Concrete-Batching plant	m^3	94.86
6.	Formworks	m^2	12.77
7.	Excavation, common	m^3	4.50
8.	Excavation, rock	m^3	7.98
9.	Embankment, rock	m^3	16.29
10.	Embankment, re-used rock	m^3	5.28
11.	Embankment, filter	m^3	15.48
12.	Embankment, outer shell	m^3	16.56
13	Embankment, core	m^3	7.98
14.	Protection dyke	m^3	2.34
15.	Backfill	m^3	2.79
16.	Foundation treatment	m^2	6.87
17.	Excavation, tunnel	m^3	58.78
18.	Rock bolt	ton	2,744.20
19.	Concrete, open	m^3	153.05
20.	Concrete, tunnel	m^3	169.26
21.	Re-bar	ton	1,920.00
22.	Shotcrete, open	m^3	349.12
23.	Shotcrete, tunnel	m^3	368.47
24.	Grouting hole, curtain	m	58.77
25.	Grouting hole, consolidation	m	14.01
26.	Cement grouting	ton	31.66
27.	Steel rib	ton	2,498.94

Table 13-2-4 Estimated Cost for Metal Work (as of 1987)

1. Steel Pipe (per ton)		
1. FOB	M$	4,600
2. OG & I	M$	305
3. Erection	M$	1,995
Total	M$	6,900
2. Gate/Valve(per ton)		
1. FOB	M$	6,085
2. OG & I	M$	420
3. Erection	M$	2,195
Total	M$	8,700
3. Trashrack,Stoplog (per ton)		
50% of Gate/Value	M$	3,500

Table 13-2-5 Estimated Cost for Site Preparation

a.	Access Road	
	length 3 km × 300,000 Ringgit/km =	0.9×10^6 Ringgit
b.	Relocation Road of Logging Track	
	length 8 km × 300,000 Ringgit/km =	2.4×10^6 Ringgit
c.	Construction Power	
	Lump sum	7.2×10^6 Ringgit
d.	Telecommunication	
	Lump sum	0.8×10^6 Ringgit
e.	Base Camp Facilities	
	2,500 m² × 400 Ringgit/m²	1.0×10^6 Ringgit
	total	12.3×10^6 Ringgit

Table 13-3-1 Estimated Project Cost

F.W.L (m)	88.1
N.W.L (m)	80
Pmax (MW)	267.6
Qf(m3/s.day)	80
Qmax (m3/s)	640
Qmax/Qf	8

GRAND TOTAL 640,125,400 (Ringgit)

ITEM	TOTAL AMOUNT (Ringgit)	FOREIGN CURRENCY (Ringgit)	LOCAL CURRENCY (Ringgit)
1. Preliminaries			
(1) Site Preparation	12,300,000	0	12,300,000
(2) Road Relocation	26,250,000	0	26,250,000
(3) Environment	15,549,000	9,329,400	6,219,600
(4) Contingencies	5,409,900	932,940	4,476,960
Subtotal	59,508,900	10,262,340	49,246,560
2. Civil and Metal Works			
(1) Dam	149,262,200	74,631,100	74,631,100
(2) Waterway	18,688,700	6,727,932	11,960,768
(3) Powerhouse/ Switchyard	50,711,100	15,720,441	34,990,659
(4) Metal Works	19,616,000	15,692,800	3,923,200
(5) Contingencies	34,760,900	16,131,201	18,629,699
Subtotal	273,038,900	128,903,474	144,135,426
3. Electrical & Mechanical Works			
(1) Turbine	45,400,000	39,190,000	6,210,000
(2) Generator	75,315,000	69,321,000	5,994,000
(3) Transformer/ Switchgear	16,960,000	15,773,000	1,187,000
(4) Transmission line	4,120,000	3,180,000	940,000
(5) Contingencies	7,090,000	6,373,200	716,800
Subtotal	148,885,000	133,837,200	15,047,800
4.(1) Resettlement/ Compensation	80,706,000	0	80,706,000
(2) Contingencies	8,070,600	0	8,070,600
Subtotal	88,776,600	0	88,776,600
5. Others			
(1) Engineering	50,848,000	38,136,000	12,712,000
(2) Owners' Administration	12,712,000	0	12,712,000
(3) Interest During Construction	0	0	0
(4) Contingencies	6,356,000	3,813,600	2,542,400
Subtotal	69,916,000	41,949,600	27,966,400
GRAND TOTAL	640,125,400	314,952,614	325,172,786

Table 13-3-2 Breakdown of Cost for Civil and Metal Works

Lebir Dam Project Feasibility Study			GRAND TOTAL (Ringgit)		238,277,962
Cost Breakdown of Civil and Metal Works (1/2)					
1. Civil Works					
(1) Dam					
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)
(1)-1 Main dam	(a) Clearing & Stripping	(m2)	125,800	1.50	188,700
	(b) Excavation , common	(m3)	249,300	4.50	1,121,850
	(C) Excavation , rock	(m3)	106,900	7.98	853,062
	(d) Embankment , rock	(m3)	1,088,100	16.29	17,725,149
	(e) Embankment , re-used Rock	(m3)	400,000	5.28	2,112,000
	(f) Embankment , fine filter	(m3)	160,600	15.48	2,486,088
	(g) Embankment , coarse filter	(m3)	160,600	15.48	2,486,088
	(h) Embankment , core	(m3)	391,600	7.98	3,124,968
	(i) Embankment , outer shell	(m3)	161,100	16.56	2,667,816
	(j) Foundation treatment	(m2)	21,000	6.87	144,270
	(k) Grouting hole , curtain	(m)	9,980	58.77	586,525
	(l) Grouting hole , consolidation	(m)	3,070	14.01	43,011
	(m) Cement grouting	(m)	13,050	31.66	413,163
	(n) Instrumentation	L.S.	1	2,000,000.00	2,000,000
	(o) Miscellaneous ((a)to(n))*3%	L.S.	1	1,078,580.70	1,078,581
	Subtotal				37,031,271
(1)-2 Upstream & Downstream Cofferdams	(a) Excavation , common	(m3)	121,100	4.50	544,950
	(b) Excavation , rock	(m3)	51,900	7.98	414,162
	(c) Embankment , rock	(m3)	384,300	16.29	6,260,247
	(d) Embankment , fine filter	(m3)	34,100	15.48	527,868
	(e) Embankment , coarse filter	(m3)	34,100	15.48	527,868
	(f) Embankment , core	(m3)	50,400	7.98	402,192
	(g) Embankment , outer shell	(m3)	154,600	16.56	2,560,176
	(h) Foundation treatment	(m3)	8,900	6.87	61,143
	(i) Riprap	(m3)	50,400	16.56	834,624
	(j) Grouting hole , curtain	(m)	1,700	58.77	99,909
	(k) Cement grouting	(m)	1,700	31.66	53,822
	(l) Miscellaneous ((a)to(k))*3%	L.S.	1	368,608.83	368,609
	Subtotal				12,655,570
(1)-3 Spillway	(a) Clearing & Stripping	(m2)	124,900	1.50	187,350
	(b) Excavation , common	(m3)	1,259,600	4.50	5,668,200
	(c) Excavation , rock	(m3)	59,200	7.98	472,416
	(d) Concrete	(m3)	121,600	153.05	18,610,880
	(e) Re-bar	(ton)	3,500	1,920.00	6,720,000
	(f) Shotcrete	(m3)	420	349.12	146,630
	(g) Backfill	(m3)	255,500	2.79	712,845
	(h) Miscellaneous ((a)to(g))*3%	L.S.	1	975,549.63	975,550
	Subtotal				33,493,871
(1)-4 Diversion tunnels	(a) Excavation , common	(m3)	94,700	4.50	426,150
	(b) Excavation , rock	(m3)	46,500	7.98	371,070
	(c) Tunnel excavation	(m3)	189,100	58.78	11,115,298
	(d) Open concrete	(m3)	13,200	153.05	2,020,260
	(e) Tunnel concrete	(m3)	57,800	169.26	9,783,228
	(f) Re-bar	(ton)	1,750	1,920.00	3,360,000
	(g) Rock bolt (tunnel)	(ton)	128	2,744.20	351,258
	(h) Shotcrete (tunnel)	(m3)	4,200	368.47	1,547,574
	(i) Steel rib	(ton)	495	2,498.94	1,236,975
	(j) Open shotcrete	(m3)	480	349.12	167,578
	(k) Plug concrete	(m3)	8,500	169.26	1,438,710
	(l) Protection dyke	(m3)	17,200	2.34	40,248
	(m) Miscellaneous ((a)to(l))*3%	L.S.	1	955,750.47	955,750
	Subtotal				32,814,099
(1)-5 Saddle dam 1	(a) Clearing & Stripping	(m2)	91,900	1.50	137,850
	(b) Excavation , common	(m3)	868,100	4.50	3,906,450
	(c) Embankment , rock	(m3)	914,400	16.29	14,895,576
	(d) Embankment , fine filter	(m3)	110,100	15.48	1,704,348
	(e) Embankment , coarse filter	(m3)	110,100	15.48	1,704,348
	(f) Embankment , core	(m3)	260,900	7.98	2,081,982
	(g) Foundation treatment	(m2)	15,600	6.87	107,172
	(h) Grouting hole , curtain	(m)	6,620	58.77	389,057
	(i) Grouting hole , consolidation	(m)	2,200	14.01	30,822
	(j) Cement grouting	(m)	8,820	31.66	279,241
	(k) Outer shell	(m3)	136,400	16.56	2,258,784
	(l) Miscellaneous ((a)to(k))*3%	L.S.	1	824,868.90	824,869
	Subtotal				28,320,499
(1)-6 Saddle dam 2	(a) Clearing & Stripping	(m2)	68,800	1.50	103,200
	(b) Excavation , common	(m3)	195,100	4.50	877,950
	(c) Earthfill(from Saddle dam 1)	(m3)	653,100	2.79	1,822,149
	(d) Riprap	(m3)	63,300	16.56	1,048,248
	(e) Embankment , coarse filter	(m3)	15,800	15.48	244,584
	(f) Toe fill	(m3)	9,500	16.29	154,755
	(g) Miscellaneous ((a)to(f))*3%	L.S.	1	127,526.58	127,527
	Subtotal				4,378,413
(1)-7 Bottom outlet	(a) Tunnel excavation	(m3)	3,600	58.78	211,608
	(b) Tunnel concrete	(m3)	1,600	169.26	253,890
	(c) Re-bar	(ton)	45	1,920.00	86,400
	(d) Miscellaneous ((a)to(c))*3%	L.S.	1	16,556.94	16,557
	Subtotal				568,455
TOTAL					149,262,178

Table 13-3-2 (c o n t i n u e d)

Cost Breakdown of Civil and Metal Works (2/2)

