will refer to those stated in Subsection 9.2 for the rehabilitation works of the 230 kV transmission line.

It is possible that the works of the Cam Ranh-Dien Khanh line will interrupt the supply of power for a long period of time. Although all the existing supports will be replaced with new supports, it is recommended that maximum use be made of the existing overhead earthwires, except the partial replacement of the seriously damaged parts which is necessary for the economical upgrade plan.

10.2.3 Insulators and Hardware

Both porcelain-made and glass-made insulator units should be procured not only for the purpose of upgrading, but also for maintenance purposes. Special insulators for antipollution should be supplemented for the Thap Cham-Phan Thiet and Thap Cham-Cam Ranh lines. The existing insulator sets are designed for the 110 kV systems, therefore, no modifications are required for the upgrade plan. However, since some hardware of the insulator sets has been lost or damaged, these should be supplemented or replaced with new fittings in the original design.

The works for the supplement and replacement of certain parts of the lines will be carried out in the same way as the works for the rehabilitation of the 230 kV transmission line.

10.3 Upgrade Plan for the Substation Facilities

The new 110 kV substations will be constructed at the new land adjacent to the existing 66 kV substations, to minimize a period of power interruption required for the upgrading works. After the new 110 kV substations have been completed, the transmission lines will be disconnected from the existing 66 kV substations and reconnected to the new 110 kV substations. The switching-over from the existing 66 kV to the new 110 kV substation is required to be done simultaneously at every substation after the new substation facilities are completely installed and tested.

Each new 110 kV substation will be of conventional, outdoor open type bus-and-switch arrangements for the 110 kV switchgear.

The basic arrangement for the 110 kV circuits and equipment for the substations of Thap Cham, Phan Ri and Phan Thiet have already been made by the energy center of PC-2.

Meanwhile, that for the Cam Ranh and Dien Khanh Substations will be formulated by the Study Team referring to the design philosophy of PC-2.

The existing Ninh Son Substation will be demolished after the 66 kV transmission line between the Da Nhim Power Station and the Thap Cham Substation. The electric power supply to the Ninh Son area will be continued from the Da Nhim Power Station by the existing 15 kV distribution line.

10.4 Basic Design of the Transmission Line Facilities for Upgrading

10.4.1 Supports and Related Facilities

(1) Supports

Repairs and modifications will be made to replacement of the damaged supports and the line connection of the new 110 kV substations in the Da Nhim-Thap Cham-Cam Ranh section, i.e. new steel tubular poles. The existing timber poles of the Cam Ranh-Dien Khanh line will be replaced with new supports. These new supports will be local-made concrete poles. New steel tubular poles will be designed in accordance with the following original design conditions.

1) Type of Poles

The following three types will be applied. The basic dimensions of the supports are indicated in Figure 10.2.

Type PA : Supports used for the straight line section with suspension type insulator sets and reinforced by staywires. The height of the supports will be standard, + 2 m and + 5 m.

Type PC : Supports used at the angle points up to a deviation of 45 degrees with tension type insulator sets and reinforced by staywires. The height of the supports will be standard, + 2 m and + 5 m.

Type PD : Supports used at the terminal points of the overhead earthwires and power conductors or at the heavy angle points up to 60 degrees with tension type insulator sets and reinforced by staywires. The height of the supports will be standard, + 2 m and + 5 m.

2) Design Conditions

The design wind span and weight span will be 150 m and 300 m, respectively under the following design wind pressure.

Projected area of the power conductors	:	100 kg/sq.m
Projected area of the overhead earthwires	:	110 kg/sq.m
Projected area of the insulator sets	:	140 kg/sq.m
Projected area of the steel tubular poles	:	80 kg/sq.m
Projected area of the crossarms	:	170 kg/sq.m

The following are the maximum working tensions of the power conductors and overhead earthwires:

ACSR 336.4 MCM	:	1,500 kg
Galvanized steel stranded wire 22 sq.mm	:	600 kg

The foundations of the supports will be designed under the assumption that the ultimate bearing capacity is 40 tons/sq.m and the minimum safety factor for compression and overturning is 3.0.

3) Quality of Materials

The quality of materials used for the supports will be the same as that of the materials used for the 230 kV transmission line, the quality of which is equivalent to JIS SS-41 and SS-50 or more.

4) Inspection of Products before Shipment

The following inspections and test items will be specified and will be carried out in the manufacturer's factory before the products are shipped.

- Assembling test of the poles
- Measurement of the basic dimensions
- Testing the tensile and bending strength of the materials
- Galvanization in the adhesion and uniformity tests
- Testing the insertion and screwing function of the bolts and nuts

(2) Staywires and Accessories

The staywires and their accessories which will be manufactured will be similar to the existing products, but with an additional turn-buckle at the upper part of the wire set for the easy adjustment of its tension after construction. The material of the staywires will be galvanized steel stranded wire. The size and strength of the wires and their accessories will be selected in order to provide a sufficient safety factor of more than 2.5 against the maximum load computed from the support design.

The foundations of the staywires will consist of an anchor plate and an anchor rod, and is designed with a safety factor of more than 3.0 against the uplifting load under the assumptions that the angle of repose is 20 degrees and unit weight of the soil above the anchor plate is 1.5 ton/cu.m.

Tests on the staywires and accessories will be conducted for the following items in the manufacturer's factory, before shipment:

- Tensile strength of the staywire set
- Galvanization in the adhesion and uniformity tests

10.4.2 Overhead Earthwires and Power Conductors with Fittings

(1) Overhead Earthwires and Fittings

Like the earthwires of the 230 kV transmission line, the earthwires will be made from galvanized steel stranded wires. The following technical particulars will be specified for the procurement of the wires.

		22 mm^2 Wire	50 mm^2 Wire
Standard applied	:	JIS G-3537	JIS G-3537
Tensile strength of material	:	90 kg/mm^2	90 kg/mm^2
Stranding	:	7/2.0 mm	n.a
Section of stranded wire	:	21.99 mm^2	48.64 mm^2
Outside dia. of the stranding wire	:	6.0 mm	9.2 mm
Tension of the stranding wire	:	1,820 kg	n.a

Since the wires will not be used for the new construction but used for the partial replacement or repair of the existing facilities, the standard length of the wire per drum may be 1,000 m, work for easy transportation and handling in the field.

The volume of zinc for galvanization will be specified as 230 g/m^2, for general use.

Midspan joints, suspension type and tension type clamps will be procured for repair and maintenance purposes. The midspan joints will be made from steel and will be compression type joints, and the strength of the joint will be more than 95% of the ultimate tensile strength of the earthwire. The suspension type and tension type clamps will be made from steel and will be bolt tightening type clamps. The suspension clamps will be designed so that the wire should not slip from the clamp at a load of less than 60% of the maximum working tension of the wire, while, the tension type clamp will not allow the wire to slip at a load of not less than the maximum working tension.

Tests on and inspection of the following items will be conducted before shipment.

Overhead earthwires	-	Construction of the stranding
	-	Tensile strength
	-	Elongation and twisting
	-	Galvanization in zinc volume and uniformity
Fittings	-	Appearance
	-	Galvanization in zinc volume and uniformity
	-	Bolt tightening function

(2) Power Conductors and Fittings

The technical particulars of ACSR 336.4 MCM (ASTM code name : Linnet) to be procured will be specified in accordance with the requirements of JIS or IEC standards as follows:

Stranding (Number and diameter of Individual wires)	:	Al 26/2.888mm + St 7/2.245mm
Calculated section (aluminium wire)	:	170.56 mm^2
(steel wire)	:	27.86 mm^2
(total)	:	198.42 mm^2
Outside diameter of the stranded ACSR	:	18.28 mm
Unit weight of the complete ACSR	:	655.3 kg/km
Ultimate tensile strength of ACSR	:	6,110 kg
Electrical resistance (at 20°C)	:	0.1612 ohm/km
Young's modulas (aluminium wire)	:	6,300 kg/mm^2
(steel wire)	:	21,000 kg/mm^2
Linear expansion coefficient (aluminium wire)	:	23 x 10^{-6}/°C
(steel wire)	:	1.5 x 10^{-6}/°C

Like the overhead earthwires, the conductors will not be used for the new construction but used for the partial replacement or repair of the existing conductors, the standard length per drum may be 1,000 m, for easy transportation and handling in the field.

However, the length per drum of the conductors for the Cam Ranh-Dien Khanh will be 2,000 m for lessening numbers of joints. The volume of zinc for galvanization of the steel cores will be specified as 230 g/m^2, for general use.

Fittings such as midspan joints, repair sleeves, suspension clamps and tension clamps will be procured for the repair and maintenance of the power conductors. Midspan joints of ACSR consist of an aluminium sleeve and a steel sleeve, and are compression type joints. The strength of the midspan joints after they have been compressed should be more than the ultimate tensile strength of the power conductor.

The repair sleeve of ACSR is composed of aluminium only which is designed to wrap a damaged part of the conductor. The strength of the compressed sleeve will be specified as for the midspan joints.

The suspension clamps will be free center types which allow free movement of the conductor around the clamping point. Armour rods will not be used for the lines because they have a short span length of 100m to 150m only. The tension clamps will be compression type and bolt-tightening type as used for the existing lines. The suspension clamps will be designed so that the conductor should not slip at a load of less than 60% of the maximum working tension of the conductor, while, the tension

type clamp will not allow the conductor to slip at a load of not less than the maximum working tension.

The following inspections and tests will be specified to be conducted by the manufacturer at his factory before the products are shipped:

Aluminium individual wire	-	Appearance and dimension
	-	Tensile strength
	-	Elongation and twisting
	-	Galvanization in zinc volume and uniformity
Steel individual wire	-	Appearance and dimension
	-	Tensile strength
	-	Elongation and twisting
	-	Galvanization in zinc volume and uniformity
Complete ACSR	-	Construction, appearance, and dimension
	-	Tensile strength
	-	Electrical resistance
Drum	-	Appearance and weight
Fittings	-	Appearance
	-	Galvanization in zinc volume and uniformity
	-	Bolt tightening function

10.4.3 Insulators and Hardware

(1) Insulators

Insulators to be procured are both porcelain-made and glass-made and their technical and mechanical characteristics will be specified as follows. The values in brackets are those of the antipollution type insulators.

1)	Dimension	:	254 mm x 146 mm (254 mm x 146 mm)
2)	Type of insulator	:	Ball-socket, cap and pin type
3)	Power freq. withstand voltage (wet)	:	40 kV (41 kV)
4)	Impulse withstand voltage	:	110 kV (120 kV)
5)	50% impulse flashover voltage	:	125 kV (150 kV)
6)	Power freq. oil puncture voltage	:	140 kV (140 kV)

7) Electromechanical load : 12,000 kgf (12,000 kgf)
8) Total creepage distance : 280 mm (430 mm)

The retaining pin of the insulator unit will be made of stainless steel and its size shall conform to IEC standards.

(2) Insulator Sets

The insulator sets with the complete hardware will be used mainly for maintenance purposes, and the construction and strength of the sets will be same as those used for the Da Nhim-Thap Cham-Cam Ranh line. The construction, dimensions, and specifications of the sets are shown in Figure 10.3.

Following are construction of each type of insulator sets:

	No. of String per Set	No. of Units per String
Single suspension insulator set	1	8
Special single suspension insulator set	1	8
Double suspension insulator set	2	8
Special double suspension insulator set	2	8
Single tension insulator set	1	8
Special single tension insulator set	1	8
Double tension insulator set	2	8
Reversible light duty tension set	1	8

Electrical and mechanical characteristics of insulator sets complete with all fittings shall be as specified below:

	Suspension Set		Tension Set	
	Single	Double	Single	Double
Minimum withstand voltage				
Power frequency, dry	375 kV	375 kV	375 kV	375kV
Power frequency, wet	295 kV	295 kV	295 kV	295 kV
50% flashover voltage, impulse positive 1.2 x 50 μ-sec.	630 kV	630 kV	630 kV	630 kV
Minimum mechanical strength	7 tons	12 tons	7 tons	12 tons

(including clamp)

10.4.4 Tools and Devices Used for Maintenance Purposes

Tools and devices for the maintenance of the transmission lines required by PC-2 are summarized in Tables 10.3 and 10.4, with the items, quantities, and specifications.

10.5 Basic Design of Upgraded Substations

10.5.1 Common Clause for Basic Design of Substation Facilities

The new equipment will be complete with all the necessary accessories, erection and maintenance tools and spare parts.

In principle, all the electrical equipment will comply with the latest revision of the authorized standards of the International Electrotechnical Commission (IEC). The voltage rating applied to the electrical equipment will be specified as follows:

	Rated Voltage	Lightning Impulse Withstand Voltage	Power-frequency Withstand Voltage
230 kV equipment :	245 kV	950 kV	395 kV
110 kV equipment :	123 kV	550 kV	230 kV
22 kV equipment :	24 kV	125 kV	50 kV

The DC control supply voltage will be DC 220 V for the Da Nhim Power Station and DC 110 V for the new 110 kV substations, except for the PLC equipment.

10.5.2 Basic Design of Substation Facilities for Da Nhim Power Station

(1) Circuit configuration of additional substation facilities

Power supply to the new 110 kV substations is planned to be made by replacing the existing 230/110 kV, 63 MVA transformer by a new 125 MVA one. The existing 230 kV and 110 kV switchgear for the existing transformer circuit will be used as they are. A 110 kV single bus will newly be provided for interconnection of the 230/110 kV transformer, the existing 110 kV transmission line for the Nha Trang Substation and the new 110 kV transmission line for the Thap Cham Substation.

The following substation equipment is planned to be installed additionally and will be arranged in coordination with the existing 110 kV switchgear.

1) 230/110 kV, 125 MVA transformer : 1 bank

2) 230 kV switchgear
- 230 kV lightning arrester : 1 set

3) 110 kV single bus : 1 lot

4) 110 kV switchgear
   a) 230/110 kV transformer circuit
      - 110 kV circuit breaker : 1set
      - 110 kV disconnecting switch : 1 set
   b) New 110 kV transmission line circuit
      - 110 kV circuit breaker : 1 set
      - 110 kV disconnecting switch with ES : 1 set
      - 110 kV disconnecting switch : 1 set
      - 110 kV current transformer (single-phase) : 3 sets
      - 110 kV lightning arrester (single-phase) : 3 sets

   The existing 110 kV voltage transformers will be relocated to the new 110 kV bus circuit.

5) Power line carrier system equipment : 1 lot

The control board and relay board for the additional 110 kV circuits will be provided under the urgent rehabilitation plan for the substation facilities described in Chapter 8.

On the basis of the above condition, the Study Team made the preliminary design for the additional substation facilities. The proposed single line diagram and arrangement of the equipment are shown in Figures 10.8 to 10.10.

(2) Type and rating of Transformer

The new 230/110 kV transformer will be of three-phase, oil-immersed, on-load tap-changing, auto-transformers with closed delta tertiary winding. The bushings for the primary and secondary terminals will be provided with ring-core type current transformers for measuring and protective relaying. The principal rating for the transformer will be specified as follows:

1) Rated power : 125,000 kVA

The rated power of the transformer is determined at 125,000 kVA taking into consideration the result of the power demand forecast described in Clause 10.1.2, the installed capacity of each 110 kV substation, the permissible current capacity of the 110 kV upgraded line and the existing 230/110 kV transformer capacity (63,000 kVA).