(2) P o w e r W a t e r w a y

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)
(2)-1 Power intake	(a) Excavation , common	(m3)	502,900	4.50	2,263,050
	(b) Excavation , rock	(m3)	539,200	7.98	4,302,816
	(c) Concrete	(m3)	3,600	153.05	550,980
	(d) Shotcrete (open)	(m3)	8,700	349.12	3,037,344
	(e) Rock bolt	(ton)	25	2,744.20	68,605
	(f) Intake tunnel excavation	(m3)	2,600	58.78	152,828
	(g) Intake tunnel concrete	(m3)	670	169.26	113,404
	(h) Gate shaft excavation (tunnel)	(m3)	14,700	58.78	864,066
	(i) Gate shaft concrete (tunnel)	(m3)	8,000	169.26	1,354,080
	(j) Re-bar	(ton)	688	1,920.00	1,320,960
	(k) Miscellaneous ((a)to(j))*3%	L.S.	1	420,843.99	420,844
	Subtotal				14,448,977
(2)-2 Penstock tunnel	(a) Tunnel excavation	(m3)	31,100	58.78	1,828,058
	(b) Tunnel concrete	(m3)	8,100	169.26	1,371,006
	(c) Shotcrete (tunnel)	(m3)	1,240	368.47	456,903
	(d) Rock bolt	(ton)	17	2,744.20	46,651
	(e) Steel rib	(ton)	81	2,498.94	202,414
	(f) Re-bar	(ton)	110	1,920.00	211,200
	(g) Miscellaneous ((a)to(f))*3%	L.S.	1	123,486.96	123,487
	Subtotal				4,239,719
	TOTAL				18,688,696

(3) P o w e r h o u s e / S w i t c h y a r d

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)
(3)-1 Powerhouse	(a) Excavation , common	(m3)	73,700	4.50	331,650
	(b) Excavation , rock	(m3)	161,300	7.98	1,287,174
	(c) Shotcrete	(m3)	670	349.12	233,910
	(d) P.S. tendon	(m)	7,750	127.51	988,203
	(e) Backfill	(m3)	19,600	2.79	54,684
	(f) Concrete (Substructure)	(m3)	48,600	153.05	7,438,230
	(g) Concrete , draft	(m3)	25,400	153.05	3,887,470
	(h) Re-bar	(ton)	5,440	1,920.00	10,444,800
	(i) Architectural work	L.S.	1	17,500,000.00	17,500,000
	(j) Miscellaneous ((a)to(i))*3%	L.S.	1	1,264,983.63	1,264,984
	Subtotal				43,431,105
(3)-2 Tailrace	(a) Excavation , common	(m3)	277,500	4.50	1,248,750
	(b) Excavation , rock	(m3)	241,700	7.98	1,928,766
	(c) Concrete	(m3)	12,300	153.05	1,882,515
	(d) Re-bar	(m3)	370	1,920.00	710,400
	(e) Miscellaneous ((a)to(d))*3%	L.S.	1	173,112.93	173,113
	Subtotal				5,943,544
(3)-3 Switchyard	(a) Excavation , common	(m3)	63,100	4.50	283,950
	(b) Excavation , rock	(m3)	11,800	7.98	94,164
	(c) Concrete	(m3)	4,000	153.05	612,200
	(d) Re-bar	(ton)	160	1,920.00	307,200
	(e) Miscellaneous ((a)to(d))*3%	L.S.	1	38,925.42	38,925
	Subtotal				1,336,439
	TOTAL				50,711,088
	Civil Works Total				218,661,962

2. M e t a l W o r k s

(1) M e t a l W o r k s

ITEM		UNIT	QUANTITY	UNIT RATE (Ringgit)	AMOUNT (Ringgit)
(1)-1 Penstock steel		(ton)	920	6,900.00	6,348,000
(1)-2 Diversion tunnel stoplog		(ton)	650	3,500.00	2,275,000
(1)-3 Intake gate & screen	Gates	(ton)	400	8,700.00	3,480,000
	Screen	(ton)	420	3,500.00	1,470,000
	Rake	(ton)	86	3,500.00	301,000
(1)-4 Tailrace gates		(ton)	300	8,700.00	2,610,000
(1)-5 Bottom outlet valve		(ton)	360	8,700.00	3,132,000
	Metal Works Total				19,616,000

Table 13-3-3 Ratio between Foreign Currency and Local Currency of Each Cost Item

	F/C	L/C
1. Preliminaries		
(1) Site Preperation	0	100
(2) Road Relocation	0	100
(3) Environment	60	40
2. Civil and Metal Works		
(1) Dam	50	50
(2) Waterway	36	64
(3) Powerhouse/switch yard	31	69
(4) Metal Works	80	20
3. Electrical and Mechanical Works		
(1) Turbine	86	14
(2) Generator	92	8
(3) Transformer/Switchgear	93	7
(4) Transmission Line	77	23
4. Resettlement		
(1) Resettlement/Compensation	0	100
5. Others		
(1) Engineering	75	25
(2) Owner's Administration	0	100

Table 13-3-4 Project Cost for Major Project Component

Unit :Million M$

Item	Without contingency				With contingency		
	Total	Dam	Power	Env.	Dam	Power	Env.
(1)Site Preparation	12.3	4.902 (0.4)	7.380 (0.6)	0	5.412	8.118	0
(2)Road Relocation	26.25	0	0	26.250	0	0	28.875
(3)Environment	15.549	0	0	15.549	0	0	17.104
(4)Dam	149.262	149.262	0	0	171.651	0	0
(5)Waterway	18.689	0	18.689	0	0	21.492	0
(6)Powerhouse	50.711	0	50.711	0	0	58.318	0
(7)Penstock Metal	6.348	0	6.348	0	0	6.983	0
(8)Power Gates	7.861	0	7.861	0	0	8.647	0
(9)Diversion Metal	2.275	2.275	0	0	2.503	0	0
(10)Bottom Outlet Metal	3.132	3.132	0	0	3.445	0	0
(11)Bottom Outlet Civil	0	0	0	0	0	0	0
(12)Power E/M	141.795	0	141.795	0	0	148.885	0
(13)Resstle./Camp.	80.706	0	0	80.706	0	0	88.776
(14)Engineering	50.848	43.221 (0.85)	7.627 (0.15)	0	47.543	8.390	0
(15)Admi.	12.712	7.627 (0.6)	1.271 (0.1)	3.814 (0.3)	8.390	1.398	4.195
Total	578.438	210.437	241.682	126.319	238.944	262.231	138.950
Grand Total	578.438				640.125		

Table 13-4-1 Progress Rate of Project Implementation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Preliminaries												
(1) Site Preperation	—	—	—	30	40	30	—	—	—	—	—	—
(2) Road Relocation	—	—	—	—	—	0	20	30	50	—	—	—
(3) Environment	—	—	—	—	—	0	0	50	40	10	—	—
(4) {(1)+(2)+(3)} ×10%												
2. Civil and Metal Works												
(1) Dam	—	—	—	—	0	20	20	20	25	10	5	—
(2) Waterway	—	—	—	—	0	20	20	20	25	10	5	—
(3) Powerhouse/switch yard	—	—	—	—	0	20	20	20	25	10	5	—
(4) Metal Works	—	—	—	—	—	—	20	30	35	10	5	—
(5) {(1)+(2)+(3)} ×15%+(4) ×10%												
3. Electrical & Mechanical Works												
(1) Turbine	—	—	—	—	—	0	20	27	32	20	1	—
(2) Generator	—	—	—	—	—	0	20	5	49	25	1	—
(3) Transformer/Switchgear	—	—	—	—	—	0	20	0	59	20	1	—
(4) Transmission Line	—	—	—	—	—	—	0	0	79	21	—	—
(5) {(1)+(2)+(3)+(4)} × 5%												
4. Resettlement												
(1) Resettlement/Compensation	—	2	10	15	15	15	15	18	10	—	—	—
(2) (1) ×10%												
5. Others												
(1) Engineering	—	0	22	6	5	10	15	20	15	5	2	—
(2) Owner's Administration	—	2	5	5	10	18	18	18	17	5	2	—
(3) Interest During Construction	—	—	—	—	—	—	—	—	—	—	—	—
(4){(1)+(2)+(3)}×10%												

Table 13-4-2 Disbursement of Project Cost (Total Amount)

(Ringgit)

F.W.L (m)	88.1
N.W.L (m)	80
Pmax (MW)	267.6
Qf(m3/s.day)	80
Qmax (m3/s)	640
Qmax/Qf	8

GRAND TOTAL: 640,125,400

(10^3 Ringgit)

ITEM	AMOUNT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Preliminaries														
(1) Site Preparation	12,300,000	0	0	0	0	3690	4920	3690	0	0	0	0	0	0
(2) Road Relocation	26,250,000	0	0	0	0	0	0	0	5250	7875	13125	0	0	0
(3) Environment	15,549,000	0	0	0	0	0	0	0	0	7775	6220	1555	0	0
(4) Contingencies	5,409,900	0	0	0	0	369	492	369	525	1565	1935	156	0	0
Subtotal	59,508,900	0	0	0	0	4059	5412	4059	5775	17215	21280	1711	0	0
2. Civil and Metal Works														
(1) Dam	149,262,200	0	0	0	0	0	0	29852	29852	29852	37316	14926	7463	0
(2) Waterway	18,688,700	0	0	0	0	0	0	3738	3738	3738	4672	1869	934	0
(3) Powerhouse/ Switchyard	50,711,100	0	0	0	0	0	0	10142	10142	10142	12678	5071	2536	0
(4) Metal Works	19,616,000	0	0	0	0	0	0	0	3923	5885	6866	1962	981	0
(5) Contingencies	34,760,900	0	0	0	0	0	0	6560	6952	7148	8887	3476	1738	0
Subtotal	273,038,900	0	0	0	0	0	0	50292	54607	56765	70419	27304	13652	0
3. Electrical & Mechanical Works														
(1) Turbine	45,400,000	0	0	0	0	0	0	0	9080	12258	14528	9080	454	0
(2) Generator	75,315,000	0	0	0	0	0	0	0	15063	3766	36904	18829	753	0
(3) Transformer/ Switchgear	16,960,000	0	0	0	0	0	0	0	3392	0	10006	3392	170	0
(4) Transmission line	4,120,000	0	0	0	0	0	0	0	0	0	3255	865	0	0
(5) Contingencies	7,090,000	0	0	0	0	0	0	0	1377	801	3235	1608	69	0
Subtotal	148,885,000	0	0	0	0	0	0	0	28912	16825	67928	33774	1446	0
4.(1) Resettlement/ Compensation	80,706,000	0	0	1614	8071	12106	12106	12106	12106	14527	8071	0	0	0
(2) Contingencies	8,070,600	0	0	161	807	1211	1211	1211	1211	1453	807	0	0	0
Subtotal	88,776,600	0	0	1775	8878	13317	13317	13317	13317	15980	8878	0	0	0
5. Others														
(1) Engineering	50,848,000	0	0	0	11187	3051	2542	5085	7627	10170	7627	2542	1017	0
(2) Owners' Administration	12,712,000	0	0	254	636	636	1271	2288	2288	2288	2161	636	254	0
(3) Interest During Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(4) Contingencies	6,356,000	0	0	25	1182	369	381	737	992	1246	979	318	127	0
Subtotal	69,916,000	0	0	279	13005	4056	4194	8110	10907	13704	10767	3496	1398	0
GRAND TOTAL	640,125,400	0	0	2054	21883	21432	22923	75778	113518	120489	179272	66285	16496	0

Table 13-4-2 (Continued)
(Foreign Currency)

(Ringgit)

F.W.L (m)	88.1
N.W.L (m)	80
Pmax (MW)	267.6
Qf(m3/s.day)	80
Qmax (m3/s)	640
Qmax/Qf	8

GRAND TOTAL
314,952,614

(10^3 Ringgit)

ITEM	AMOUNT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Preliminaries														
(1) Site Preparation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2) Road Relocation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Environment	9,329,400	0	0	0	0	0	0	0	0	4665	3732	933	0	0
(4) Contingencies	932,940	0	0	0	0	0	0	0	0	467	373	93	0	0
Subtotal	10,262,340	0	0	0	0	0	0	0	0	5132	4105	1026	0	0
2. Civil and Metal Works														
(1) Dam	74,631,100	0	0	0	0	0	0	14926	14926	14926	18658	7463	3732	0
(2) Waterway	6,727,932	0	0	0	0	0	0	1346	1346	1346	1682	673	336	0
(3) Powerhouse/ Switchyard	15,720,441	0	0	0	0	0	0	3144	3144	3144	3930	1572	786	0
(4) Metal Works	15,692,800	0	0	0	0	0	0	0	3139	4708	5492	1569	785	0
(5) Contingencies	16,131,201	0	0	0	0	0	0	2912	3226	3383	4190	1613	807	0
Subtotal	128,903,474	0	0	0	0	0	0	22328	25781	27507	33952	12890	6446	0
3. Electrical & Mechanical Works														
(1) Turbine	39,190,000	0	0	0	0	0	0	0	7838	10581	12541	7838	392	0
(2) Generator	69,321,000	0	0	0	0	0	0	0	13864	3466	33967	17330	693	0
(3) Transformer/ Switchgear	15,773,000	0	0	0	0	0	0	0	3155	0	9306	3155	158	0
(4) Transmission line	3,180,000	0	0	0	0	0	0	0	0	0	2512	668	0	0
(5) Contingencies	6,373,200	0	0	0	0	0	0	0	1243	702	2916	1450	62	0
Subtotal	133,837,200	0	0	0	0	0	0	0	26100	14749	61242	30441	1305	0
4.(1) Resettlement/ Compensation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2) Contingencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Others														
(1) Engineering	38,136,000	0	0	0	8390	2288	1907	3814	5720	7627	5720	1907	763	0
(2) Owners' Administration	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Interest During Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(4) Contingencies	3,813,600	0	0	0	839	229	191	381	572	763	572	191	76	0
Subtotal	41,949,600	0	0	0	9229	2517	2098	4195	6292	8390	6292	2098	839	0
GRAND TOTAL	314,952,614	0	0	0	9229	2517	2098	26523	58173	55778	105591	46455	8590	0

Table 13-4-2 (Continued)
(Local Currency)

(Ringgit)

F.W.L (m)	88.1
N.W.L (m)	80
Pmax (MW)	267.6
Qf(m3/s.day)	80
Qmax (m3/s)	640
Qmax/Qf	8

GRAND TOTAL
325,172,786

(10^3 Ringgit)

ITEM	AMOUNT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Preliminaries														
(1) Site Preparation	12,300,000	0	0	0	0	3690	4920	3690	0	0	0	0	0	0
(2) Road Relocation	26,250,000	0	0	0	0	0	0	0	5250	7875	13125	0	0	0
(3) Environment	6,219,600	0	0	0	0	0	0	0	0	3110	2488	622	0	0
(4) Contingencies	4,476,960	0	0	0	0	369	492	369	525	1099	1561	62	0	0
Subtotal	49,246,560	0	0	0	0	4059	5412	4059	5775	12084	17174	684	0	0
2. Civil and Metal Works														
(1) Dam	74,631,100	0	0	0	0	0	0	14926	14926	14926	18658	7463	3732	0
(2) Waterway	11,960,768	0	0	0	0	0	0	2392	2392	2392	2990	1196	598	0
(3) Powerhouse/ Switchyard	34,990,659	0	0	0	0	0	0	6998	6998	6998	8748	3499	1750	0
(4) Metal Works	3,923,200	0	0	0	0	0	0	0	785	1177	1373	392	196	0
(5) Contingencies	18,629,699	0	0	0	0	0	0	3647	3726	3765	4697	1863	932	0
Subtotal	144,135,426	0	0	0	0	0	0	27963	28827	29258	36466	14413	7208	0
3. Electrical & Mechanical Works														
(1) Turbine	6,210,000	0	0	0	0	0	0	0	1242	1677	1987	1242	62	0
(2) Generator	5,994,000	0	0	0	0	0	0	0	1199	300	2937	1499	60	0
(3) Transformer/ Switchgear	1,187,000	0	0	0	0	0	0	0	237	0	700	237	12	0
(4) Transmission line	940,000	0	0	0	0	0	0	0	0	0	743	197	0	0
(5) Contingencies	716,800	0	0	0	0	0	0	0	134	99	318	159	7	0
Subtotal	15,047,800	0	0	0	0	0	0	0	2812	2076	6685	3334	141	0
4.(1) Resettlement/ Compensation	80,706,000	0	0	1614	8071	12106	12106	12106	12106	14527	8071	0	0	0
(2) Contingencies	8,070,600	0	0	161	807	1211	1211	1211	1211	1453	807	0	0	0
Subtotal	88,776,600	0	0	1775	8878	13317	13317	13317	13317	15980	8878	0	0	0
5. Others														
(1) Engineering	12,712,000	0	0	0	2797	763	636	1271	1907	2542	1907	636	254	0
(2) Owners' Administration	12,712,000	0	0	254	636	636	1271	2288	2288	2288	2161	636	254	0
(3) Interest During Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(4) Contingencies	2,542,400	0	0	25	343	140	191	356	420	483	407	127	51	0
Subtotal	27,966,400	0	0	279	3776	1539	2098	3915	4615	5313	4475	1399	559	0
GRAND TOTAL	325,172,786	0	0	2054	12654	18915	20827	49254	55346	64711	73678	19830	7908	0

14. Economic and Financial Analyses

14. Economic and Financial Analyses

The economic and financial analyses of the Lebir Hydro Power Project (hereinafter referred to as the Lebir Project) are made based in principle on the following basic conditions (a detail explanation on the method of economic analysis is presented in Attachment 14-1 of Appendix):

- Constant Malaysia dollar (M$) shall be based on the 1987 price.

- The base year of the present worth value calculation shall be 1998.

- Discount rate shall be set at 6, 8, 10, 12, 14, 16, 18 and 20%.

14.1. Basic Approaches to Economic and Financial Analyses

The basic approaches to the economic analysis are as summarized below:

(1) The economic advantage of the Lebir Project is compared with that of the least cost alternative power source, which can be represented by a combined cycle power project in the western region of Peninsular Malaysia (hereinafter referred to as the CCYW Project).

Further, a supplemental study based on the latest information on thermal units is carried out and its result is presented in Attachment 14-2 of Appendix.

(2) The rated generating capacity (gross) of the Lebir Project used for the analysis is set at 267.6 MW. Studies are also made of the derated capacity (gross) of 240.5 MW in consideration of water level variation in the reservoir in the dry season.

(3) The monetary benefit from the flood control is assumed to be M$16.133 x 10^6/year. It is calculated based on the estimated benefit of M$ 8.155 x 10^6/year at the 1986 prices, adjusted by price escalation to the 1987 value, and further by the rate of increase in population and in GDP per capita.

Studies are also made of the estimated benefit of M$27.3 x 10^6/year based on the "Study for Kelantan River Basin-Wide Flood Mitigation Project".

(4) The monetary benefit from improved irrigation is calculated in the economic price. It is estimated to be M$14.994 x 10^6 at the discount rate of 10%.

(5) Sensitivity analysis is made of the following variation cases:

i. Cases in which the construction cost both for the Lebir Project and the CCYW Project is increased and decreased by 10%.

ii. A case in which the completion date of the Lebir Project is delayed by six months.

iii. Cases in which the fuel cost of M$3.538/MBTU is increased to M$5.0, M$7.5 and M$10.0/MBTU to approximate to the international market price level.

The basic approaches to the financial analysis are as summarized below:

(1) Revenues from energy sales are compared with costs of power production by the power sources consisting of the Lebir Project and then the existing thermal power plant(s) to meet the energy requirements with an annual load factor of 68%.

(2) The same generating capacity (gross) as used for the economic analysis is applied to the financial analysis.

(3) Sensitivity analysis is made of the following variation cases:

i. Cases in which the construction cost for the Lebir Project is increased and decreased by 10%.

ii. A case in which the completion date of the Lebir Project is delayed by six months.

(4) Benefits from the flood control and the improved irrigation are to do with the national interest, but are not directly to do with the NEB's interest. Hence, these are not considered in the financial analysis. However, an attempt is made for reference to calculate the benefit in the market price. The amount is estimated to be M$14.485 x 10^6 at the discount rate of 10%.

Input variables used for the economic and financial analyses are given in Table 14.1. Equations used for the analyses are shown in Table 14.2.

14.2. Calculation of Costs and Benefits

Table 14-3 shows the annual levelized fixed cost of the Lebir Project calculated at various discount rates for different cases. Table 14-4 shows the annual unit fixed cost of the CCYW Project calculated at various discount rates for different cases. Shown in Table 14-5 is the annual levelized fixed cost of the CCYW Project calculated by using the annual unit fixed cost given in Table 14-4, on the assumption that its generating capacity (net) would be equal to that of the Lebir Project.

Table 14-6 shows the unit variable cost of the CCYW Project calculated in different fuel costs. Shown in Table 14-7 is the annual variable cost of the CCYW Project calculated by using the unit variable cost given in Table 14.6, assuming that its net generation would be equal to that of the Lebir Project.

Tables 14-8 and 14-9 are the present worth values of the net benefit from the improved irrigation, calculated at various discount rates. The values are calculated in both economic and market prices. The detail of the calculation is as described in Chapter 8. Shown in Table 14-10 is the annual net benefit from the improved irrigation, calculated at various discount rates by using the values given in Tables 14-8 and 14-9.

14.2.1. Economic Analysis

The economic analysis is made by comparing the cost for the Lebir Project with the cost for the alternative power source both in generating capacity and energy output.

The Lebir Project has a side effect on the mitigation of damage to property through the flood control. It also has a side effect on the increase in agricultural yields through the improved irrigation. Therefore, the amount equivalent to the benefit from such effects must be deducted from the cost.

Tables 14-11 (1) and 14-11 (2) show the annual levelized fixed cost of the Lebir Project given in Table 14-3 less the annual benefits from the flood control and the improved irrigation.