2)	Rated primary voltage	:	230 kV
3)	Rated secondary voltage	:	121 kV
4)	Connection symbol	:	YN, a0, d1

(3) Type and Rating of Switchgear

The type and principal rating of each switchgear will be specified as follows:

1) 230 kV lightning arresters

a)	Type	:	Metal-oxide gapless type
b)	Rated voltage	:	204 kV or higher
c)	Continuous operational voltage	:	156 kV or higher
d)	Discharge current	:	10 kA

2) 110 kV circuit breaker

a)	Type	:	Three-pole, SF_6 gas type
b)	Rated voltage	:	123 kV
c)	Rated current	:	1,250 A
d)	Rated short-circuit breaking current	:	25 kA

3) 110 kV disconnecting switches

a)	Type	:	Three-pole, manual handle operated type with an earthing switch of manual operated type
b)	Rated voltage	:	123 kV
c)	Rated short-time withstand current	:	25 kA

4) 110 kV current transformers

a)	Type	:	Single-phase, three-core, multi-ratio type
b)	Highest system voltage	:	123 kV
c)	Rated current ratio	:	400-200/5-5-5 A

d) Rated short-time thermal current : 25 kA

e) Accuracy class

- for measuring : 1.0
- for protective relaying : 5P20

5) 110 kV lightning arresters

a) Type : Metal-oxide gapless type

b) Rated voltage : 102 kV or higher

c) Max. continuous operating voltage : 78 kV or higher

d) Nominal discharge current : 10 kA

10.5.3 Basic Design of 110 kV Substations

The circuit configuration, switchgear arrangement and transformer capacity for each substation of Thap Cham, Phan Ri and Phan Thiet will generally conform to the design philosophy of PC-2. However, the technical specifications for each equipment will be reviewed and proposed by the Study Team.

On the other hand, the basic design of the Cam Ranh and Dien Khanh Substations for PC-3 will be formulated by the Study Team on reference to the design philosophy of the other 110 kV substations for PC-2, after ascertening the PC-3's opinion on the circuit configuration and the transformer capacity.

(1) Major equipment for substations

The substations of Thap Cham (T.C), Phan Ri (P.R), Phan Thiet (P.T), Cam Ranh (C.R) and Dien Khanh (D.K) will be composed of the following equipment.

		T.C	P.R	P.T	C.R	D.K
1)	Main transformer :	1 bank	1 bank	1 bank	1 bank	1 bank
2)	House-service trans. :	1 bank	1 bank	1 bank	1 bank	1 bank
3)	110 kV switchgear					
	- 110 kV T/L circuit :	3 cct.	2 cct.	1 cct.	3 cct.	2 cct.
	- 110 kV bus circuit :	1 cct.	1 cct.	1 cct.	1 cct.	1 cct.
	- 110 kV M.TR circuit :	1 cct.	1 cct.	1 cct.	1 cct.	1 cct.
4)	22 kV switchgear					
	- 22 kV TR circuit :	1 cct.	1 cct.	1 cct.	1 cct.	1 cct.
	- 22 kV D/L circuit :	4 cct.	3 cct.	3 cct.	4 cct.	4 cct.
	- 22 kV H.TR circuit :	1 cct.	1 cct.	1 cct.	1 cct.	1 cct.
	- 22 kV capacitor circuit :	-	-	-	1 cct.	1 cct.

5)	Control and relay board	:	1 lot	1 lot	1 lot	1 lot	1 lot
6)	DC supply system	:	1 lot	1 lot	1 lot	1 lot	1 lot
7)	AC and DC panels	:	1 lot	1 lot	1 lot	1 lot	1 lot
8)	PLC system	:	1 lot	1 lot	1 lot	1 lot	1 lot

110 kV bus connection of Thap Cham, Phan Ri and Phan Thiet Substations for PC-2 will employ the single bus scheme. On the other hand, 110 kV bus connection of the Cam Ranh and Dien Khanh Substations for PC-3 will be the main and transfer bus scheme to follow the PC-3's design policy.

On the basis of the above condition, the Study Team made the preliminary design of each 110 kV substation. The proposed single line diagram and arrangement drawings for the major circuits of each 110 kV substation are shown in Figures 10.11 to 10.25.

(2) Type and rating of main transformer

The main transformer for each substation will be of three-phase, three-winding, oil-immersed, on-load tap-changing transformer. The principal rating for the main transformer will be specified as follows:

1) Rated power
   a) Phan Thiet Substation : 25,000 kVA
   b) Other four substations : 16,000 kVA
2) Rated primary voltage : 115 kV
3) Rated secondary voltage : 15 kV/22 kV

The distribution line voltage is now 15 kV but is planned to be upgraded to 22 kV in the future. Therefore, the secondary winding of the main transformer will be designed for dual voltage rating of 69 kV and 115 kV which can be switched over easily from the outside of the transformers by changing the connection of the secondary winding.

4) Connection symbol : YN, yn0, d1

(3) Type and rating for 110 kV switchgear

The type and the principal rating of each switchgear will be specified as follows:

1) 110 kV circuit breaker
   a) Type : Three-pole, SF_6 gas type

b) Rated voltage : 123 kV
c) Rated current : 1,250 A
d) Rated short-circuit breaking current : 25 kA

2) 110 kV disconnecting switches

a) Type : Three-pole, motor-driven type

Each disconnecting switch for the transmission line for the Thap Cham, Phan Ri and Phan Thiet Substation will be equipped with an earthing switch and that for the main transformer circuit will be equipped with two earthing switches.

Each disconnecting switch for the transmission line end and the bus-tie circuit for the Cam Ranh and Dien Khanh Substations will be equipped with an earthing switch.

All the earthing switches will be of manual handle operated type.

b) Rated voltage : 123 kV
c) Rated short-time withstand current : 25 kA

3) 110 kV current transformers

a) Type : Single-phase, three-core, multi-ratio type
b) Highest system voltage : 123 kV
c) Rated current ratio
- Transmission line circuit : 400-200/5-5-5 A
- 16 MVA main transformer circuit : 125/5-5-5 A
- 25 MVA main transformer circuit : 200/5-5-5 A
d) Rated short-time thermal current : 25 kA
e) Accuracy class
- for measuring : 1.0
- for protective relaying : 5P20

4) 110 kV voltage transformers

a) Type
- Bus circuit : Single-phase, capacitor voltage transformer with two separate secondary windings

- Transmission line circuit : Single-phase, capacitor voltage transformer

The voltage transformer for each transmission line circuit will be used as a coupling capacitor for the power line carrier system and will be constructed to mount a line trap on the top.

b) Highest system voltage : 123 kV

c) Rated voltage ratio

- Bus circuit : 110 kV/$\sqrt{3}$: 110 V/$\sqrt{3}$: 110 V/3
- Transmission line circuit : 110 kV/$\sqrt{3}$: 110 V/$\sqrt{3}$

d) Accuracy class

- for measuring : 1.0
- for protective relaying : 3P

5) 110 kV lightning arresters

a) Type : Metal-oxide gapless type

b) Rated voltage : 102 kV or higher

c) Max. continuous operating voltage : 78 kV or higher

d) Nominal discharge current : 10 kA

(4) 22 kV switchgear

The 22 kV switchgear will be of indoor use, metal-clad switchgear assembly and will be installed in the control building. The 22 kV circuit breakers will be of indoor use, vacuum type or SF6 gas type of withdrawable construction. The current transformers and voltage transformers will be of epoxy resin molded type. As for the rating of the voltage transformer, the primary voltage is recommended to be rated at 15 kV because the 22 kV circuit is expected to be operated with 15 kV for the time being.

The 22 kV disconnecting switches will be of outdoor use, three-phase gang-operated type with a manual operating handle. The 22 kV lightning arresters will be of outdoor use, metal-oxide gapless type. The disconnecting switches and the lightning arresters will be installed on the dead end pole of each 22 kV distribution line feeder.

On the other hand, power capacitors will be connected to the 22 kV circuits for the Cam Ranh and Dien Khanh Substation for PC-3 to follow the PC-3's design policy. The power capacitor will be of outdoor installation and will be rated at 4,000 kvar.

The major components of the 22 kV switchgear for each 110 kV substation are shown in the single line diagram attached herewith.

(5) House-service transformer

The house-service transformer for each substation will be of three-phase, two-winding, dry molded type with an off-circuit tap changer to be housed in an indoor use cubicle and will be installed in the same room as the 22 kV switchgear cubicles in the control building. The principal rating for the house-service transformer will be specified as follows:

1)	Rated power	:	200 kVA
2)	Rated primary voltage	:	15 kV

The primary voltage of the house-service transformer will be rated at 15 kV because the 22 kV circuit is expected to be operated with 15 kV for the time being and the transformer has a small capacity. Accordingly, the house-service transformer is required to be replaced when the operational voltage of the distribution lines is upgraded to 22 kV.

3)	Rated secondary voltage	:	400 V
4)	Connection symbol	:	D, yn 11

(6) Control and relay boards

The control and relay boards will be of duplex switchboard construction so arranged that the front panels are used as the main control boards and the rear panels are used as the protective relay boards. The main control board will be provided with the measuring instruments, status and fault indicators, mimic diagrams, selector and control switches, which will suitably be arranged on the front surface. Such instruments will be arranged not only to monitor the operating condition of each circuit but also to permit remote control of the 110 kV circuit breakers and disconnecting switches, the 22 kV circuit breakers and the main transformer voltage adjustment on the front of the main control board. One synchronizing panel with a synchronoscope, two voltmeters and two frequency meters will be provided on the top of or at the side of the main cotrol board for manual synchrnonizing purpose of each 110 kV transmission line.

Each major measuring circuit will be provided with measuring transducers for all the electrical quantities such as current, voltage, active power, reactive power and

frequency for the future provision of data transfer from each substation to the load dispatching center.. Also, each watthour meter will be provided with a pulse transmitter.

All the electrical protective relays will employ digital relays to be consistent with current world practice for type of relays. The 110 kV transmission line protective relay will employ the distance protective relaying scheme. Each 110 kV transmission line circuit will be provided with an automatic reclosing feature. For this automatic reclosing purpose, an auto-reclosing relay with a synchronism check function will be provided for each 110 kV circuit.

On the other hand, a fault locator is planned to be provided at the Cam Ranh Substation to spot a fault point immediately on the 110 kV transmission lines of the section of Cam Ranh - Dien Khanh which is being operated by PC-3. The fault locator will be of the impedance measuring type, which will offer simple system composition and economy and is practically applied to the direct grounding system.

(7) Supply of electrical testing tools

There is shortage of electrical testing tools for carrying out the routine and special inspection of the substation equipment in the Cam Ranh and Dien Khanh Substation operated by PC-3. Therefore, the following electrical testing tools will be required for supply to PC-3.

1)	High voltage testing facilities with mobile car	:	1 set
2)	Tangent δ measuring equipment	:	1 set
3)	Standard AC voltmeter, 0-300/600 V, class 0.5	:	1 piece
4)	Standard AC voltmeter, 0-150/750 V, class 0.5	:	1 piece
5)	Standard AC voltmeter, 0-75/150 V, class 0.5	:	3 pieces
6)	Standard AC ammeter, 0-0.2/1 A, class 0.5	:	1 piece
7)	Standard AC ammeter, 0-2/10 A, class 0.5	:	2 pieces
8)	Standard AC ammeter, 0-10/50 A, class 0.5	:	1 piece
9)	Standard AC ammeter/voltmeter, 13 range, class 0.5	:	2 pieces
10)	Split-core, AC ammeter/voltmeter, 6-300 A, 150-600 V, class 2.5	:	1 piece
11)	Standard DC voltmeter, 0-150/300 V, class 0.5	:	1 piece
12)	Standard DC voltmeter, 0-75 mV, class 0.5	:	1 piece
13)	Standard DC ammeter, 0-100/300 mA, class 0.5	:	1 piece
14)	Standard DC ammeter/voltmeter, 17 range, class 0.5	:	2 pieces
15)	Standard wattmeter, three-phase, 120-240 V, 5A, class 0.5	:	1 piece

16)	Standard varmeter, three-phase, 120-240 V, 5A, class 0.5	:	1 piece
17)	Standard frequency meter, 45-55 Hz, class 0.2	:	2 pieces
18)	Phase sequence indicator	:	1 piece
19)	Insulation tester, 500 V, 1000 M-ohm	:	1 piece
20)	Insulation tester, 1000 V, 2000 M-ohm	:	1 piece
21)	Earth tester	:	1 piece
22)	Handy digital multimeter	:	3 pieces
23)	Relay testing equipment	:	1 set
24)	Portable oil tester	:	1 set
25)	Oil handling and oil purifying equipment of mobile type	:	1 set
26)	Aquameter to measure amount of moisture in oil	:	1 set
27)	Oscillographic recorder with 16 channels	:	1 set

10.5.4 Basic Design for Power Line Carrier Telephone System

The power line carrier (PLC) telephone system is planned to be provided at the Da Nhim Power Station and the five new 110 kV substations for mutual communication among them. The existing coupling equipment provided on the existing 66 kV transmission lines will not be used for the new PLC system in order to minimize a period of power interruption required for the upgrading work. Therefore, all the necessary equipment and materials will be newly provided for the new PLC system.

The coupling method of the PLC system will be one phase-to-ground coupling to follow the existing method. The coupling equipment such as line trap and coupling capacitor will be installed at the mid phase of the transmission lines.

The following equipment will be supplied to each substation for the new PLC system.

			D.N	T.C	P.R	P.T	C.R	D.K
1)	Line trap	:	1 set	3 sets	2 sets	1 set	3 sets	2 sets
2)	Coupling capacitor	:	1 set	-	-	-	-	-
3)	Coupling filter	:	1 set	3 sets	2 sets	1 set	2 sets	1 set
4)	PLC terminal							
	1-channel	:	-	-	1 set	1 set	1 set	1 set
	2-channel	:	-	2 sets	1 set	-	1 set	-
	4-channel	:	1 set	1 set	-	-	-	-
5)	Power supply	:	1 set	1 set	1 set	1 set	1 set	1 set

(Note) D.N: Da Nhim T.C: Thap Cham P.R: Phan Ri

P.T: Phan Thiet C.R: Cam Ranh D.K: Dien Khanh

10.6 Implementation Schedule of the Upgrade Plan

This section will discuss the implementation schedules for upgrading the transmission lines and substations examined by the Study Team on the basis of the work items, the present work forces, quantities of tools in hand and to be additionally procured, and other information as mentioned in the previous sections.

Since no specific implementation schedule of the upgrade plan has been prepared by either power companies it is expected that PC-2 and PC-3 will examine this schedule and establish their specific work schedules at the earliest possible time.

10.6.1 Implementation Schedule of the Transmission Lines

(1) Working forces

1) Da Nhim-Thap Cham section

For upgrading the existing line, any modification of the existing facilities is not needed, but repair of the facilities is required. Repair work for the replacement of the damaged supports, exchange of the damaged staywires, crossarms and insulators, and supplement of insulator units should be carried out. These works will be carried out under the deenergized condition.

In this district the line is a trunk line, and the deenergizing period will be limited. Since the peak hours in this district start in the evening the line should be shutdown between 8:00AM to 4:00PM in order to avoid the load peak time of 4:00PM to 8:00AM. Assuming that all the works should be completed within 10 days, it may be required to organize 9 working gangs of 12 linemen per gang. The works will be efficiently carried out by the same working forces which conducted the rehabilitation works of the 230 kV transmission line, after the completion of the rehabilitation.

2) Thap Cham-Phan Thiet section

No modification to upgrade the line facilities of this section are required. Only repairs works are needed to facilities such as crossarms, staywires for concrete poles, and replacement and supplement of earthing wires. Although works for the earthing wires will be carried out under the energizing condition, other works

should be carried out under the deenergizing condition. Like the Da Nhim-Thap Cham line, the deenergizing will be scheduled for 8 hours from 8:00AM to 4:00PM. Seven persons will be required for one gang consisting of 4 linemen to carry out the work on the supports and 3 workers to carry out the work on the ground. Since one gang will complete the repair of 2 supports/day on average, a total of 25 gangs will be arranged in order to complete the works within 10 days.