Tabulated in Tables 14-12 (1) and 14-12 (2) are the annual levelized fixed and variable costs of the CCYW Project calculated at various discount rates and in different fuel costs, on the assumption that its generating capacity (net) and annual generation (net) would be equal to those of the Lebir Project.

Plotted on Figs. 14-1, 14-2 (1), 14-2 (2), 14-3 (1) and 14-3 (2) are the annual levelized fixed costs of the Lebir Project with and without regard to benefits from the flood control and the improved irrigation on all variation cases as given in Tables 14-3, 14-11 (1) and 14-11 (2), compared with the annual levelized fixed and variable costs of the CCYW Project on all variation cases with the fuel cost set at M$3.538/MBTU as given in Table 14-12 (1).

The intersecting points of the Lebir and CCYW curves on the abscissa (discount rates) in these Figures show the economic internal rate of return (EIRR) of the Lebir Project. Tabulated in Table 14-13 are the EIRRs thus obtained.

Given below is a summary of Table 14-13 on the base case (no change in the construction costs and the completion date):

Generating Capacity (MW)	Fuel Cost (M$/MBTU)	EIRR				
		Generation only	Generation and Flood Control		Generation, Flood Control and Irrigation	
			A	B	A	B
267.6	3.538	6.7	10.0	11.7	11.8	13.2
267.6	7.5	9.5	12.3	13.9	13.6	14.8
267.6	10.0	11.2	13.6	15.1	14.6	15.8
240.5	3.538	<6.0	9.0	10.7	11.1	12.4
240.5	7.5	8.6	11.3	12.8	12.8	13.9
240.5	10.0	10.2	12.6	14.0	13.8	14.9

Note: "A" figures represent the EIRRs with the monetary benefit from the flood control estimated to be M$16.133 x 10^6 and "B" figures represents the EIRRs with the monetary benefit from the flood control estimated to be M$27.3 x 10^6.

14.2.2. Financial Analysis

The financial analysis is made by comparing costs of power production with revenues from energy sales in the following manner, when supplying electricity from the power sources consisting of the Lebir Project and the then existing power plant(s) to meet the energy requirements with an annual load factor of 68%:

Gross Generating Capcity (MW)	:	267.6	240.5
Net Generating Capacity (MW) (Gross capacity less station use and forced outage)	:	265.46	238.58
Net Generation (GWh)	:	1,581.3	1,421.2
Net Generation by Lebir Project	:	372.2	372.2
Additional Generation by Existing Thermal Power Plant(s) (GWh)	:	1,209.1	1,049.0
Energy Sales (GWh)	:	1,401.0	1,259.2
Revenues from Energy Sales ($M\$10^6$):		311.86	280.30

The net generation given above is the energy output produced by the power sources with a generating capacity equal to that of the Lebir Project to meet the energy requirements with an annual load factor of 68%. Since it is not possible to meet the requirements by the Lebir Project alone, the gap must be filled with generation by the then existing thermal power plant(s).

Energy sales are obtained by deducting transmission and distribution losses from the net generation. Revenues from energy sales are estimated by applying the average billing rate per kWh.

Such revenues from energy sales are, as a matter of course, to cover the variable cost to be spent for the additional generation by the then existing thermal power plant(s). Such variable cost is estimated as follows:

Gross Generating Capacity (MW):	267.6	240.5
Additional Generation by Existing Thermal Power Plant(s) (GWh):	1,209.1	1,049.0
Additional Variable Cost ($M\$10^6$):	45.087 (A) 54.848 (B)	39.117 (A) 47.586 (B)

Note: (A) is calculated at the heat rate set at 2,413 Kcal/kWh.

(B) is calculated at the heat rate set at 2,965 Kcal/kWh.

Tables 14-14 (1) and 14-14 (2) show the sum of the annual levelized fixed cost of the Lebir Project as given in Table 14.3 and the annual variable cost for the additional generation as given above, on all variation cases by discount rate.

The revenues from energy sales given in the above table are higher than the costs of any variation cases in Tables 14-14 (1) and 14-14 (2). This indicates that the development of the Lebir Project may be well justifiable from the financial point of view, even in an extreme case where its construction cost is overrun by 10%, its generating output is derated by water shortage, and the variable cost for additional generation by thermal power plant(s) has to be calculated at a relatively higher heat rate (lower thermal efficiency).

The financial internal rate of return (FIRR) of the Lebir Project in this extreme case is estimated by interporation to be 21.5 for the generating output of 267.6 MW and 20.1 for 240.5 MW.

14.3. Conclusion of Economic and Financial Analyses

The economic analysis indicates that the Lebir Project may produce an EIRR exceeding 10% against the alternative CCYW Project, when its fuel cost is assumed to be M$10/MBTU, but may not produce a higher EIRR than 10%, when the fuel cost is assumed to be lower than M$7.5/MBTU.

The development of the Lebir Project, however, may have effects on the significant decrease in losses of properties in the downstream basin through the control of floods, as well as on the substantial increase in agricultural yields through the improvement of irrigation.

Taking such effects into consideration, the Project may produce an EIRR exceeding 11%, even when the fuel cost of the alternative CCYW Project is assumed to be M$3.538/MBTU.

It can therefore be concluded that the development of the Lebir Project is well justifiable from the standpoint of the national interest.

The financial analysis indicates that the Lebir Project may produce a FIRR exceeding 20% even in the case of a 10% overrun of its construction cost. Therefore, it can also be concluded that the development of the Lebir Project may not be a factor to cause the NEB's electricity rates to increase.

Table 14-1 Input Variables for Economic and Financial Analyses

Prices	Constant Prices in 1987				
Base Year of Present worth calculation	1998(Commissioning : June 1998)				
Discount Rate (%)	6, 8, 10, 12, 14, 16, 18 and 20				
Analysis	Economic Analysis		Financial Analysis		Remarks
Plant	Lebir Project	CCYW Project	Costs	Benefits	
Construction Cost (M$ 10^3)	640,125.4(±10%)	345,000(±10%)	640,125.4(±10%)	—	
Construction Period (years)	10 (+6months)	3	10 (+6months)	—	
Life Time (years)	50	20	50	—	
Residual Value Rate (%)	0	0	0	—	
Generating Capacity (MW)	267.6 (240.5)	300	267.6 (240.5)	—	
Annual Generation (GWh)	373.28	—	—	373.28	
Forced Outage Rate (%)	0.5	10	0.5	—	
Maintenance Outage Days/year (days)	—	36	—	—	
Station Use Rate (%)	0.3	4	0.3	0.3	
Fixed O&M Cost (M$/kW-month)	1.45	1.15	1.45	—	
Heat Rate (Kcal/kWh)	—	2,413	2,413(2,965)	—	Thermal Efficiency 35.7%(29.0%)
Fuel Cost (M$/MBTU)	—	3.538(5.0,7.5,10.0)	3.538	—	3.3(at 1995),3.6(at 2000)
Variable O&M cost (M$/MWh)	—	2	2	—	
Load Factor (%)	—	—	—	68	
Transmission Distribution Losses (%)	—	—	—	11.4	at 1985
Average Revenue from Sales (Cents/kWh)	—	—	—	22.26	at 1985
Benefit from Flood Control (M$ 10^6 /year)	16.133(27.300)	—	—	〔 16.133 〕	
Benefit from Improved Irrigation (M$ 10^6 /year)	14.994	—	—	〔 14.485 〕	at 10% Discount Rate

Table 14-2 Equations Used for Economic and Financial Analyses

$$\text{Annual Levelized Fixed Cost of Lebir Hydro Project} = \left[\text{P.W. (M\$ } 10^{6}\text{)} \times \frac{i+(1+i)^{50}}{(1+i)^{50}-1} + \text{Generating Capacity (MW)} \times \text{Fixed O\&M Cost (M\$/kW-month)} \times 12 \times 10^{-3}\right] \cdots\cdots \text{(M\$ } 10^{6} \text{ \$/year)}$$

$$\text{Annual Levelized Unit Fixed Cost of CCYW Project} = \left[\text{Construction Unit Cost (M\$/kW)} \times \frac{(1+i)^{3}-1}{3i} \times \frac{i(1+i)^{20}}{(1+i)^{20}-1} + \text{Fixed O\&M Cost (M\$/kW-month)} \times 12\right]$$

$$\div \left[(1-\text{Forced Outage Rate (P.U)})(1-\text{Maintenance Outage days per year}/365)(1-\text{Station Use Rate (P.U)})\right] \cdots\cdots \text{(M\$/kW-year)}$$

Annual Levelized Fixed Cost of CCYW Project Assuming
Generating Capacity is Equal to that of Lebir Project = Generating Capacity of Lebir Project (MW) $\times$ (1 − Forced Outage Rate (P.U)) $\times$ (1 − Station Use Rate (P.U))

$$\times \text{ Unit Fixed Cost of CCYW Project (M\$/kW-year)} \times 10^{-3} \cdots\cdots \text{(M\$ } 10^{6} \text{ /year)}$$

$$\text{Unit Variable Cost of CCYW Project} = \text{Heat Rate (Kcal/kWh)} \times \text{Fuel Cost (M\$/MBTU)} \div \left\{251.996 \times (1-\text{Station Use Rate (P.U)})\right\} + \text{Variable O\&M Cost (M\$/MWh)} \cdots\cdots \text{(M\$/MWh)}$$

Annual Variable Cost of CCYW Project Assuming
Net Generation is Equal to that of Lebir Project = Annual Generation of Lebir Project (GWh) $\times$ (1 − Station use Rate (P.U))

$$\times \text{ Unit Variable Cost of CCYW Project} \times 10^{-3} \cdots\cdots \text{(M\$ } 10^{6} \text{ /year)}$$

P.W. : Present Worth Vlue of construction cost
i : Discount rate

Table 14-3 Annual Levelized Fixed Cost of Lebir Project

Discount Rate(%)	Construction Cost (M$ 10^6 /year) (90 %)	(100%)	(+6months)	(110%)
6	46.652	51.319	52.698	55.985
8	61.374	67.675	70.148	73.977
10	78.040	86.193	90.173	94.347
12	96.563	106.775	112.729	116.987
14	116.949	129.426	137.874	141.903
16	139.267	154.224	165.746	169.181
18	163.633	181.297	196.537	198.961
20	190.191	210.806	230.482	231.421

Table 14-4 Annual Levelized Unit Fixed Cost of CCYW Project

Discount Rate(%)	Construction Cost (M$/kW-year) (90 %)	(100%)	(110%)
6	140.679	154.341	168.003
8	164.199	180.474	196.750
10	189.954	209.091	228.228
12	217.849	240.086	262.322
14	247.783	273.346	298.908
16	279.656	308.760	337.864
18	313.375	346.226	379.076
20	348.860	385.654	422.447

Table 14-5 Annual Levelized Fixed Cost of CCYW Project Assuming Its Generating Capacity is Equal to that of Lebir Project

In case of 267.6 MW :