3) Thap Cham-Cam Ranh section

The main works for this section are the replacement of steel poles, crossarms, and insulator units, as is also the case with the works for the Da Nhim-Thap Cham section. For completing the works within the 10 days scheduled for deenergizing, eight (8) working gangs consisting of 12 linemen per gang will be sufficient.

4) Cam Ranh-Dien Khanh section

The replacement of all the existing supports will take a considerable deenergizing period. PC-3 should examine the specific implementation schedule together with the determination of the source of the work forces.

(2) Work Capability

PC-2 and PC-3 are sufficiently capable of executing the works for the Da Nhim-Thap Cham-Phan Ri-Phan Thiet and Thap Cham-Cam Ranh sections taking into account their abundant experience with similar works. It is also assured that the works for the Cam Ranh-Dien Khanh section will be smoothly executed under the supervision of PC-3.

(3) Implementation Schedule

Figures 10.4 to 10.7 show the implementation schedules prepared by the Study Team under the assumptions that the work forces and power shutdown discussed in the foregoing subsections would be arranged. The schedules are for the works under the deenergizing condition, and do not include the preparatory works and transportation of materials and tools to the site.

10.6.2 Implementation Schedule of the Substation Facilities

All the new 110 kV substations are possible to be constructed without interfering with the operation of the existing 66 kV substations because the new substations will be constructed at the new land adjacent to the site for the existing 66 kV substations. The switching-over from the existing 66 kV to the new 110 kV substation is required to be done simultaneously at the six stations after the new substation facilities are completely installed and tested. That is why the construction work for the six stations is planned to be executed in parallel as far as possible.

To advance the installation of the substation facilities smoothly and efficiently, it is to be programmed that the land formation work, the concrete foundation work and the building work should be completed before the equipment is arrived at the site. At least six months and two months will be required for the building work and the concrete foundation work respectively.

The major electrical equipment and materials of the substation facilities will be procured through the international competitive bid. The installation work and commissioning of the substation facilities will be executed by the staff of PC-2, PC-3 and the power construction companies under the guidance of the expatriate supervisors who will be dispatched from the contractor.

The equipment installation work will be executed by two working groups for outdoor equipment and for indoor equipment at every substation. If each working group will consist of ten electricians and unskilled workers, all the installation work for every substation will be completed in four months.

10.7 Recommendations for the Operation and Maintenance of the Upgraded Facilities

10.7.1 Recommendations for the Operation and Maintenance of Transmission Facilities

It is a minimum requirement to retain the present maintenance groups and organizations for repairing works, in order to properly maintain the upgraded transmission line's facilities. Tools and materials will be sufficient for the urgent repair and maintenance, for some time, of the upgraded lines, if the items listed above will be procured. It is recommended to

amend the present maintenance manual to a more specific manual referring to a sample manual for 230 kV transmission lines, presented by the Study Team.

10.7.2 Recommendations for the Operation and Maintenance of Substation Facilities

The operation and maintenance for the new substation facilities are recommended to be executed in compliance with the operation and maintenance rules and regulations to be compiled for the respective facilities referring to the instruction manuals for the operation and maintenance which will be forwarded from the contractor. The operating status of the equipment will usually be observed and recognized by the daily and periodical inspections.

The recommendable inspection and maintenance items for the major substation equipment are as follows. The inspection method will be referred to the manufacturer's instruction manuals.

(1) Transformers

1) Special inspection and maintenance (every seven years)

a) Interior inspection by overhaul of transformer
b) Inspection and cleaning for bushings, pressure relief valves, radiators and conservators
c) Replacement of gaskets
d) Change or purification of insulating oil

2) Special inspection and maintenance (every five years)

a) Overhaul inspection of auxiliary equipment such as oil pumps and cooling fans
b) Inspection of control circuits

3) Routine inspection and maintenance (every three months)

a) External inspection of auxiliary equipment, especially for operating status and bearing oil condition
b) Other general inspection

4) Insulating oil analysis and test (every three years)

(2) Switchgear

1) Special inspection and maintenance (every six years)

a) Overhaul inspection of interrupting parts (circuit breakers)
b) Overhaul inspection of operating mechanism (circuit breakers and disconnecting switches)
c) Inspection of local control boxes
d) Performance test

2) Routine inspection and maintenance (every two years)

a) External inspection of operating mechanism (circuit breakers and disconnecting switches)
b) Operation test (circuit breakers and disconnecting switches)
c) Inspection and cleaning of bushings and insulators
d) Looseness check of main circuit terminals and wiring
e) Measurement of insulation resistance
f) Measurement of leakage current (lightning arresters)
g) Other general inspection

(3) Control and relay boards

1) Special inspection and maintenance (every two years)

a) Calibration check of measuring instruments
b) Performance test of electrical protective relays

2) Routine inspection and maintenance (every one year)

a) General inspection and wiring check
b) Comprehensive operation check including sequence check
c) Measurement of insulation resistance

Table 10.1 Required Materials for Urgent Rehabilitation and Upgrade of 66 kV/110 kV Transmission Lines in the PC-2 Region

No.	Description	Unit	Q'ty	Specifications
	Da Nhim-Thap Cham Section			
M 1.	Galvanized Steel Poles			
	PA+2 type	set	2	Sumitomo Dwg. No.TPS-73130 or equival.
	PA+5 type	set	1	Sumitomo Dwg. No.TPS-73130 or equival.
	Galvanized Pole Caps			
	For PA type	piece	60	Nasu Dwg. No.J-46027 or equivalent
	For PC type	piece	15	Nasu Dwg. No.J-46027 or equivalent
	For PC & PD types	piece	15	with groundwire clamp, Nasu Dwg.No.J-46030 or equivalent
M 2.	Hardwares for Steel Poles			
	Crossarm U-band, type 15a	set	10	Nasu Dwg. No.J-46045 or equivalent
	type 15b	set	10	Nasu Dwg. No.J-46045 or equivalent
	Crossarm attachment, M-type	set	60	Nasu Dwg. No.J-46046 or equivalent
	Crossarm band for PC &PD	set	40	Nasu Dwg. No.J-46047 or equivalent
	Guy wire band, 216.7 mm	set	50	Nasu Dwg. No.J-46104 or equivalent
	267.4 mm	set	50	Nasu Dwg. No.J-46104 or equivalent
	Band for groundwire	set	50	Nasu Dwg. No.J-46048 or equivalent
	Strain Plate	piece	50	Nasu Dwg. No.J-46040B or equivalent
	- ditto -	piece	50	Nasu Dwg. No.J-46042B or equivalent
	Loop type support	set	50	Nasu Dwg. No.J-46013A or equivalent
	Eye bolt for base plate	piece	100	Nasu Dwg. No.J-46020 or equivalent
	Arm-tie band	set	100	Nasu Dwg. No.J-46050 or equivalent
	Anchor rod	set	100	Nasu Dwg. No.J-46054A or equivalent
	Anchor Plate	set	100	Nasu Dwg. No.J-46024A or equivalent
	Strain inulator	piece	200	Nasu Dwg. No.J-46010 or equivalent
	Guy wire (7/3.2mm)	meter	3,000	Galvanized steel stranded wire (55 sq.mm)
	Guy grip, thimble type	piece	200	
	ball type insulator	piece	200	
M 3.	Insulator Set			
	Single Suspension Set	set	100	NGK Dwg. No.89700#1 or equivqlent
	Special Single Suspension	set	20	NGK Dwg. No.89700#2 or equivqlent
	Double Suspension Set	set	20	NGK Dwg. No.89701#1 or equivqlent
	Special Double Supension	set	20	NGK Dwg. No.89701#2 or equivqlent
	Single Tension Set	set	50	NGK Dwg. No.89703#1 or equivqlent
	Special Single Tension set	set	10	NGK Dwg. No.89703#2 or equivqlent
	Double Teansion Set	set	20	
	Reversible Light Duty Set	set	10	NGK Dwg. No.89707#1 or equivqlent
	Standard Insulator Disc	unit	1,300	254 mmx 146mm porcelain
	Fog Type Insulator Disc	unit	200	254 mmx 146mm porcelain
M 4.	Hardware for Insulator Sets			
	Suspension Clamp	set	100	NGK Cat. No.1H-1074AU or equivalent
	Horn Hoder, ball eye	piece	50	NGK Cat. No.4H-2046A or equivalent
	socket eye	piece	50	NGK Cat. No.4H-20496B or equivalent
	Arcing Horn	piece	50	NGK Cat. No.2H-1810AU or equivalent
	- ditto -	piece	50	NGK Cat. No.2H-1810BU or equivalent
	- ditto -	piece	50	NGK Cat. No.2H-1812AU or equivalent
	- ditto -	piece	50	NGK Cat. No.2H-1812BU or equivalent
	U-bolt with 2 nuts	piece	200	NGK Cat. No.4H-1805BU or equivalent
	Clevis Eye	piece	50	NGK Cat. No.4H-488-10 or equivalent
	Clevis Socket	piece	50	NGK Cat. No.4H-20491B or equivalent
	Clevis Ball	piece	50	NGK Cat. No.4H-492C or equivalent
	Anchor Shackle	piece	200	NGK Cat. No.4H-835A or equivalent
	Chain Link	piece	100	NGK Cat. No.3H-7D or equivalent

No.	Description	Unit	Q'ty	Specifications
	Strain Clamp Set-336.4MCM	set	100	NGK Cat. No.2H-970AU or equivalent
	Susp. Clamp GSW 22sq.mm	set	100	NGK Cat. No.1H-677BU or equivalent
	Tension Clamp	set	50	NGK Cat. No.GNB-4511U or equivalent
M 5.	Hardware for Power Conductor			For ACSR 336.4 MCM
	Stockbridge Damper	piece	50	NGK Cat. No.SD-3002-3 or equivalent
	Midspan Joint	set	200	Asahi Cat. No.SP-6158 or equivalent
	Repair Sleeve	set	200	Asahi Cat. No.RS-6075 or equivalent
	Flexible Copper Earth Bond	set	500	NGK Cat. No.2H-500 or equivalent
	Dead End Clamp	set	50	NGK Cat. No.2H-1025-8 or equivalent
M 6.	Hardwares for O.H Earthwire			
	Midspan Joint (22 sq.mm)	piece	50	Asahi Cat. No.SP-6158#1 or equivalent
	Suspension Set	piece	5	NGK Cat. No.89710a or equivalent
	Tension Set for DE Tower	set	10	NGK Cat. No.89711 or equivalent
	Suspension Set for Pole	set	50	NGK Cat. No.89712 or equivalent
	Tension Set for Pole	set	20	NGK Cat. No.89713 or equivalent
M 7.	Power Conductor	km	5	ACSR 336.4 MCM
M 8.	Overhead Earthwire	km	2	GSW 22 sq.mm
	Thap Cham-Ph. Thiet Section			
M 9.	Galvanized Steel Materials			
	L 70 x 70 x 6 x 6 m long	piece	40	SS-41
	L 100 x 100x 7 x 6 m long	piece	20	SS-41
	L 50 x 50 x 4 x 6 m long	piece	40	SS-41
	Flat Bar 120 x 10 mm	piece	10	SS-41, 6 m long
	Flat Bar 70 x 6 mm	piece	20	SS-41, 6 m long
	Flat Bar 60 x 6 mm	piece	20	SS-41, 6 m long
	(Total Weight)		(4.9 tons)	
M10.	Galvanize Bolt and Nut			
	16 mm dia. x 45 mm long	piece	1,000	SS-41, with flat washer of 3mmt
	16 mm dia. x 120 mm long	piece	200	SS-41, with flat washer of 3mmt
	20 mm dia. x 90 mm long	piece	200	SS-41, with flat washer of 4mmt
	24 mm dia. x 70 mm long	piece	100	SS-50, with flat washer of 4mmt
	(Total Number)		(1,500)	
(M11.	Crossarm Set)			
	Suspension Poles	set	50	SS-41, Dwg. 0790XD07 & 08
	Tension Poles	set	15	SS-41, Dwg. XM110-04
	- ditto -	set	10	SS-41, Dwg. 0190XD07 & 08
M12.	Pole Accessories			
	Counterpoise Wire	piece	200	GSW 12 mm dia. x 25 m
	Galvanized Steel Rod	piece	300	for earthing, 16 mm dia. x 2.4 m
	Galvanized Steel Terminal	piece	1,000	For fixing C.P to pole
	Guy Wire	meter	3,000	GSW 55 sq.mm
	Guy Grip	piece	200	for guy wire, thimble type
	Anchor Shackle	piece	200	for guy wire
	Wire Clip	piece	1,000	for GSW 16 mm dia.
M13.	Midspan Joint for Russian AC	set	150	Outside diameter of ACSR : 18.8 mm Outside diameter of steel core : 6.9 mm
M14.	Repair Sleeve for Russian AC	set	200	Outside diameter of ACSR : 18.8 mm
M15.	Midspan Joint for GSW TK-50	piece	50	Outside diameter of GSW : 9.2 mm

Table 10.2 Required Materials for Rehabilitation and Upgrade of 66 kV Transmission Line in PC-3 Region

No.	Description	Unit	Q'ty	Specifications
	Thap Cham-Cam Ranh Section			
M 1.	Galvanized Steel Crossarm	set	42	with bolts and nuts
M 2.	Galvanized Steel Pole	set	2	Type PA (standard height)
	- ditto -	set	2	Typ PA + 2
M 3.	Insulator Unit			
	Standard type	unit	7,000	254 mm x 146 mm, porcelain
	Fog type	unit	3,000	254 mm x 146 mm, porcelain
M 4.	Power Conductor	ton	102	ACSR 336.4 MCM including mid-span joints
M 5.	Stay Wire	meter	2,500	GSW 55 sq.mm
	Stay Wire Fitting	set	100	
M 6.	Earthing Set	set	100	GSW 38 sq.mm for counterpoise
	Cam Ranh-D.Khanh Section			
M 7.	Insulator Unit			
	Standard type	unit	5,000	254 mm x 146 mm, porcelain
	Fog type	unit	7,000	254 mm x 146 mm, porcelain
	Insulator Hardware	set	1,000	including suspension & tension sets
M 8.	Power Conductor	ton	102	ACSR 336.4 MCM including mid-span joints
M 9.	Overhead Earthwire	km	50	GSW 22 sq.mmincluding mid-span joints
M10.	Counterpoise Set	set	400	GSW 38 sq.mm

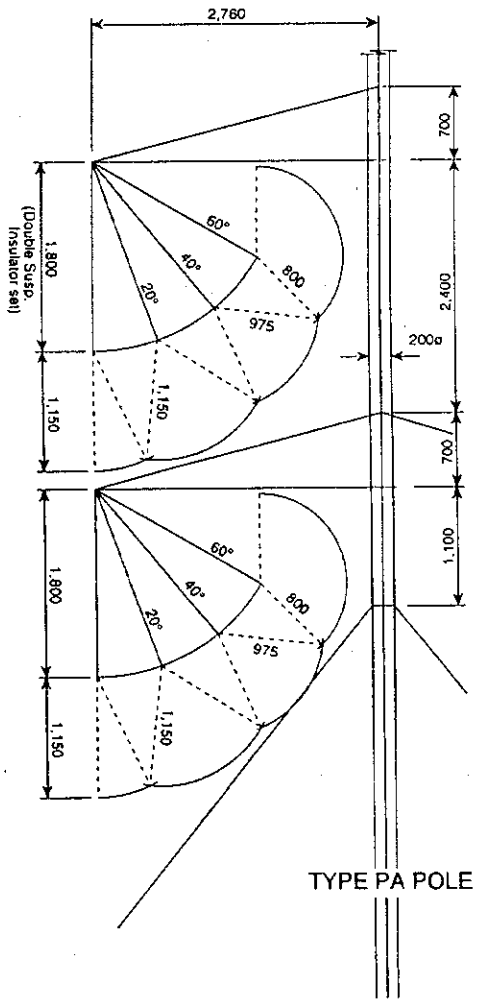
Table 10.3 Required Tools for Urgent Rehabilitation and Upgrade of 66 kV/110 kV Transmission Lines in the PC-2 Region