Discount Rate(%)	Construction Cost (M$ 10^6 /year) (90 %)	(100%)	(110%)
6	37.345	40.972	44.599
8	43.589	47.909	52.230
10	50.426	55.506	60.586
12	57.831	63.734	69.637
14	65.777	72.563	79.349
16	74.238	81.964	89.690
18	83.190	91.910	100.631
20	92.609	102.377	112.144

In Case of 240.5 MW :

Discount Rate(%)	Construction Cost (M$ 10^6 /year) (90 %)	(100%)	(110%)
6	33.563	36.823	40.082
8	39.175	43.057	46.941
10	45.319	49.885	54.451
12	51.974	57.280	62.585
14	59.116	65.215	71.313
16	66.720	73.664	80.607
18	74.765	82.602	90.440
20	83.231	92.009	100.787

Table 14-6 Unit Variable Cost of CCYW Project

Fuel Price (M$/MBTU)	Fuel Cost (M$/MWh)	Variable O&M Cost (M$/MWh)	Total Unit Cost (M$/MWh)
3.538	35.290	2.0	37.290
5.0	49.873	2.0	51.873
7.5	74.809	2.0	76.809
10.0	99.745	2.0	101.745

Table 14-7 Annual Variable Cost of CCYW Project Assuming Its Net Generation is Equal to that of Lebir Project

Fuel Price (M$/MBTU)	Total Unit Cost (M$/MWh)	Annual Variable Cost (M$ 10^6 /year)
3.538	37.290	13.878
5.0	51.873	19.305
7.5	76.809	28.585
10.0	101.745	37.865

Table 14-8 Present Worth Value of Benefit from Improved Irrigation (Calculated in the Economic Price)

(M$ 10^6)

Discount Rate (%)	Project Cost	O&M Cost	Replacement Cost	Benefit	Net Benefit
6	116.129	40.059	2.874	517.350	358.288
8	110.991	29.669	1.761	371.429	229.008
10	106.719	22.429	1.098	278.913	148.667
12	103.199	17.587	0.696	217.199	95.717
14	100.333	14.204	0.448	174.200	59.215
16	98.043	11.753	0.292	143.115	30.027
18	96.261	9.922	0.193	119.937	13.561
20	94.929	8.517	0.129	102.200	△1.375

Table 14-9 Present Worth Value of Benefit from Improved Irrigation (Calculated in Market Price)

(M$ 10^6)

Discount Rate (%)	Project Cost	O&M Cost	Replacement Cost	Benefit	Net Benefit
6	134.714	51.318	2.941	551.474	362.501
8	128.752	37.082	1.802	395.477	227.841
10	123.795	28.033	1.124	296.571	143.619
12	119.710	21.980	0.712	230.599	88.197
14	116.385	17.753	0.458	184.637	50.041
16	113.729	14.689	0.299	151.418	22.701
18	111.661	12.400	0.198	126.655	2.396
20	110.117	10.644	0.132	107.712	△13.181

Table 14-10 Annual Levelized Net Benefit from Improved Irrigation

(N$ 10^6 /year)

Discount Rate (%)	Calculated in Economic Price	Calculated in Market Price
6	22.731	22.999
8	18.720	18.624
10	14.994	14.485
12	11.526	10.620
14	8.302	7.016
16	4.807	3.634
18	2.442	0.431
20	△0.275	△2.636

Note : The Figures are Levelized over 50 Years from 1999 to 2048. The independent internal rate of return of the irrigation project can be obtained from these figures as follows ;

EIRR ≒ 19.8 %
FIRR ≒ 18.3 %

Table 14-11 (1) Annual Levelized Fixed Cost of Lebir Project Less Benefit from Flood Control and Improved Irrigation
(Benefit from Flood Control = M$ 16.133×10⁶ /Year)

Discount Rate(%)	Less Benefit from Flood Control : (M$ 10⁶ /Year) Construction Cost (90 %)	(100%)	(+6 Mos)	(110%)	Less Benefit from Flood Control and Improved Irrigation : (M$ 10⁶ /Year) Construction Cost (90 %)	(100%)	(+6 Mos)	(110%)
6	30.519	35.186	36.565	39.852	7.788	12.455	13.834	17.121
8	45.241	51.542	54.015	57.844	26.521	32.822	35.295	39.124
10	61.907	70.060	74.040	78.214	46.913	55.066	59.046	63.220
12	80.430	90.642	96.596	100.854	68.904	79.116	85.070	89.328
14	100.816	113.293	121.741	125.770	92.514	104.991	113.439	117.468
16	123.134	138.091	149.613	153.048	118.327	133.284	144.806	148.241
18	147.500	165.164	180.404	182.828	145.058	162.722	177.962	180.386
20	174.058	194.673	214.349	215.288	174.333	194.948	214.624	215.563

Table 14-11 (2) Annual Levelized Fixed Cost of Lebir Project Less Benefit from Flood Control and Improved Irrigation
(Benefit from Flood Control = M$ 27.3×10⁶ /Year)

Discount Rate(%)	Less Benefit from Flood Control : Construction Cost (90 %)	(100%)	(+6 Mos)	(110%) (M$ 10⁶ /Year)	Less Benefit from Flood Control and Improved Irrigation : Construction Cost (90 %)	(100%)	(+6 Mos)	(110%) (M$ 10⁶ /Year)
6	19.352	24.019	25.398	28.685	△3.379	1.288	2.667	5.954
8	34.074	40.375	42.848	46.677	15.354	21.655	24.128	27.957
10	50.740	58.893	62.873	67.047	35.746	43.899	47.879	52.053
12	69.263	79.475	85.429	89.687	57.737	67.949	73.903	78.161
14	89.649	102.126	110.574	114.603	81.347	93.824	102.272	106.301
16	111.967	126.924	138.446	141.881	107.160	122.117	133.639	137.074
18	136.333	153.997	169.237	171.661	133.891	151.555	166.795	169.219
20	162.891	183.506	203.182	204.121	163.166	183.781	203.457	204.396

Table 14-12 (1) Annual Levelized Fixed and Variable Costs of CCYW Project Assuming Its Generating Capacity and Annual Generation are Equal to Those of Lebir Project (In Case of 267.6MW)

(M$ 10^6 /Year)

Discount Rate(%)	At Fuel Cost of M$3.538/MBTU: Construction Cost (90%)	(100%)	(110%)	At Fuel Cost of M$5.0/MBTU: Construction Cost (90%)	(100%)	(110%)	At Fuel Cost of M$7.5/MBTU: Construction Cost (90%)	(100%)	(110%)	At Fuel Cost of M$10.0/MBTU: Construction Cost (90%)	(100%)	(110%)
6	51.223	54.850	58.477	56.650	60.277	63.904	65.930	69.557	73.184	75.210	78.837	82.464
8	57.467	61.787	66.108	62.894	67.214	71.535	72.174	76.494	80.815	81.454	85.774	90.095
10	64.304	69.384	74.464	69.731	74.811	79.891	79.011	84.091	89.171	88.291	93.371	98.451
12	71.709	77.612	83.515	77.136	83.039	88.942	86.416	92.319	98.222	95.696	101.599	107.502
14	79.655	86.441	93.227	85.082	91.868	98.654	94.362	101.148	107.934	103.642	101.428	117.214
16	88.116	95.842	103.568	93.543	101.269	108.995	102.823	110.549	118.275	112.103	119.829	127.555
18	97.068	105.788	114.509	102.495	111.215	119.936	111.775	120.495	129.216	121.055	129.775	138.496
20	106.487	116.255	126.022	111.914	121.682	131.449	121.194	130.962	140.729	130.474	140.242	150.009

Table 14-12 (2) Annual Levelized Fixed and Variable Costs of CCYW Project Assuming Its Generating Capacity and Annual Generation are Equal to Those of Lebir Project (In Case of 240.5MW)

(M$ 10^6 /Year)

Discount Rate(%)	At Fuel Cost of M$3.538/MBTU: Construction Cost (90 %)	(100%)	(110%)	At Fuel Cost of M$5.0/MBTU: Construction Cost (90 %)	(100%)	(110%)	At Fuel Cost of M$7.5/MBTU: Construction Cost (90 %)	(100%)	(110%)	At Fuel Cost of M$10.0/MBTU : Construction Cost (90 %)	(100%)	(110%)
6	47.441	50.701	53.960	52.868	56.128	59.387	62.148	65.408	68.667	71.428	74.688	77.974
8	53.053	56.935	60.819	58.480	62.362	66.246	67.760	71.642	75.526	77.040	80.922	84.806
10	59.197	63.763	68.329	64.624	69.190	73.756	73.904	78.470	83.036	83.184	87.750	92.316
12	65.852	71.158	76.463	71.279	76.585	81.890	80.559	85.865	91.170	89.839	95.145	100.450
14	72.994	79.093	85.191	78.421	84.520	90.618	87.701	93.800	99.898	96.981	103.080	109.178
16	80.598	87.542	94.485	86.025	92.969	99.912	95.305	102.249	109.192	104.585	111.529	118.472
18	88.643	96.480	104.318	94.070	101.907	109.745	103.350	111.187	119.025	112.630	120.467	128.305
20	97.109	105.887	114.665	102.536	111.314	120.092	111.816	120.594	129.372	121.096	129.874	138.652

Table 14-13 Economic Internal Rate of Return of Lebir Project (EIRR %)