No.	Description	Unit	Q'ty	Specifications
T 1.	Engine Winch, SEW-30	set	2	EW-2000S
T 2.	Conductor Tensioner	unit	2	1.2 m dia. Shoe-Chain Type
T 3.	Hand Winch (BV)	set	4	Model BV-1000
T 4.	Lever Block	set	3	0.75 tons capacity (LB008)
	- ditto -	set	3	1.5 tons capacity (LB015)
T 5.	Tower Form (3 meters)	set	10	Dwg. No. TF-100
T 6.	Insulator Replacer	set	5	Dwg. No. K-200 including 1 set for double tension set
	Insulator Lifter	set	4	Dwg.No. K-201
T 7.	Torque Wrench	set	4	50-225 kgf.cm, Model 225 QL
	- ditto -	set	4	200-900 kgf.cm, Model 900 QL
T 8.	Wire Joint Clevis	piece	20	12-14 mm (C324)
T 9.	Turnbuckle (hook type)	set	10	2 tons lever-operatig load
	- ditto - (clevis type)	set	10	2 tons lever-operatig load
T10.	Hydraulic Compressor	set	4	with a 25m tube and dies for ACSR 410sq.mm, 336.4MCM, AC2K, and GSW 22,38,50 sq.mm
T11.	Wire Rope (10 mm dia.)	km	2	In 200 meter coil
	Wire Rope (14 mm dia.)	km	1	In 200 meter coil
T12.	Nylon Rope (16 mm dia.)	km	2	In 200 meter coil
T13.	Hand Drill	set	2	For bolt holing at site
T14.	Pulling Grip for Power Conductor	set	20	Braid Type Grip for 19-25 mm
	Pulling Grip for O.H Earthwire	set	20	Braid Type Grip for 26-32 mm
T15.	Swivel for 2,500 kg Pulling	set	30	Clevis-type (No.2)
T16.	Stringing Roller	set	30	(S-303)
T17.	Aerial Conductor Car	set	4	For Single Conductor Use
T18.	Temporary Earthing Equipment	set	10	For 150k V transmission line use
	- ditto -	set	5	For 300 kV transmission line use
T19.	Conductor Cutter	set	3	With dies for ACSR 410mm sq.mm, 336.4 MCM, 185 sq.mm and 200 sq.mm
T20.	Oil Pressure type Cutter	set	2	Model S-40
T21.	U-type Clevis	piece	20	Model UCH-500
	- ditto -	piece	20	Model UCH-800
T22.	Hanger for Pulley	set	10	for 2,600 kg (L75)
	- ditto -	set	10	for 3,200 kg (L90)
T23.	Tension Meter	set	2	For 1 ton use, (T-100N)
	- ditto -	set	2	For 3 tons use, (T-100N)
T24.	Chicago type Conductor Grip	set	10	For 18-32 mm
T25.	Conductor Hook	set	5	(K-401)
T26.	Tirfore	set	2	Model T-13
T27.	Wire Clip, MR-8 type	piece	20	WK-112
	MR-10 type	piece	20	WK-112
	MR-14 type	piece	20	WK-112
T28.	Safety Belt for Lineman	set	50	With 2 m Safety Rope
T29.	Snatch Block, 2 tons capacity	set	4	Double wheel (2S100)
	5 tons capacity	set	4	Double wheel (2S150)
	2 tons capacity	set	4	Single wheel (1S100)
	5 tons capacity	set	4	Single wheel (1S150)
T30.	Pressed Steel Plate Block	set	10	150 mm
T31.	Aluminium Pulley	set	40	Urethan lining (Dwg.No.P-101-E)
T32.	Stringing Tension Meter	set	2	Dwg.No. T-550X
T33.	Drum Stand	set	2	Oil Jack type (R-311)
T34.	Derrick with Pedestal	set	2	Dwg.No. D-1800
T35.	Binocular	unit	4	Type 1406

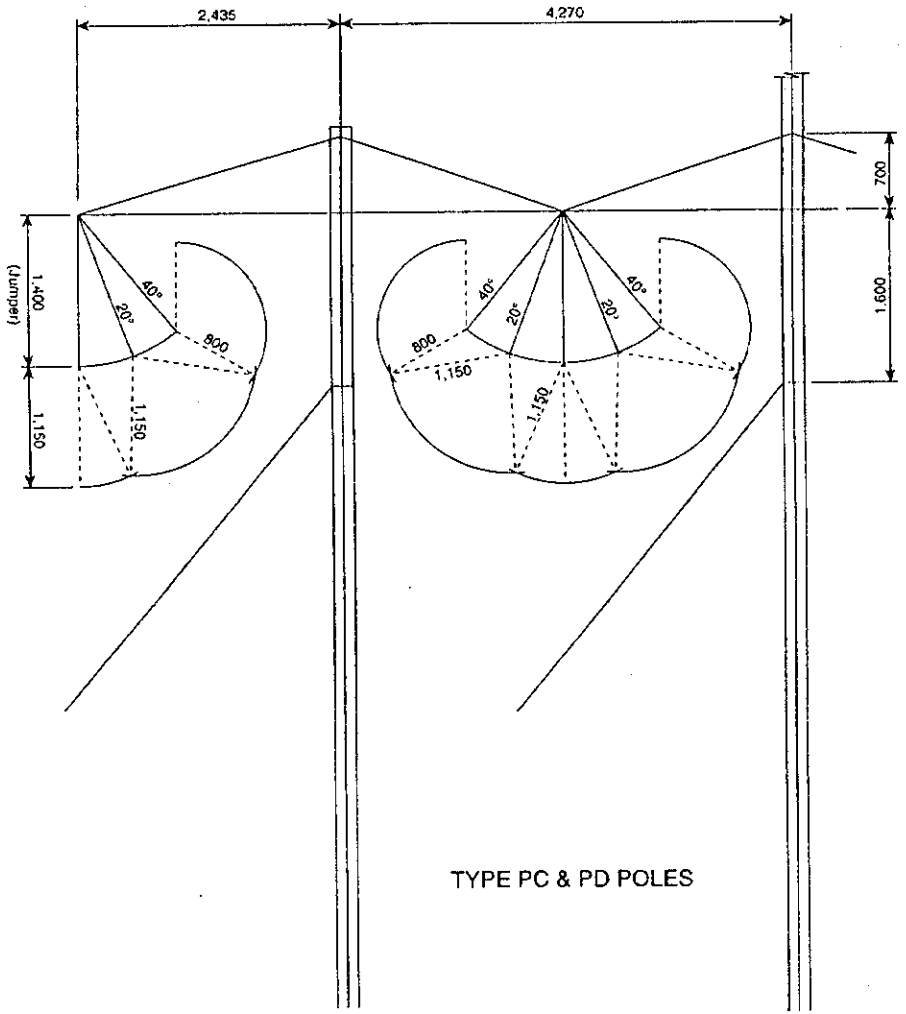
Table 10.4 Required Tools for Urgent Rehabilitation and Upgrade of 66 kV Transmission Line in PC-3 Region

No.	Description	Unit	Q'ty	Specifications
T 1.	Engine Winch	set	4	Mounting on 4WD vehicle
T 2.	Hand Winch	set	2	20 tons capacity in combination with pulley
T 3.	Hand Winch (B.V)	set	5	4 ton capacity in combination with pulley
T 4.	Conductor Tensioner	unit	5	1.2 m dia. Shoe cain type
T 5.	Chain Hoist	set	5	4.5 - 6.0 ton capacity
T 6.	Tirfor	set	10	Model T0-13
T 7.	Aluminium Ladder	set	5	5m + 7m (12m) long per set
T 8.	Insulator Replacer	set	10	Complete set for 254 mm x 146 mm
T 9.	Torque Wrench	set	5	200 - 900 kgf-cm
T10.	Gin Pole	set	5	15 m long in total
T11.	Pulling Grip for Power Conductor	set	10	Braid type grip for ACSR 300 sq.mm
	- ditto -	set	10	Braid type grip for ACSR 185 sq.mm
T12.	Pulling Grip for OH Earthwire	set	10	Pulling Grip for GSW 70 sq.mm
T13.	Turn Buckle	set	10	3 - 5 tons capacity
T14.	Hydraulic Compressor	set	5	with a 25 m tube and dies for ACSR Linnet and 185 sq.mm, GSW 22 and 70 sq.mm
T15.	Hydraulic Cutter	set	5	for ACSR Linnet and ACSR 185 sq.mm
T16.	Hand Drill	set	5	For bolt holing at site
T17.	Swivel for 2,000 kg Pulling	set	10	Clevis type
T18.	Swivel for 4,000 kg Pulling	set	10	Clevis type
T19.	Fault Insulator Detector	set	10	Gap-type detector for 230 kV line
	- ditto -	set	10	Gap-type detector for 110 kV line
T20.	Aerial Conductor Ca	set	5	For single conductor use
	- ditto -	set	2	For four conductor use
T21.	Earthing Roller	set	10	
T22.	Temporary Earthing Equipment	set	40	For transmission line use
T23.	Line Throwing Equipment	set	5	Spring type
T24.	Portable Hydraulic Punch	set	1	For bolt-holing
T25.	Ratchet Spanner	set	10	For bolts of 14 mm and 16 mm
	- ditto -	set	10	For bolts for 16 mm and 18 mm
	- ditto -	set	10	for bolts of 20 mm and 22 mm
T26.	Tension Meter	set	5	For 3 tons use
	- ditto -	set	5	For 5 tons use
T27.	Come-along Clamp	set	20	For ACSR 300 sq.mm
	- ditto -	set	20	For ACSR 185 sq.mm
T28.	Wire Grip	set	5	Model WG-4000
T29.	Pulley Block	set	200	309 mm dia. urethane-lined
T30.	Snatch Block	set	10	3 wheels
	- ditto -	set	10	1 wheel
T31.	Lever Block	set	10	3 - 6 tons capacity
T32.	Screw Anchor	set	10	
T33.	Joint Protector	set	10	For ACSR 185 sq.mm
	- ditto -	set	10	For ACSR 300 sq.mm
	- ditto -	set	10	For ACSR 500 sq.mm
T34.	Yoke	set	10	For stringing use, 6 tons capacity
T35.	Wire Rope, 10 mm dia.	km	5	In 200 m coil with 25 connectors
	Wire Rope, 12 mm dia.	km	5	In 200 m coil with 25 connectors
	Wire Rope, 14 mm dia.	km	5	In 200 m coil with 25 connectors
T36.	Nylon Rope, 12 mm dia.	km	4	In 200 m coil
	Nylon Rope, 16 mm dia.	km	4	In 200 m coil

unit : mm

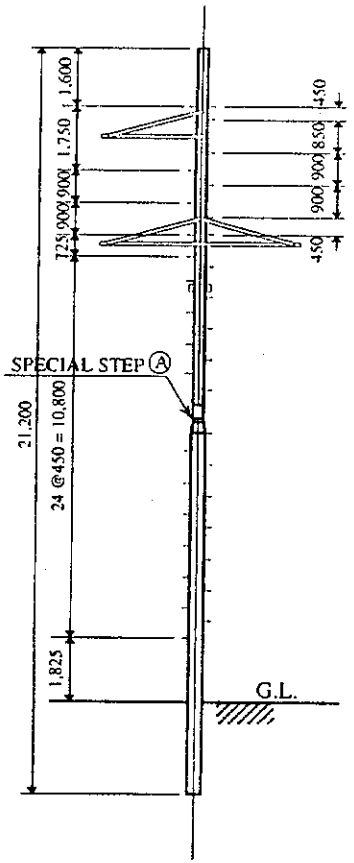


TYPE PA POLE



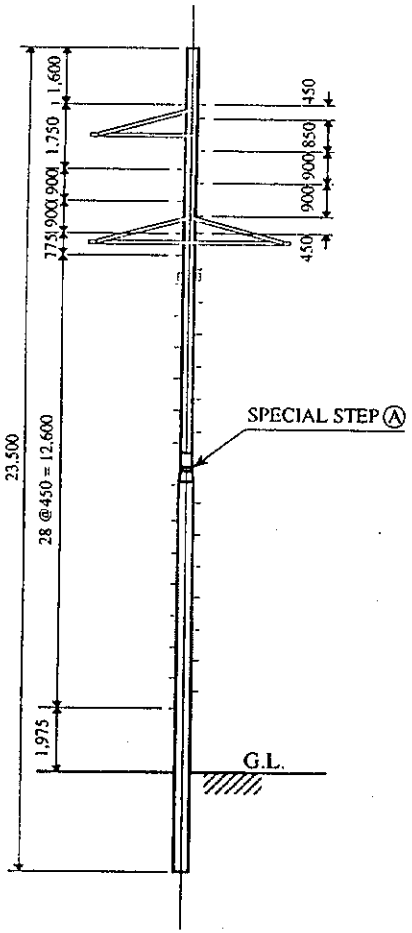
TYPE PC & PD POLES

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.1 Clearance Diagram for 110 kV Transmission Line



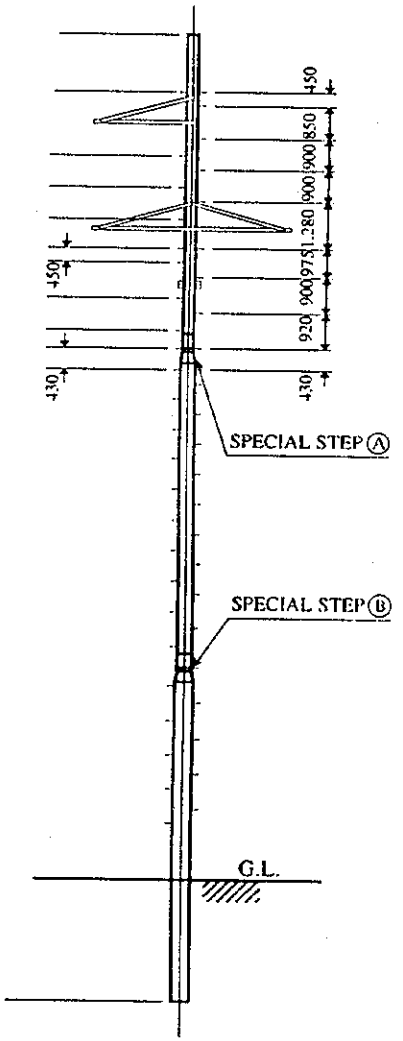
TYPE PA

Q'ty STEP BOLT 33 pcs.
SPECIAL STEP 1 pc.



TYPE PA + 2

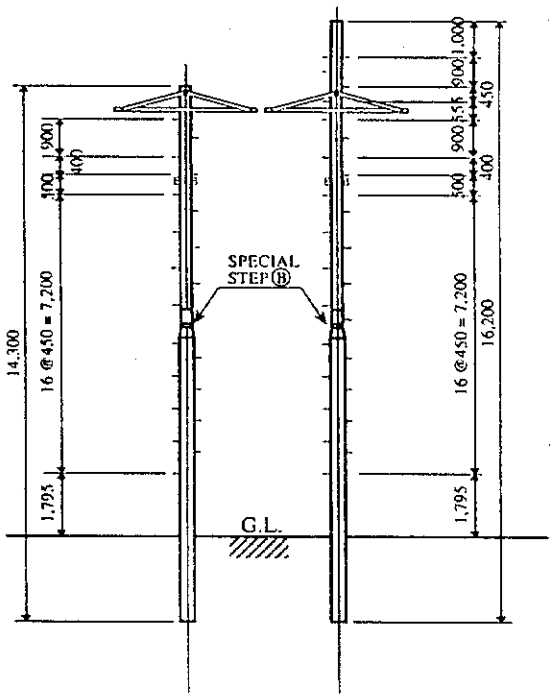
Q'ty STEP BOLT 37 pcs.
SPECIAL STEP 1 pc.