Generating Capacity (MW)	Fuel Cost (M$/MBTU)	Construction Cost of CCYW Project	Annual Levelized Cost Without Regard to Benefit from Flood Control and Improved Irrigation — Construction Cost (90 %)	(100%)	(+6 Mos)	(110%)	Annual Levelized Cost Less Benefit from Flood Control — Construction Cost (90 %) A	B	(100%) A	B	(+6 Mos) A	B	(110%) A	B	Annual Levelized Cost Less Benefit from Flood Control and Improved Irrigation — Construction Cost (90 %) A	B	(100%) A	B	(+6 Mos) A	B	(110%) A	B
267.6	3.538	(90%)	7.1	6.0	< 6	< 6	10.5	12.4	9.1	10.8	8.6	10.2	7.9	9.6	12.3	13.8	11.1	12.5	10.6	11.8	10.1	11.3
267.6	3.538	(100%)	8.1	6.7	6.4	< 6	11.4	13.5	10.0	11.7	9.3	11.0	8.7	10.3	13.2	14.6	11.8	13.2	11.2	12.4	10.7	11.9
267.6	3.538	(110%)	9.2	7.6	7.1	6.5	12.6	14.6	10.9	12.7	10.1	11.7	9.4	11.1	14.1	15.5	12.6	14.0	11.8	13.1	11.3	12.6
267.6	5.0	(100%)	9.3	7.9	7.4	6.9	12.5	14.3	10.9	12.5	10.1	11.6	9.5	11.1	13.9	15.3	12.5	13.8	11.8	13.0	11.3	12.5
267.6	7.5	(100%)	11.2	9.5	9.0	8.5	14.0	15.8	12.3	13.9	11.4	12.9	10.9	12.4	15.1	16.5	13.6	14.8	12.8	14.0	12.3	13.5
267.6	10.0	(100%)	12.9	11.2	10.4	9.8	15.4	17.2	13.6	15.1	12.6	13.9	12.1	13.5	16.1	17.5	14.6	15.8	13.7	14.8	13.2	14.4
240.5	3.538	(90%)	6.2	< 6	< 6	< 6	9.5	11.3	8.3	9.9	7.9	9.4	7.3	8.9	11.6	13.0	10.5	11.8	10.0	11.2	9.5	10.7
240.5	3.538	(100%)	7.0	< 6	< 6	< 6	10.4	12.2	9.0	10.7	8.5	10.1	7.9	9.5	12.3	13.7	11.1	12.4	10.5	11.7	10.1	11.2
240.5	3.538	(110%)	7.8	6.5	6.2	< 6	11.2	13.2	9.7	11.5	9.1	10.8	8.5	10.1	13.0	14.4	11.7	13.1	11.1	12.3	10.6	11.8
240.5	5.0	(100%)	8.2	6.9	6.5	6.0	11.3	13.1	9.9	11.5	9.3	10.8	8.7	10.2	13.0	14.3	11.7	13.0	11.1	12.3	10.6	11.8
240.5	7.5	(100%)	10.1	8.6	8.1	7.6	12.9	14.5	11.3	12.8	10.6	11.9	10.0	11.4	14.1	15.4	12.8	13.9	12.1	13.2	11.6	12.7
240.5	10.0	(100%)	11.8	10.2	9.6	9.1	14.3	15.9	12.6	14.0	11.8	13.1	11.2	12.6	15.2	16.4	13.8	14.9	13.0	14.0	12.6	13.6

Note : "A" figures show EIRRs with the monetary benefit from the flood control estimated to be M$ 16.133 $\times 10^6$.

"B" figures show EIRRs with the monetary benefit from the flood control estimated to be M$ 27.3 $\times 10^6$.

Table 14-14 (1) Sum of Annual Levelized Fixed Cost of Lebir Project and Annual Variable Cost for Additional Generation by Existing Thermal Power Plant(s) (Heat Rate = 2.413 kcal/kWh)

Discount Rate(%)	In Case of 267.6 MW : Construction Cost (90 %)	(100%)	(+6 Mos)	(110%)	In Case of 240.5 MW : Construction Cost (90 %)	(100%)	(+6 Mos)	(110%)
	(M$×10⁶ /Year)				(M$×10⁶ /Year)			
6	91.739	96.406	97.785	101.072	85.769	90.436	91.815	95.102
8	106.461	112.762	115.235	119.064	100.491	106.792	109.265	113.094
10	123.127	131.280	135.260	139.434	117.157	125.310	129.290	133.464
12	141.650	151.862	157.816	162.074	135.680	145.892	151.846	156.104
14	162.036	174.513	182.961	186.990	156.066	168.543	176.991	181.020
16	184.354	199.311	210.833	214.268	178.384	193.341	204.863	208.298
18	208.720	226.384	241.624	244.048	202.750	220.414	235.654	238.078
20	235.278	255.893	275.569	276.508	229.308	249.923	269.599	270.538

Table 14-14 (2) Sum of Annual Levelized Fixed Cost of Lebir Project and Annual Variable Cost for Additional Generation by Existing Thermal Power Plant(s) (Heat Rate = 2.965 kcal/kWh)

Discount Rate(%)	In Case of 267.6 MW : Construction Cost (90 %)	(100%)	(+6 Mos)	(110%) (M$×10⁶ /Year)	In Case of 240.5 MW : Construction Cost (90 %)	(100%)	(+6 Mos)	(110%) (M$×10⁶ /Year)
6	101.500	106.167	107.546	110.833	94.238	98.905	100.284	103.571
8	116.222	122.523	124.996	128.825	108.960	115.261	117.734	121.563
10	132.888	141.041	145.021	149.195	125.626	133.779	137.759	141.933
12	151.411	161.623	167.577	171.835	144.149	154.361	160.315	164.573
14	171.797	184.274	192.722	196.751	164.535	177.012	185.460	189.489
16	194.115	209.072	220.594	224.029	186.853	201.810	213.332	216.767
18	218.481	236.145	251.385	253.809	211.219	228.883	244.123	246.547
20	245.039	265.654	285.330	286.269	237.777	258.392	278.068	279.007

Fig. 14-1 Annual Levelized Cost of Lebir Project without Regard to Benefit from Flood Control and Improved Irrigation (Generating Capacity 267.6 MW)

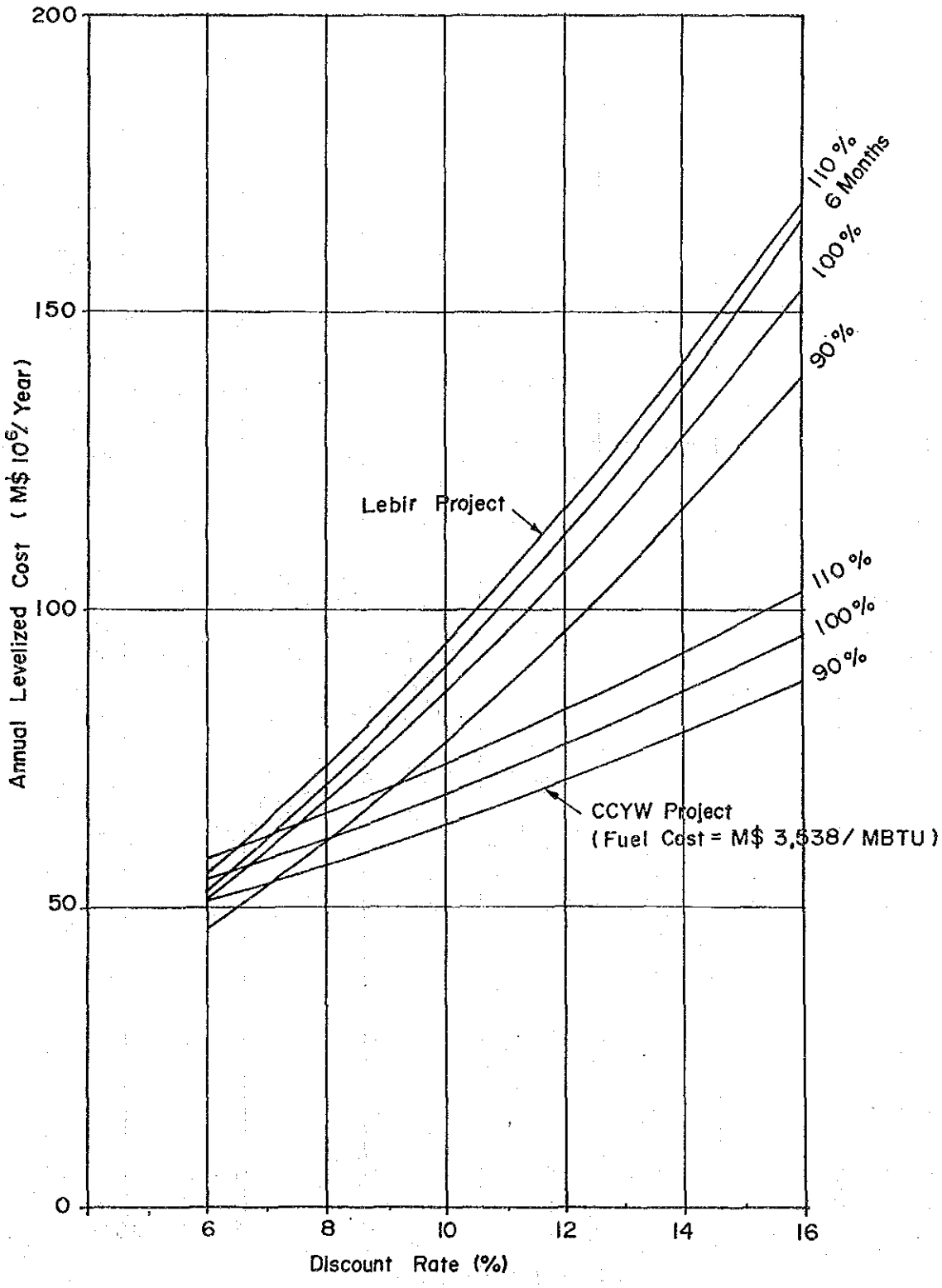


Fig.14-2(1) Annual Levelized Cost of Lebir Project
Less Benefit from Flood Control
(Generating Capacity : 267.6 MW
Benefit from Flood Control : M$ 16.133 x 10^6)