TYPE PA + 5

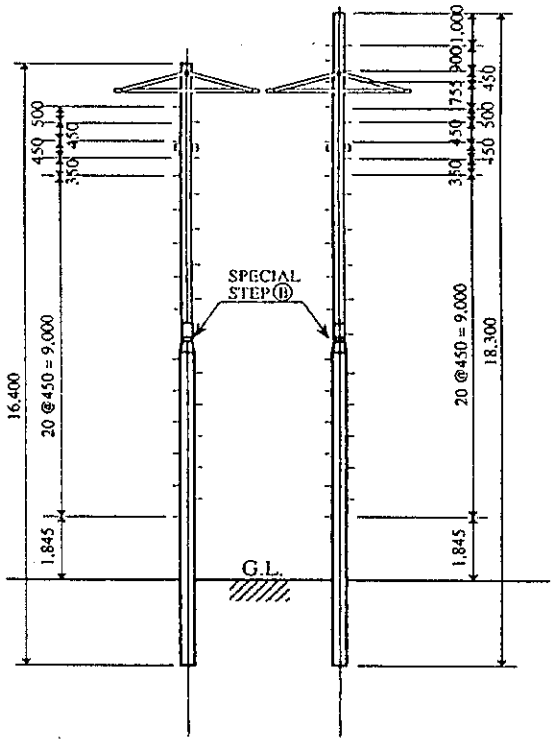
Q'ty STEP BOLT 43 pcs.
SPECIAL STEP 2 pcs.

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.2 (1) Outline of 110 kV Steel Tubular Poles



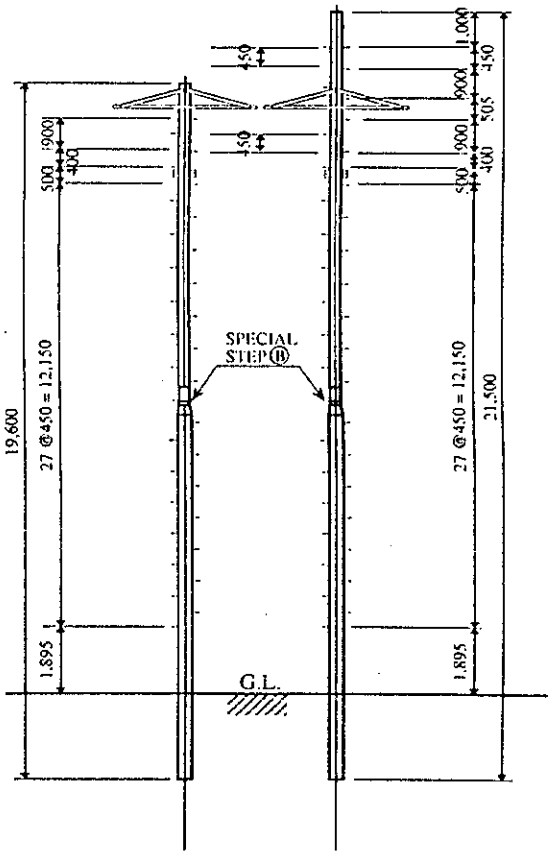
PC & PD TYPE

Q'ty STEP BOLT 45 pcs.
SPECIAL STEP 2 pcs.



PC + 2 & PL 2 TYPE

Q'ty STEP BOLT 53 pcs.
SPECIAL STEP 2 pcs.

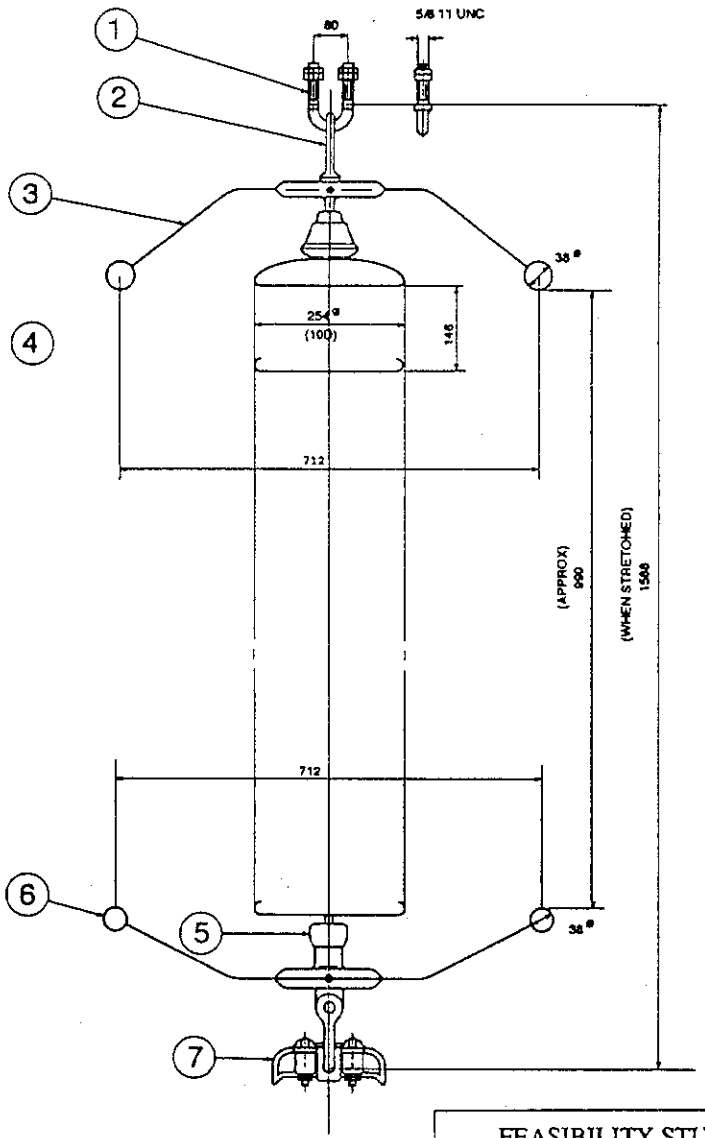


PC + 5 & PD + 5 TYPE

Q'ty STEP BOLT 67 pcs.
SPECIAL STEP 2 pcs.

TOLERANCE OF STEP BOLTS INTERVAL ±25 mm

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.2 (2) Outline of 110 kV Steel Tubular Poles



CAT. NO. OF STRING				8A-15292A	8A-15293A
DRG. NO. OF STRING				89700 #1	89700 #2
ITEM	DESCRIPTION	MAIN MATERIAL	REQD	CAT.NO.	
1	U-BOLT	HIGH TENSION STEEL	1	4H-1805BU	
2	HORN HOLDER BALL-EYE	HIGH TENSION STEEL	1	4H-2046A	
3	ARCING HORN	STEEL	1	2H-1810AU	
4	SUSPENSION INSULATOR	PORCELAIN	8	CA-525EC	CA-825EC
5	HORN HOLDER SOCKET-EYE	MALLEABLE IRON	1	4H-20496L	
6	ARCING HORN	STEEL	1	2H-1810BU	
7	SUSPENSION CLAMP	ALUMINIUM ALLOY	1	1H-1075AU	
SUITABLE CONDUCTOR SIZE OF CLAMP				A.C.S.R. 7.6Ø~18.5Ø	
MIN BREAKING STRENGTH OF STRING				7000kg	
TYPE OF BALL AND SOCKET PARTS				IEC 15mmA	

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY	Figure 10.3 Assembling of 110 kV Insulator Sets
	JAPAN INTERNATIONAL COOPERATION AGENCY	

Work Item	Working Days of One Gang										No. of Linemen per Gang	No. of Gang Required	Total No. of Linemen (m/d)
	1	2	3	4	5	6	7	8	9	10			
Suspension Type Poles (12 positions)													
Erection of Temporary Poles	2 poles										6	12	72
Shift of O.H. Earthwires & Conductors											6	12	144
Removal of Damaged Poles				2 poles							6	12	72
Erection of New Poles					2 poles						6	12	72
Re-stringing of Earthwires & Conductors											6	12	144
Removal of Temporary Poles								2 poles			6	12	72
Tension Type Poles (6 positions)													
Erection of Temporary Poles	2 poles										3	12	36
Shift of O.H. Earthwires & Conductors											3	12	108
Removal of Damaged Poles											3	12	36
Erection of New Poles						2 poles					3	12	36
Re-stringing of Earthwires & Conductors											3	12	108
Removal of Temporary Poles										2 poles	3	12	36
Total Number of Linemen (man-day)											9	–	936

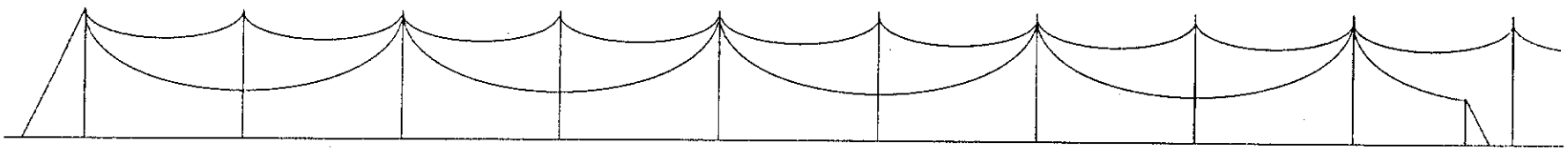
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.4 Implementation Schedule of Repair of Da Nhim-Thap Cham Line

Work Item	Working Days of One Gang										No. of Linemen per Gang	No. of Gang Required	Total No. of Linemen (m/d)
	1	2	3	4	5	6	7	8	9	10			
Replacement of Crossarms													
460 Suspension Poles & 25 Tension Poles					2 poles	per day	per gang				7	25	1,750

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.5 Implementation Schedule of Repair of Thap Cham-Phan Thiet Line

Work Item	Working Days of One Gang										No. of Linemen per Gang	No. of Gang Required	Total No. of Linemen (m/d)
	1	2	3	4	5	6	7	8	9	10			
Rehabilitation of Suspension Insulator Sets													
Total 240 poles (3 poles/day/gang)											5	8	400
Rehabilitation of Tension Insulator Sets													
Total 15 poles (2 poles/day/gang)											7	2	170
Replacement of Crossarms (42 poles)											7	3	147
Replacement of Damaged Poles (4 poles)													
Erection of Temporary Poles											12	2	24
Shift of O.H. Earthwires & Conductors											12	2	48
Removal of Damaged Poles											12	2	24
Erection of New Poles											12	2	24
Re-stringing of Earthwires & Conductors											12	2	48
Removal of Temporary Poles											12	2	24
Total Number of Linemen (man-day)													909

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.6 Implementation Schedule of Repair of Thap Cham-Cam Ranh Line



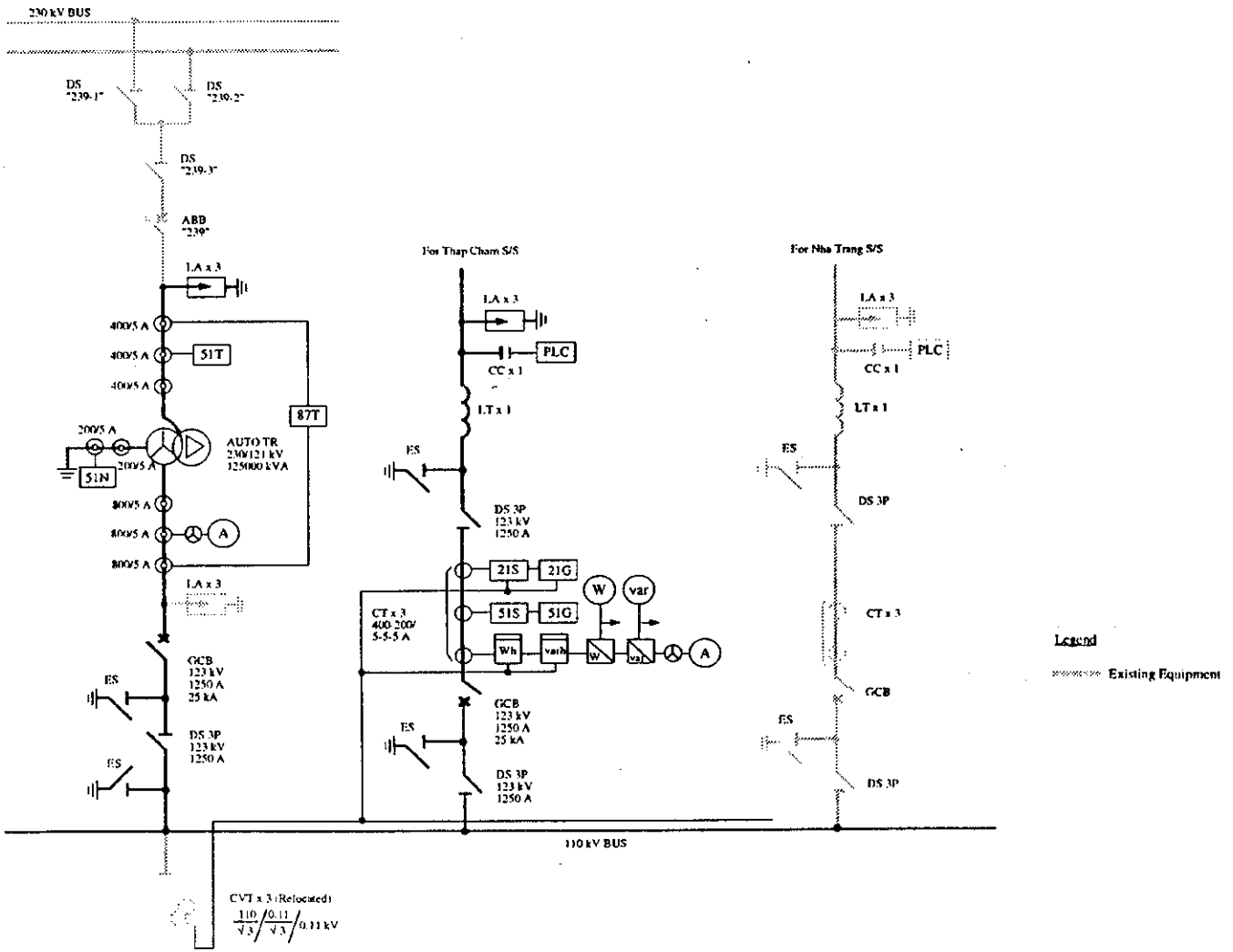
There are 310 support positions in the whole section of the Cam Ranh-Dien Khanh line. One sub-section between tension type supports is assumed to be 10 spans on the average. Following work schedule is for one sub-section by a working group consisting of 15 linemen and 5 general workers. One sub-section will be completed in 15 days.

Work Item	Working Days/Section															Worker/Gang			Total Workers		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Line-men	General	Total	Line-men	General	Total
Provision of Backstay & Temporary Pole (*1)																15	5	20	15	5	20
Shift of Power Conductor at Every Other Position (*2)																15	5	20	30	10	40
Replacement of Poles at Every Other Position (*3)																15	5	20	45	15	60
Replacement of Conductors & O.H. Earthwires (*4)																15	5	20	30	10	40
Shift of Power Conductor at Remaining Positions (*1)																15	5	20	30	10	40
Replacement of Poles at Remaining Positions (*2)																15	5	20	45	15	60
Replacement of Conductors & O.H. Earthwires (*3)																15	5	20	39	15	40
Total Workers required for A Section (*4)																			225	75	300

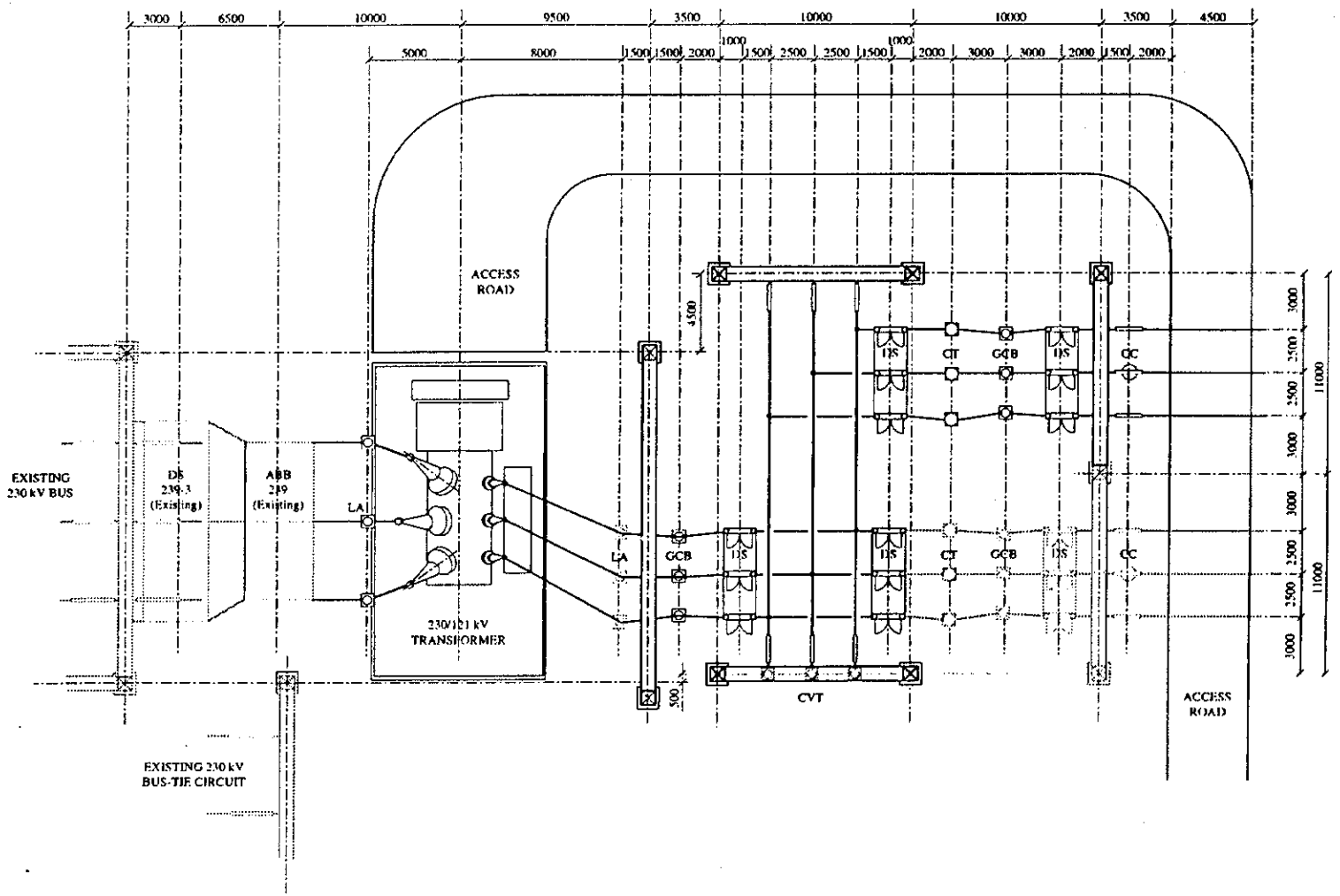
Note:

(*1) Erection of a temporary pole at one end of the section, and installation of backstay wires at both ends of the section
(*2) Dismantling of overhead earthwires and power conductors from the existing poles at every other position, and adjustment of sags to keep necessary ground clearance
(*3) Erection of new poles at locations of dismantled poles
(*4) Installation of overhead earthwires and power conductors to new poles

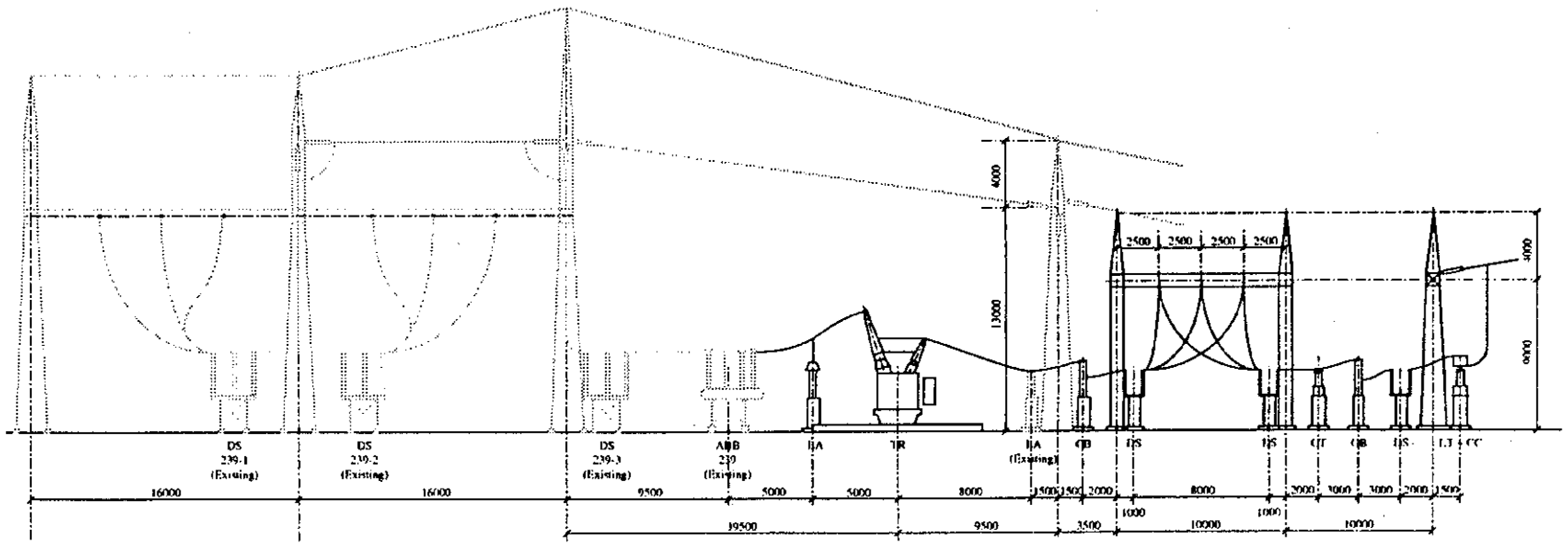
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.7 Implementation Schedule of Repair of Cam Ranh-Dien Khanh Line



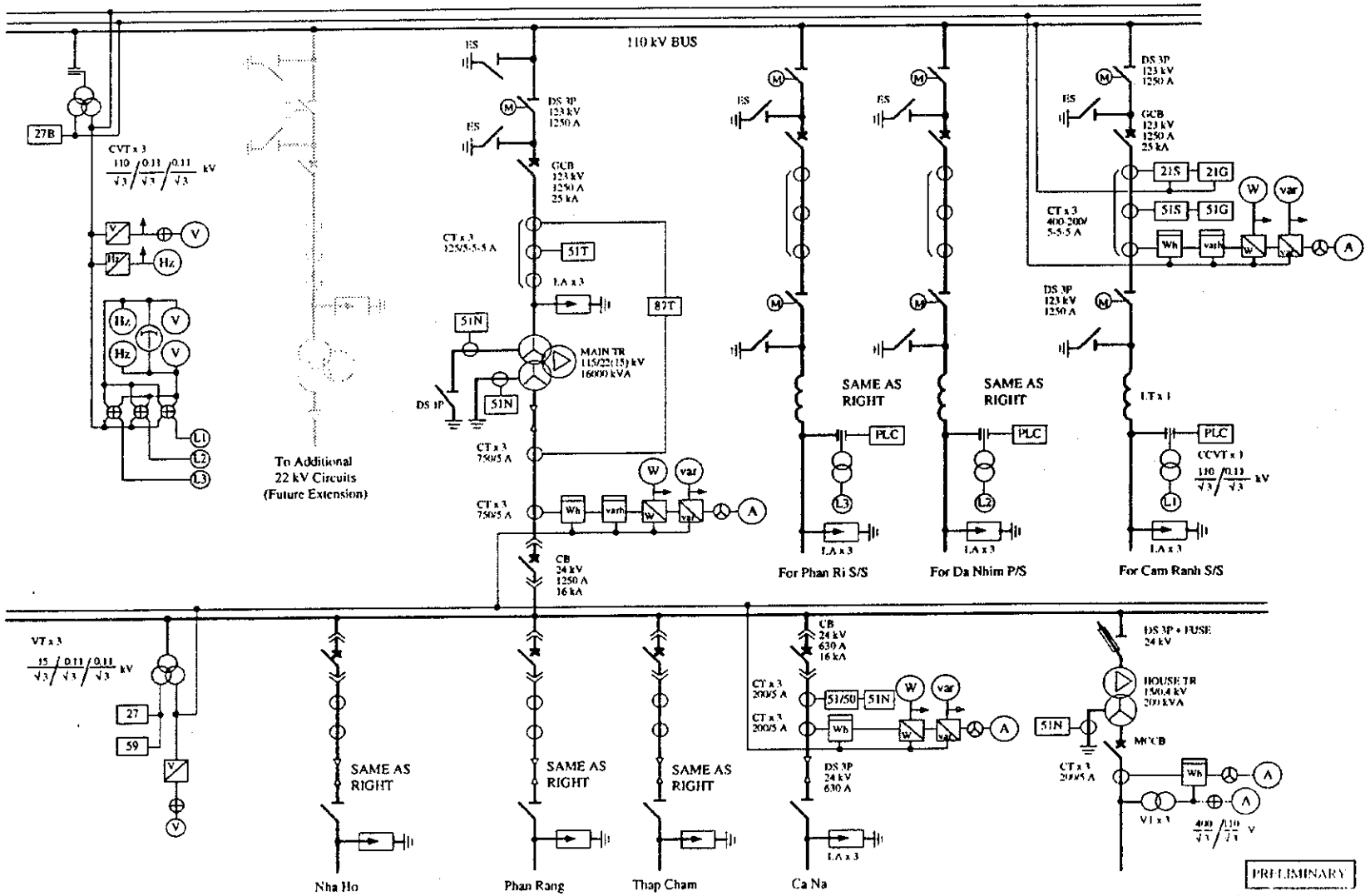
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.8 Single Line Diagram of 110kV Upgrading Facilities for Da Nhim Power Station



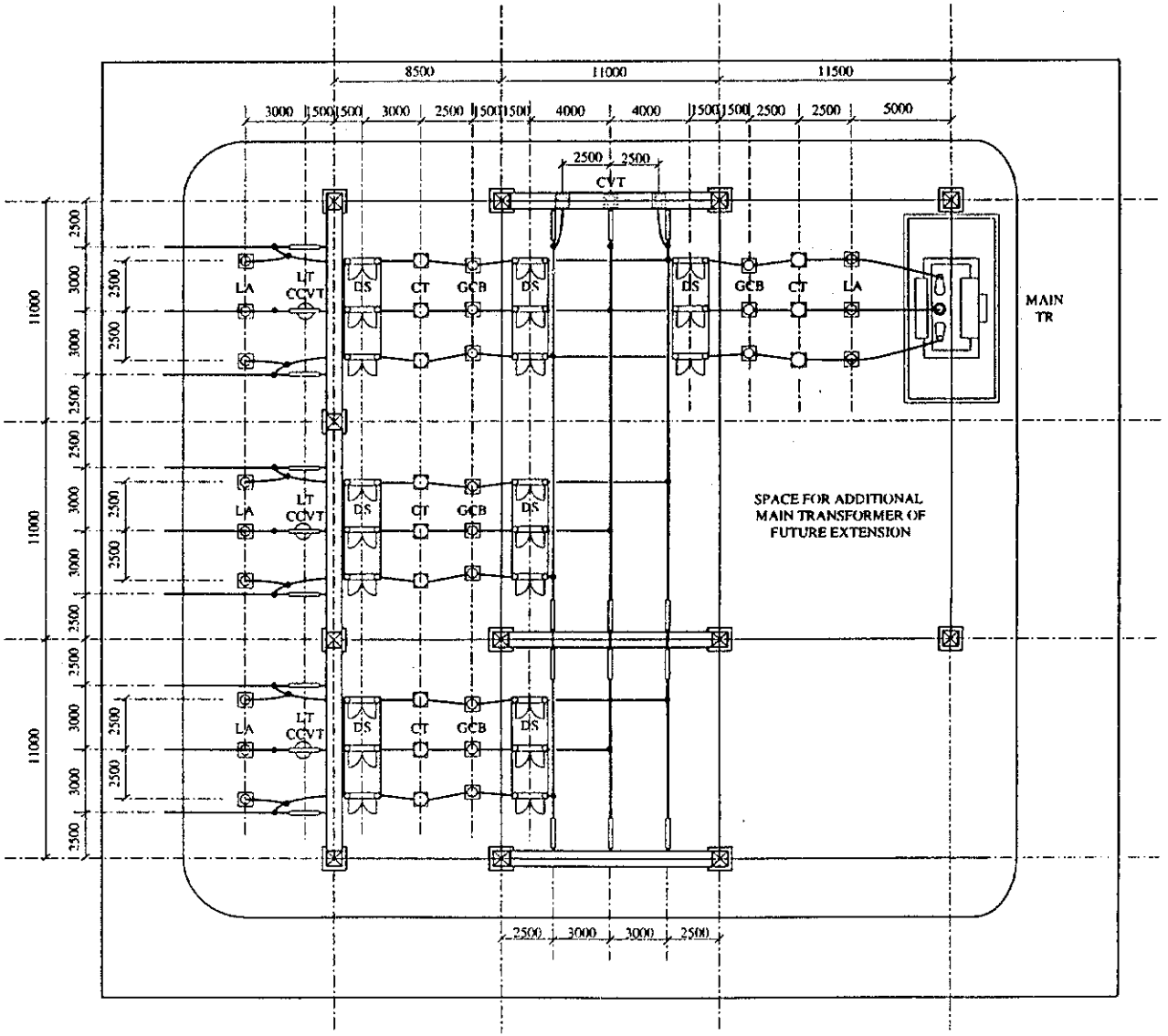
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.9 General Layout of 110 kV Upgrading Facilities for Da Nhim Power Station