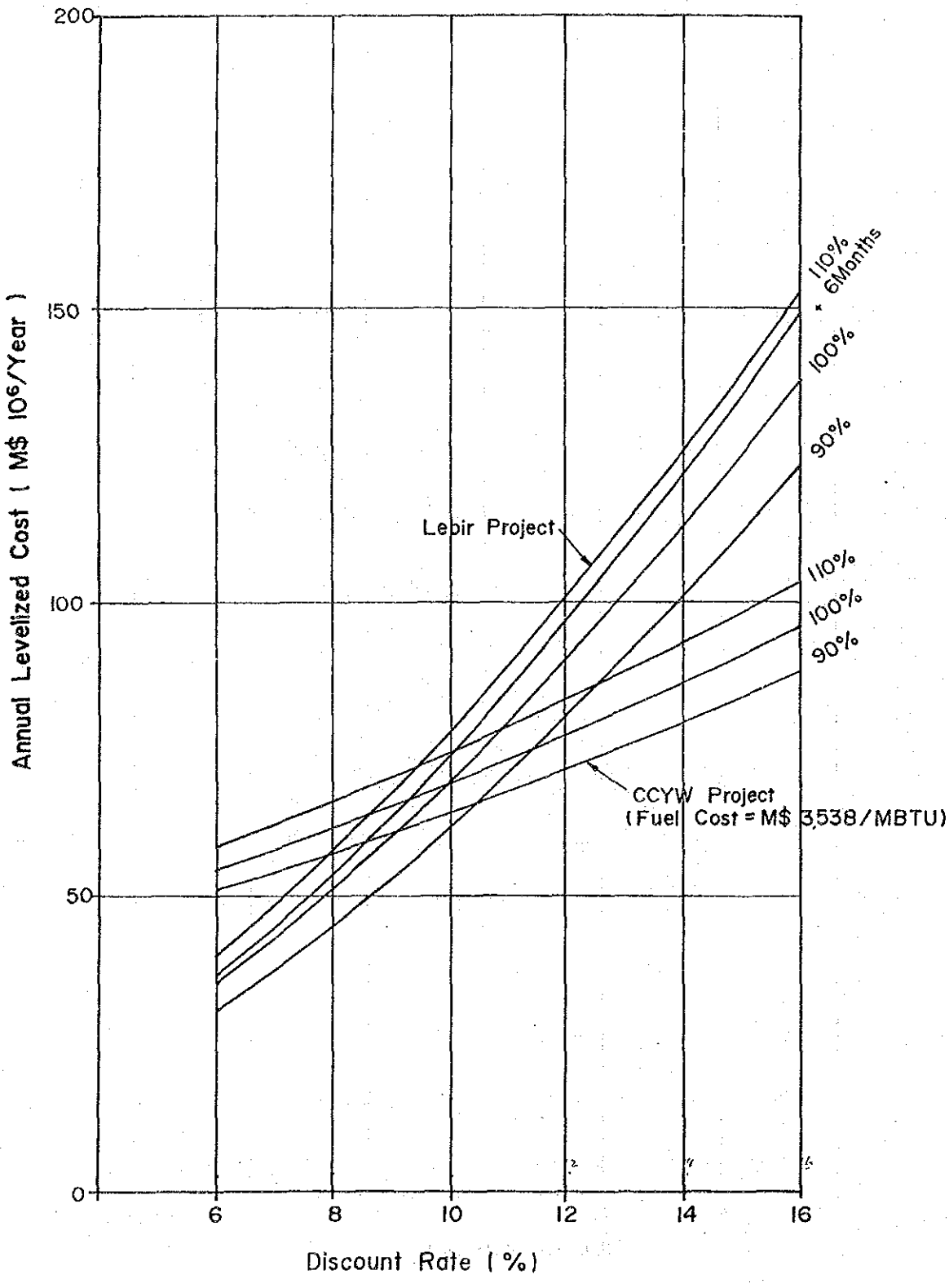


Fig.14-2 (2) Annual Levelized Cost of Lebir Project
Less Benefit from Flood Control
(Generating Capacity : 267.6 MW
Benefit from Flood Control : M$ 27.3x10^6)

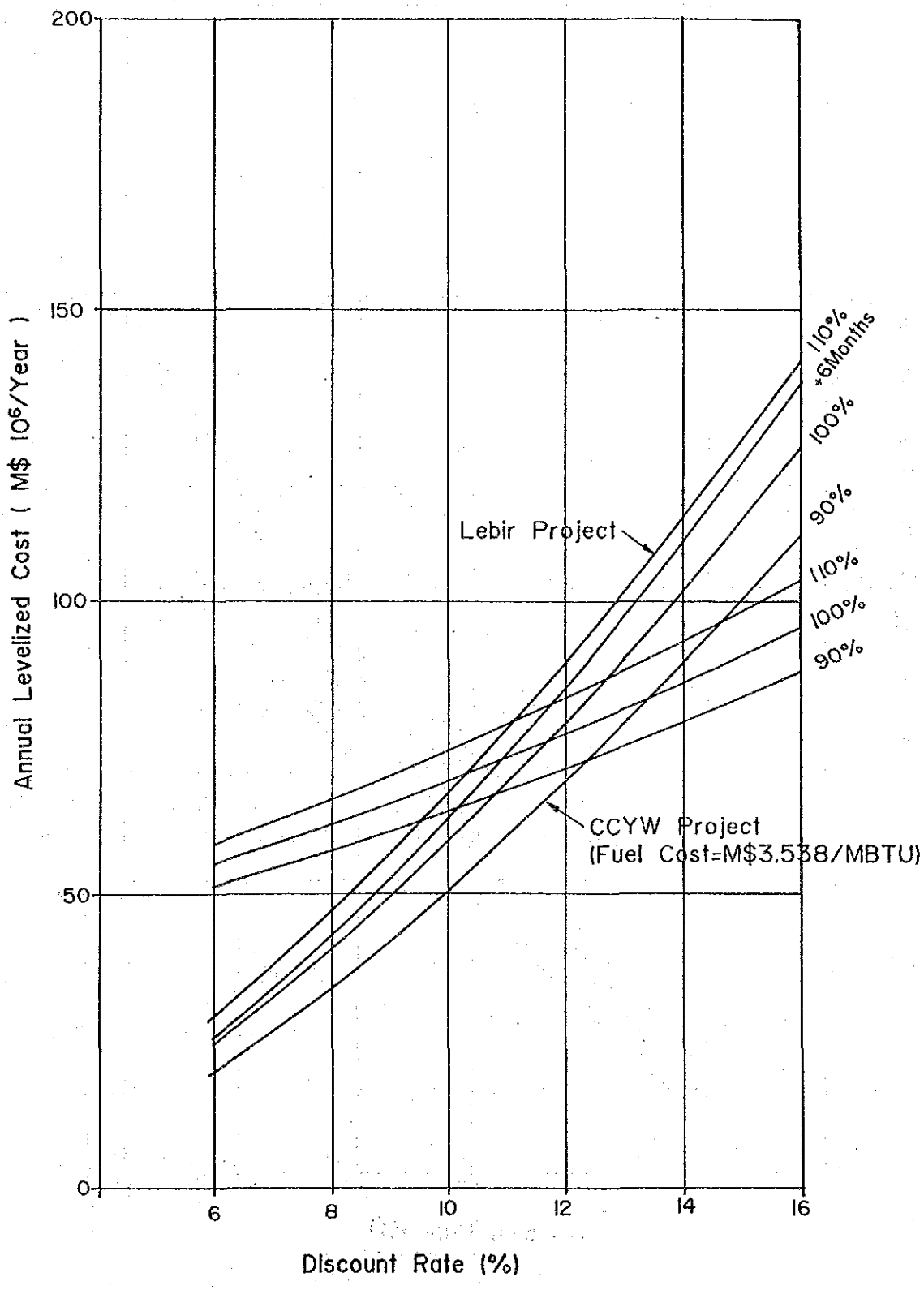


Fig.14-3(1) Annual Levelized Cost of Lebir Project
Less Benefit from Flood Control and Improved Irrigation
(Generating Capacity : 267.6 MW
Benefit from Flood Control : M$ 16.133 x 10^6)

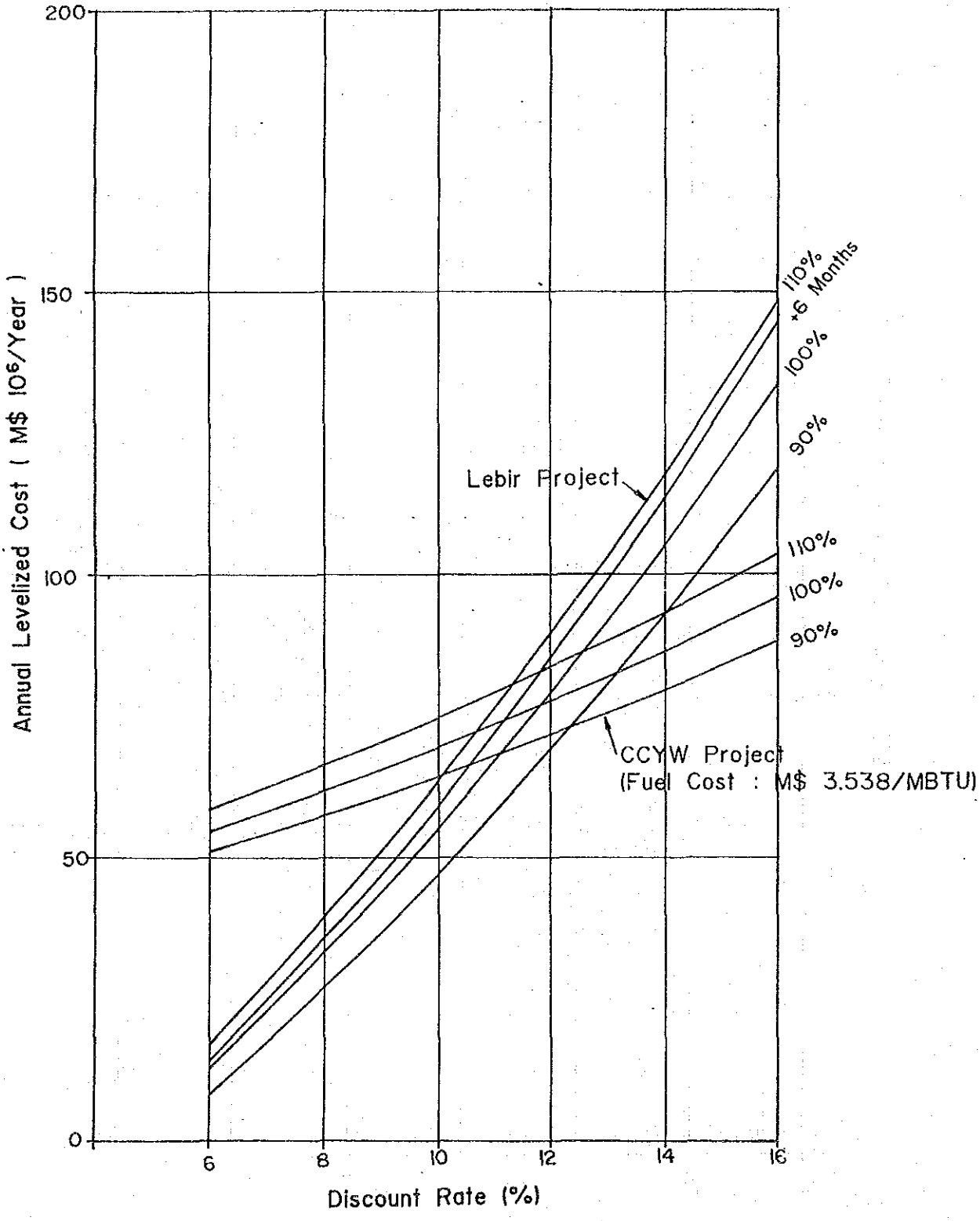


Fig.14-3(2) Annual Levelized Cost of Lebir Project
Less Benefit from Flood Control and Improved Irrigation
(Generating Capacity : 267.6 MW
Benefit from Flood Control : M$ 27.3 x10^6)