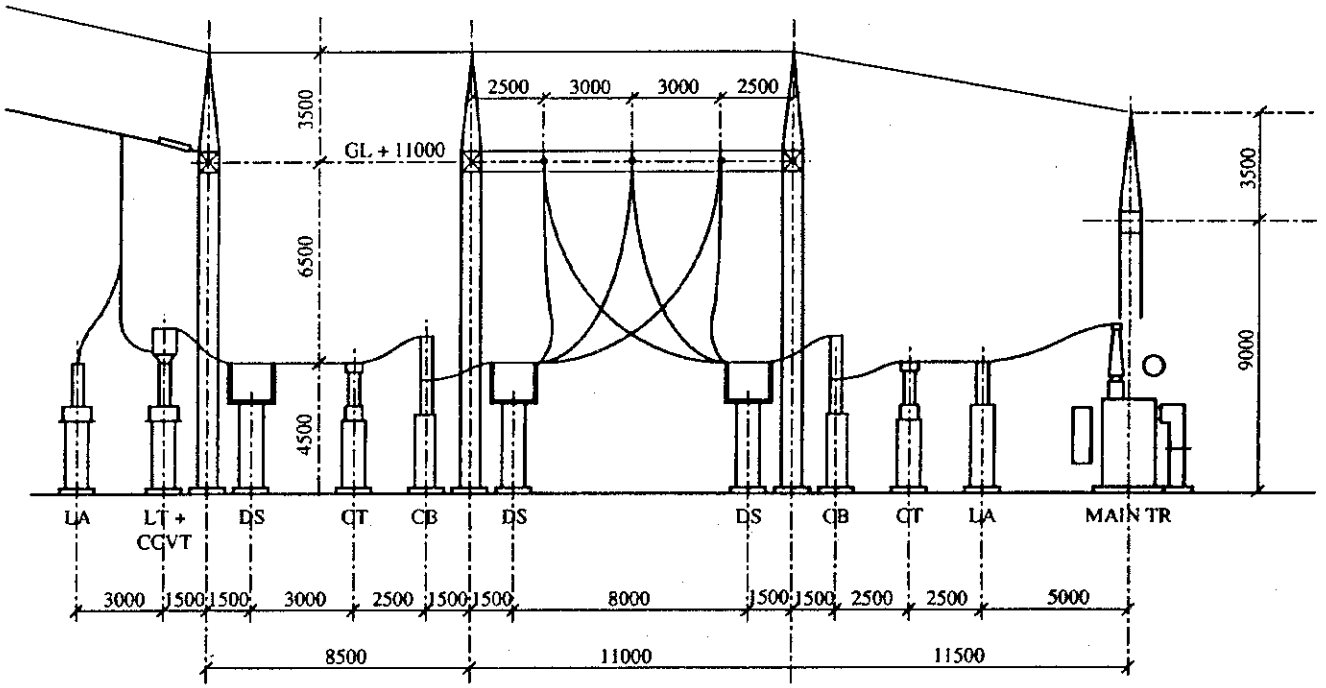
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.10 Sectional Layout of 110 kV Upgrading Facilities for Da Nhim Power Station



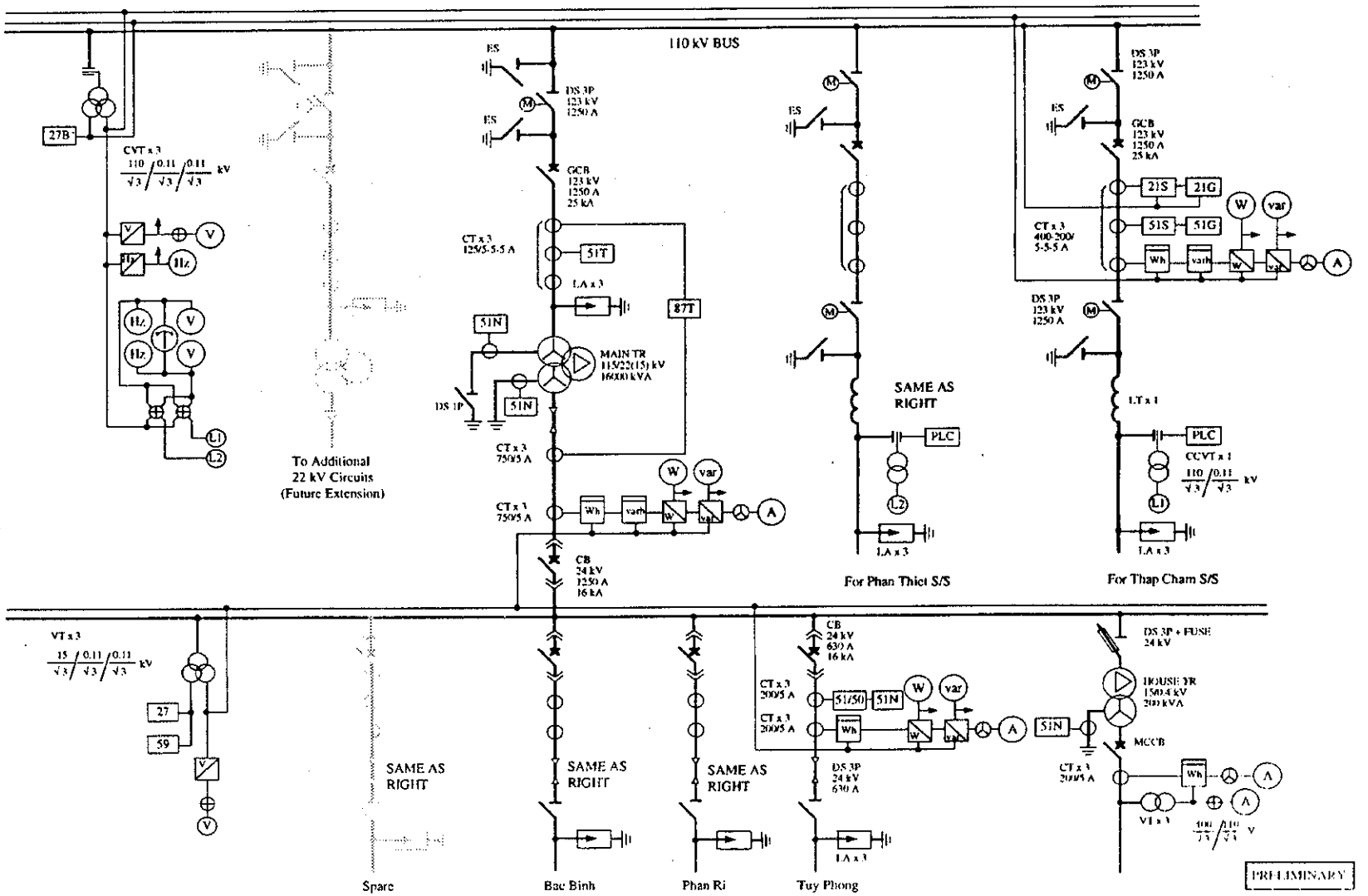
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.11 Single Line Diagram of Main Circuit for 110kV Thap Cham Substation



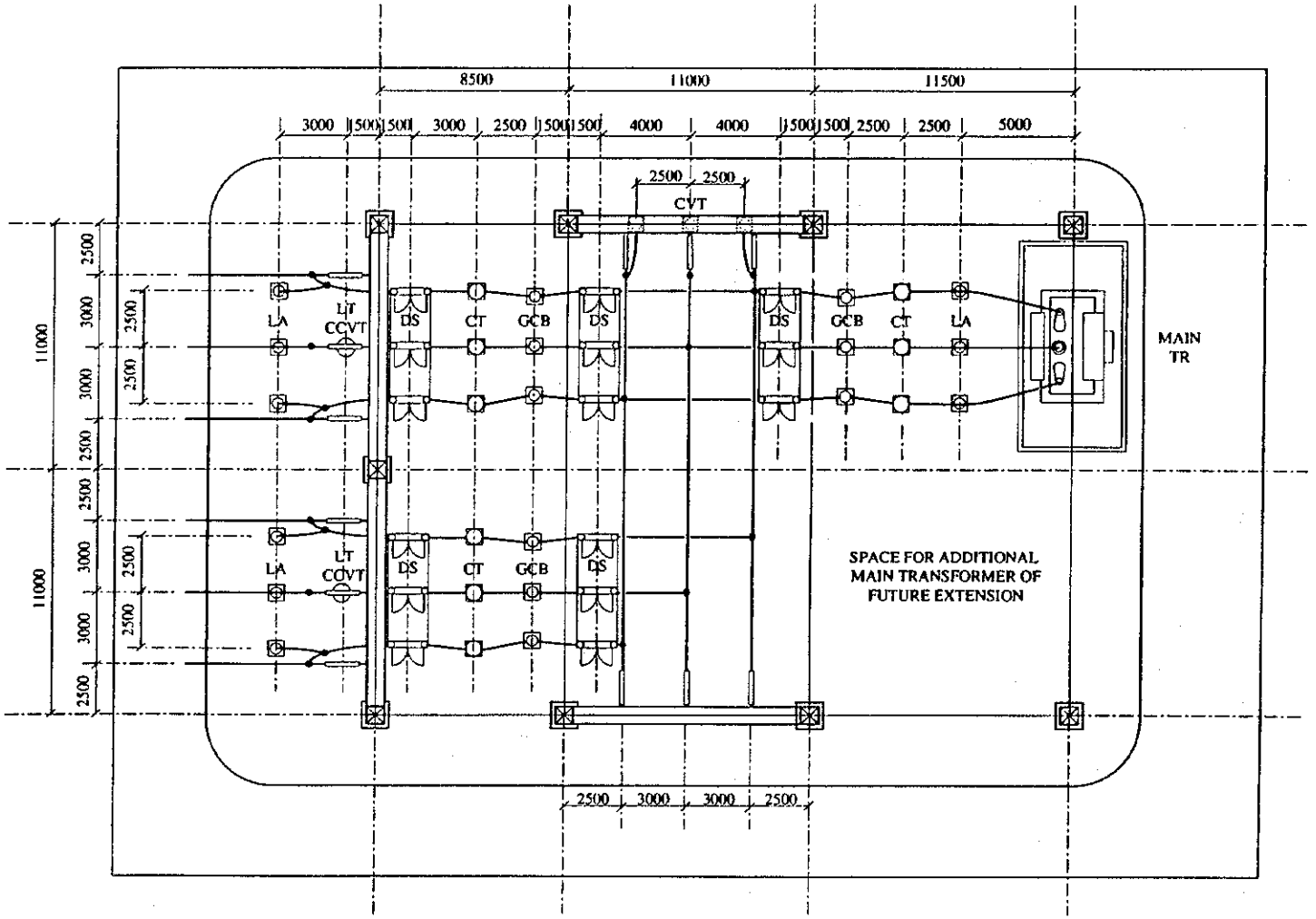
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.12 General Layout for 110kV Thap Cham Substation



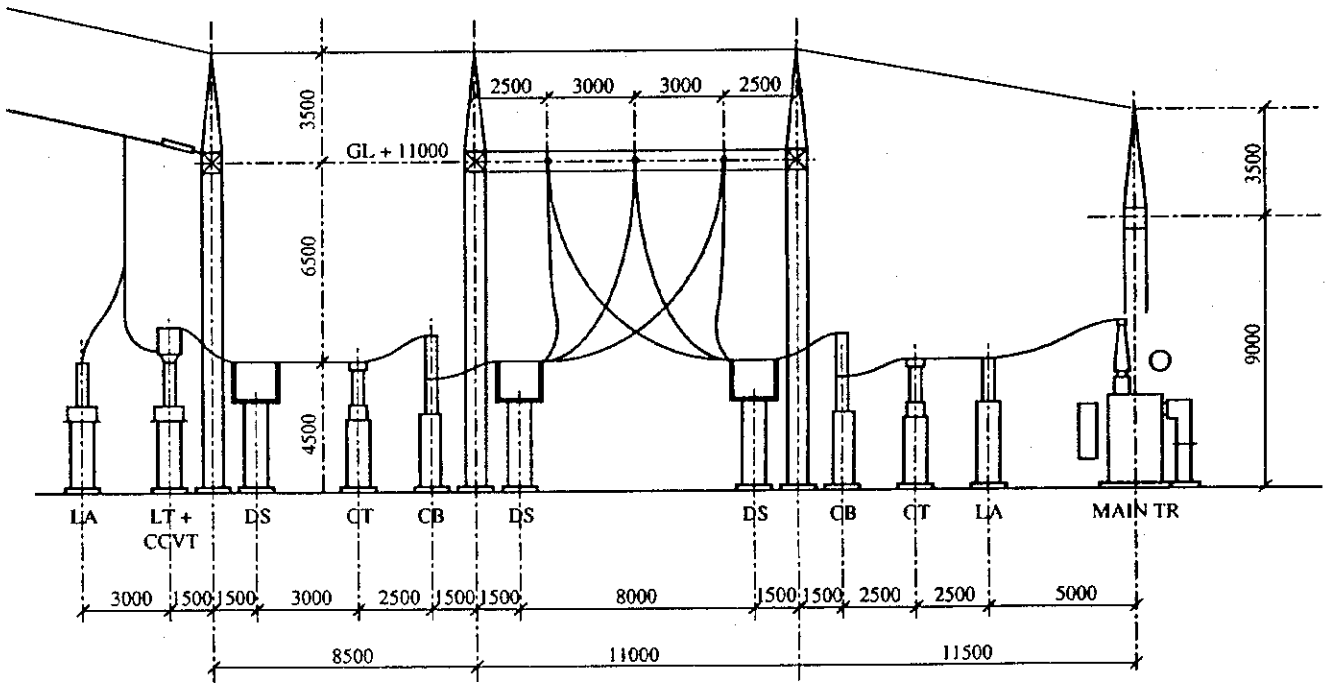
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.13 Sectional Layout for 110kV Thap Cham Substation



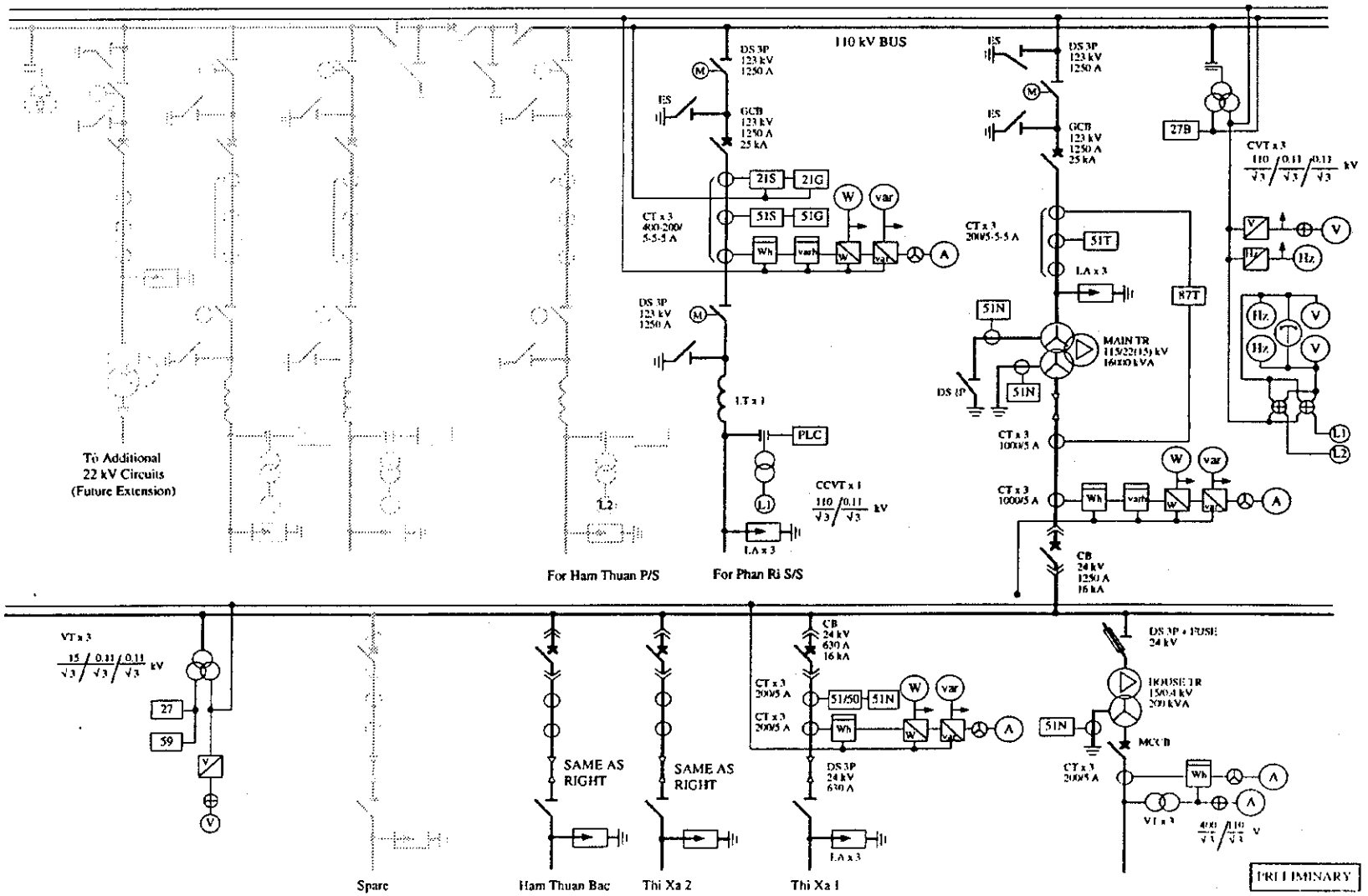
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.14 Single Line Diagram of Main Circuit for 110kV Phan Ri Substation