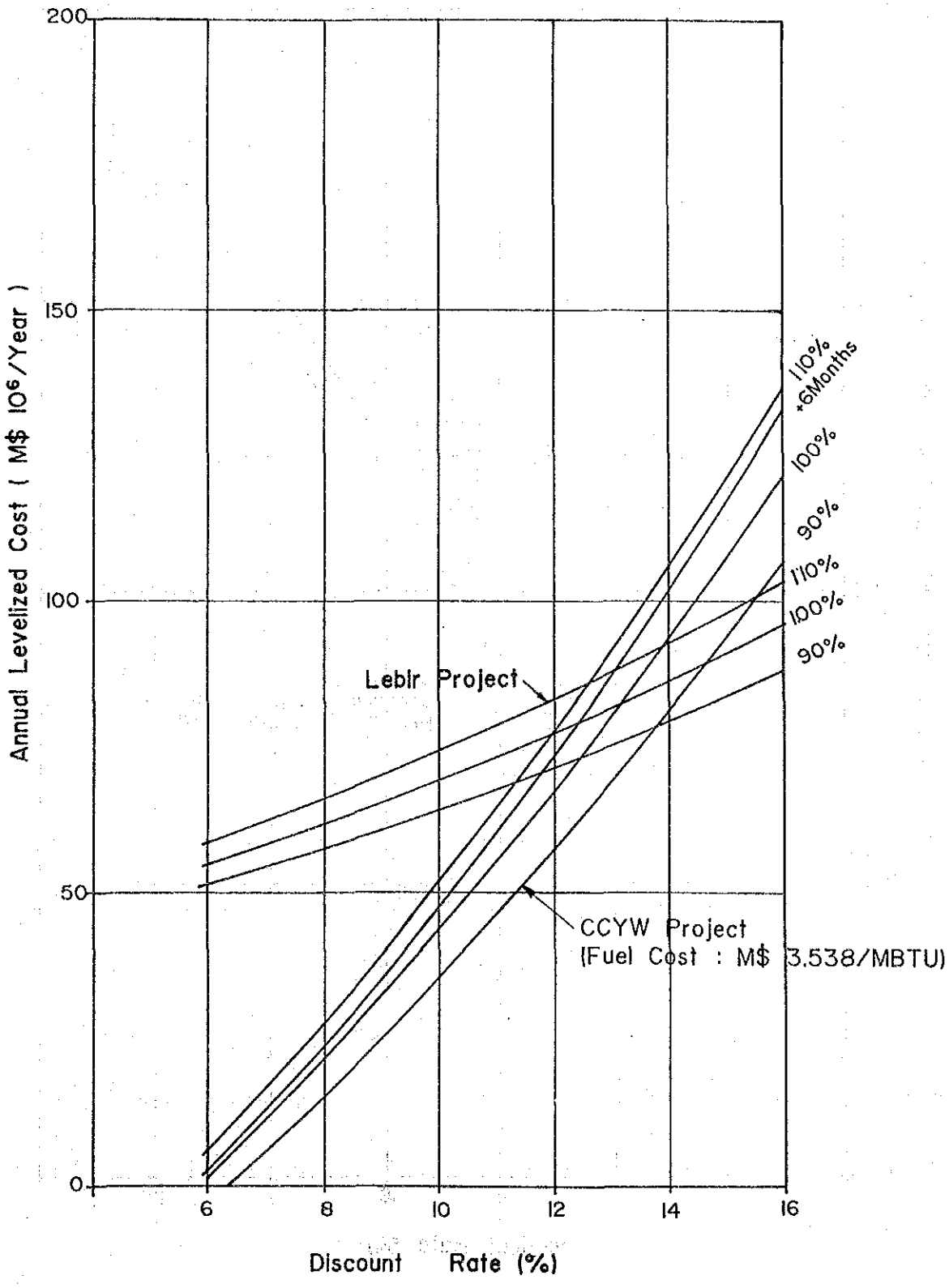
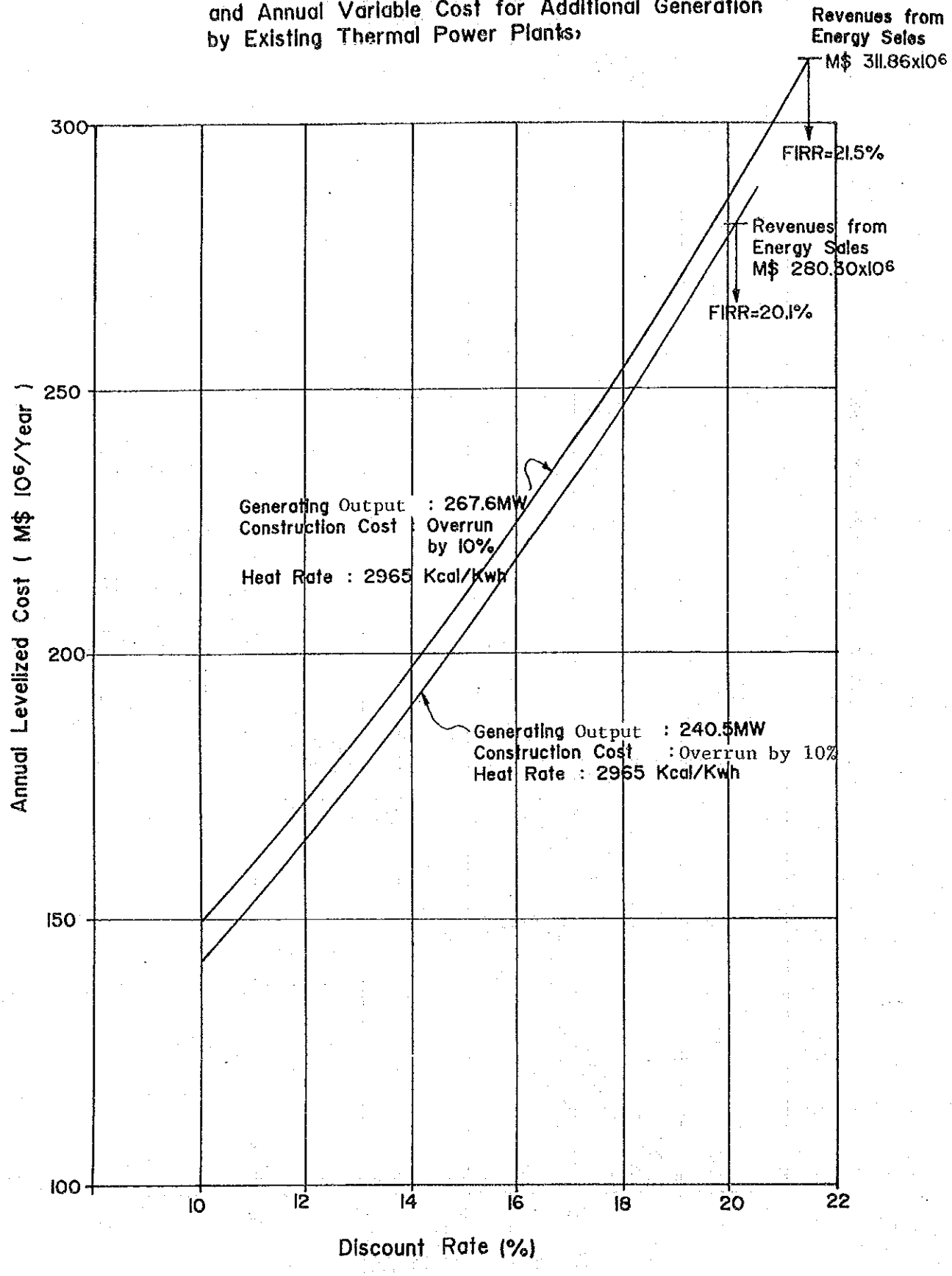


Fig. 14-4 Sum of Annual Levelized Fixed Cost of Lebir Project and Annual Variable Cost for Additional Generation by Existing Thermal Power Plants



APPENDIX

APPENDIX FIGURE LIST

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APPENDIX ATTACHMENT LIST

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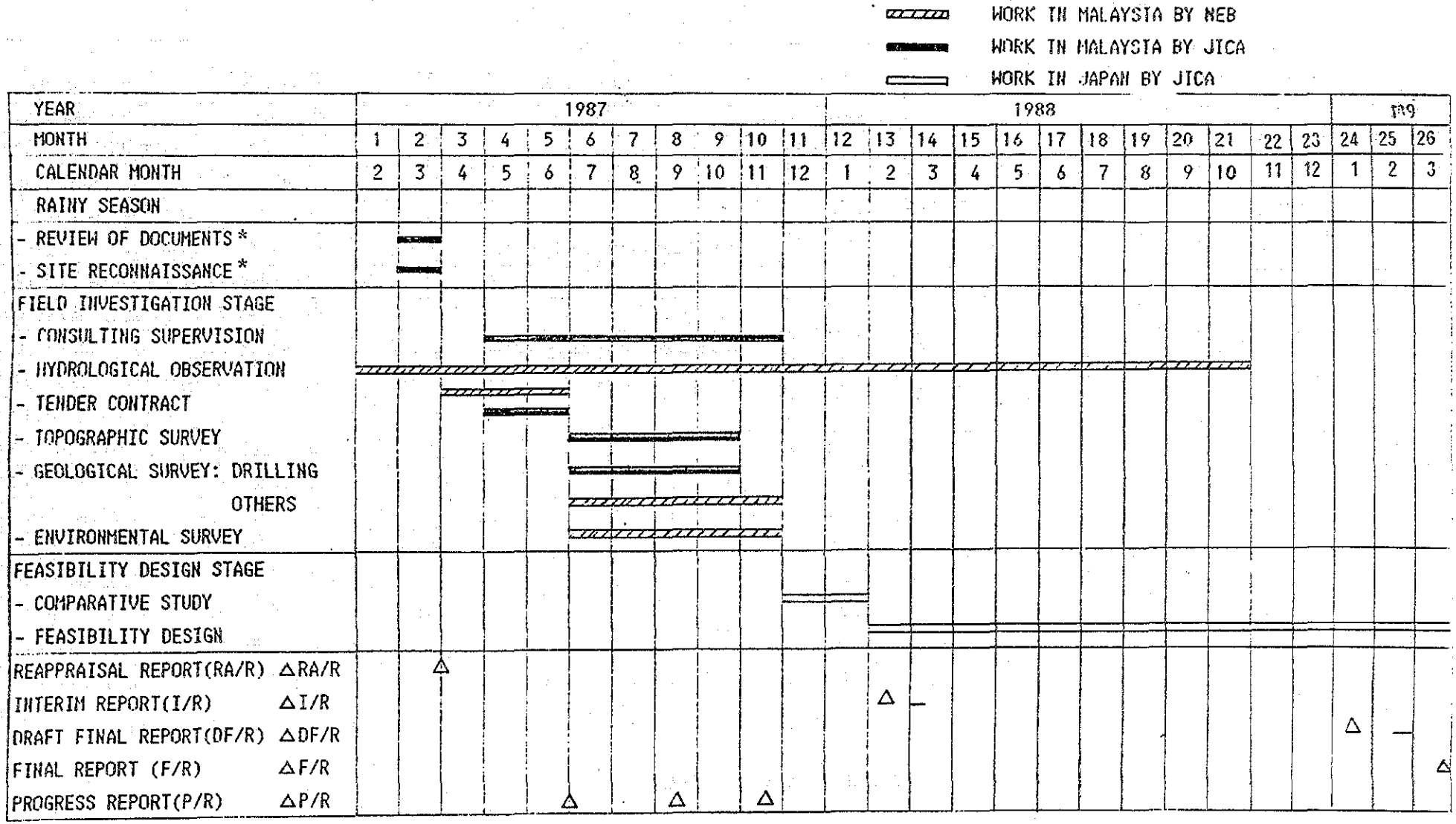
FIG. 1-1 SCHEDULE FOR FEASIBILITY STUDY OF LEBIR DAM PROJECT



Note : * Shifted backward by 0.5 months from the agreed schedule in S/W

FIG. 1-2 PERSONNEL MANNING SCHEDULE