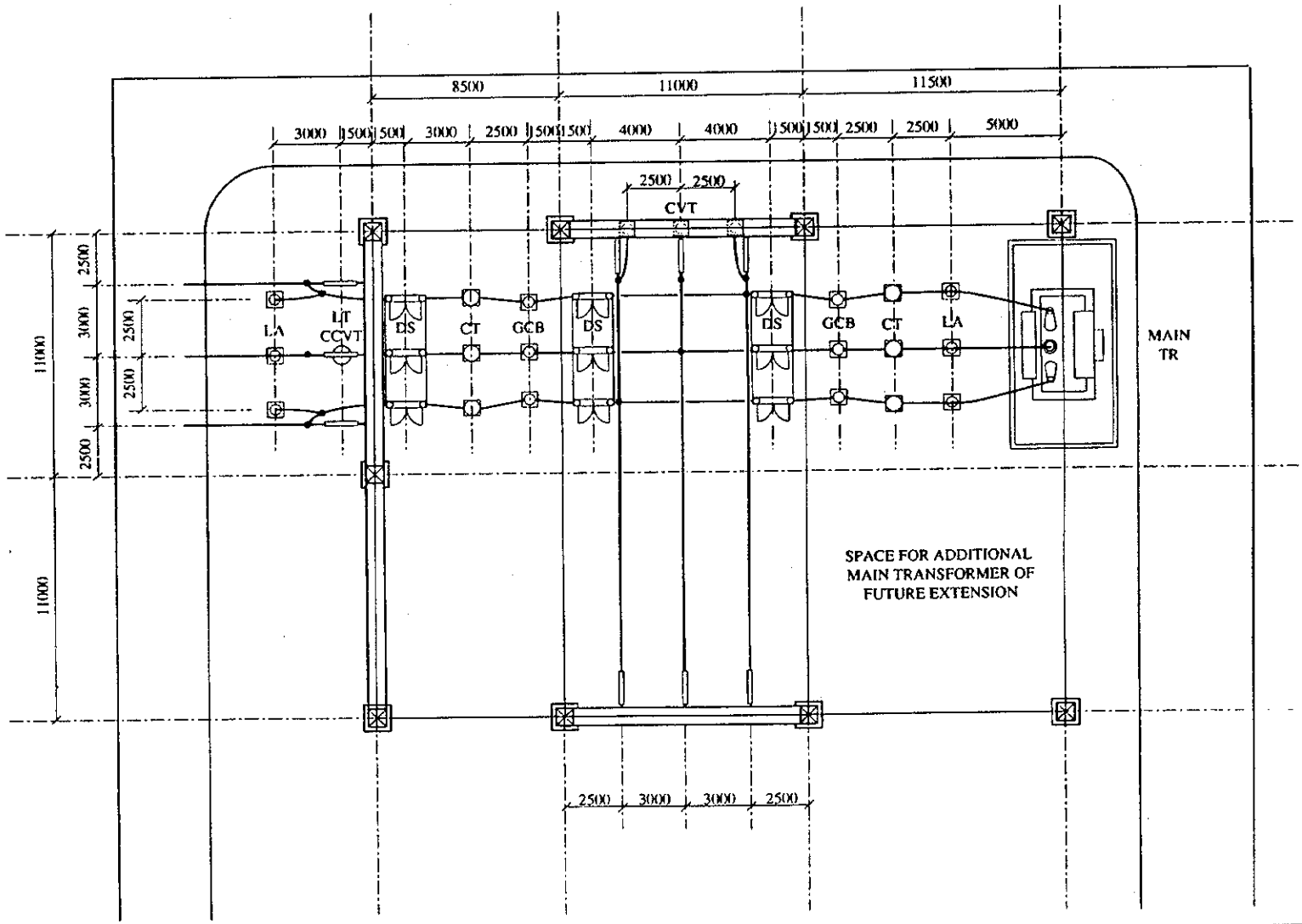
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.15 General Layout for 110kV Phan Ri Substation



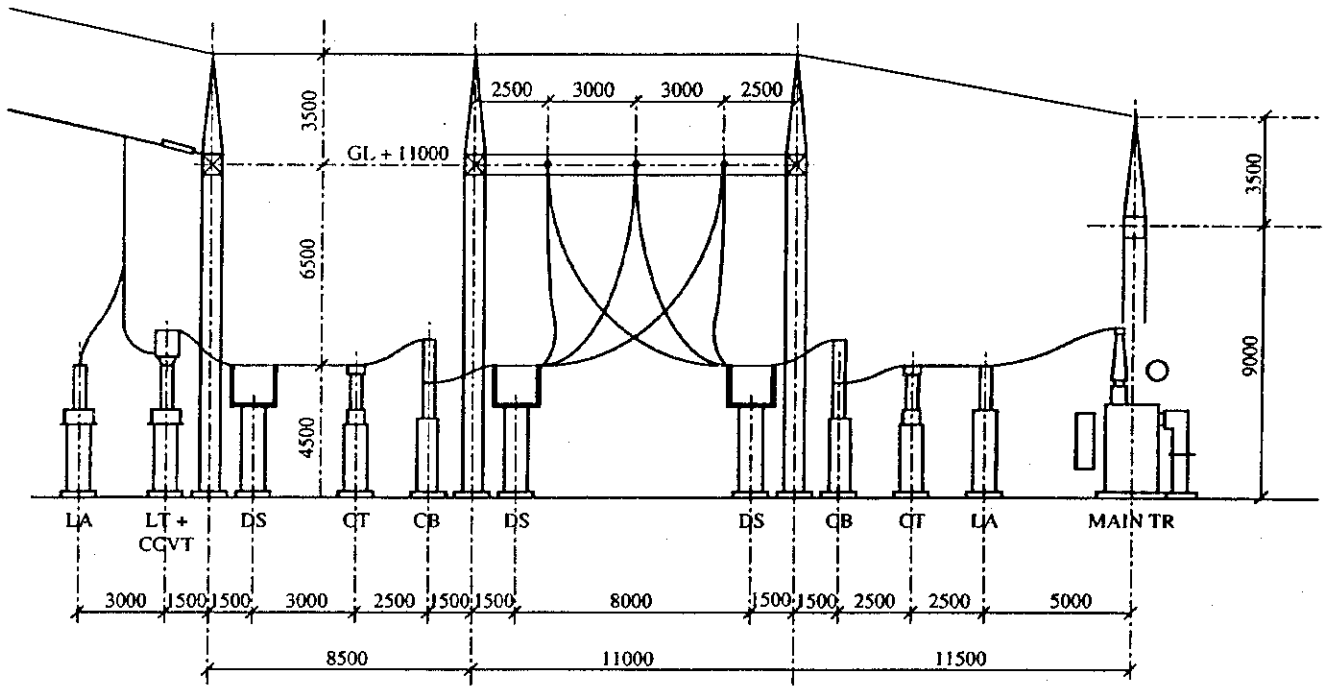
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.16 Sectional Layout for 110kV Phan Ri Substation



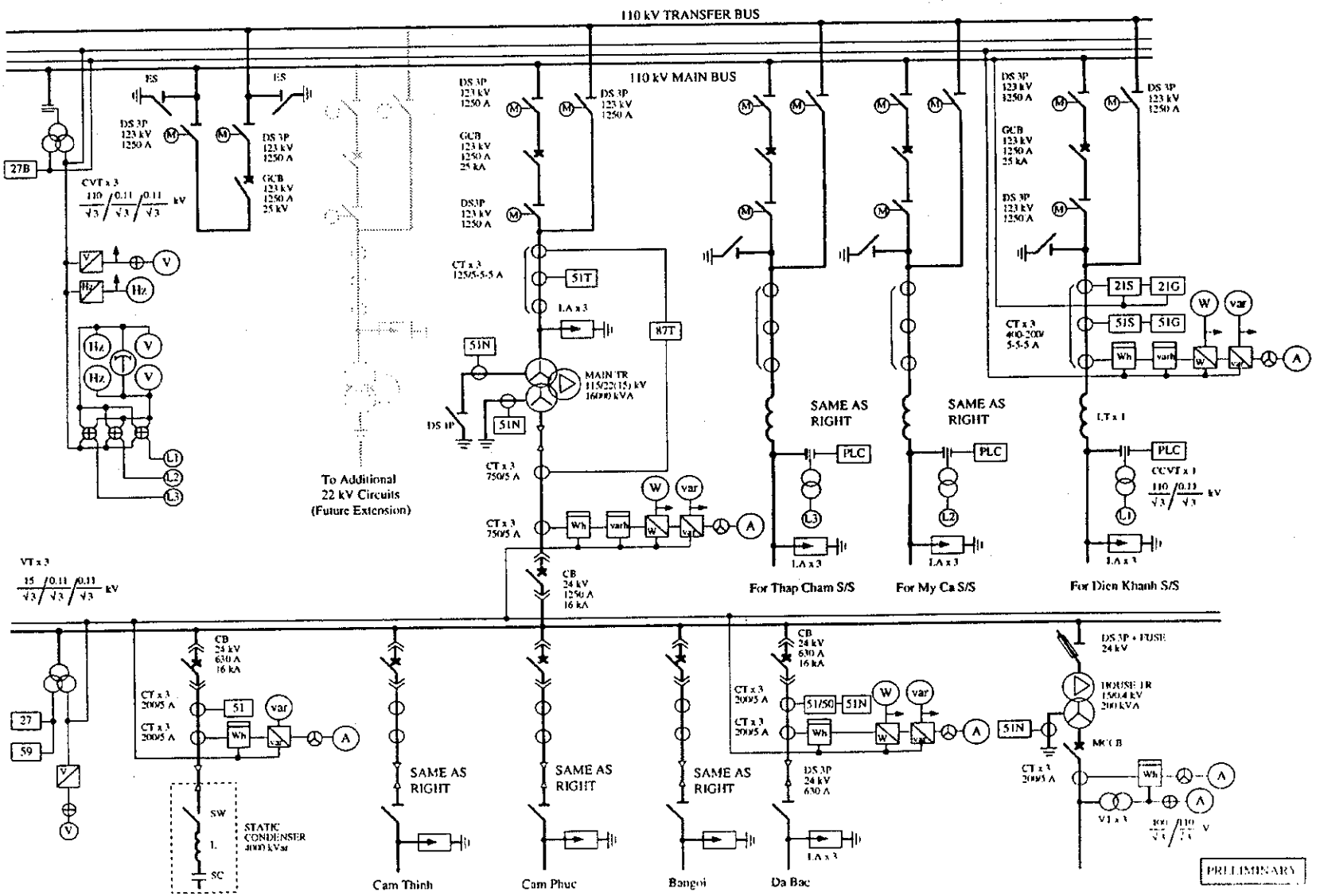
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.17 Single Line Diagram of Main Circuit for 110kV Phan Thiet Substation



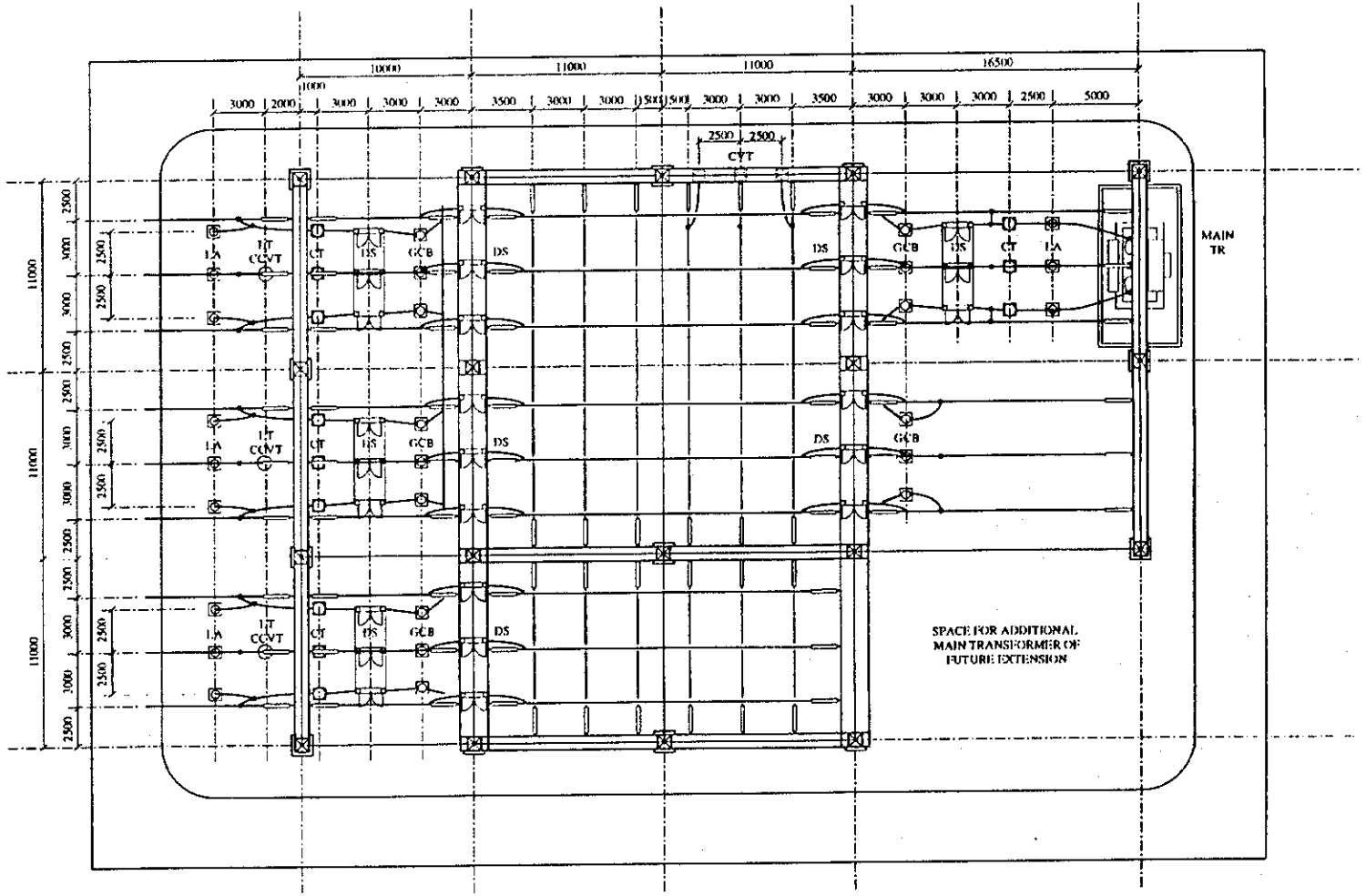
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.18 General Layout for 110kV Phan Thiet Substation



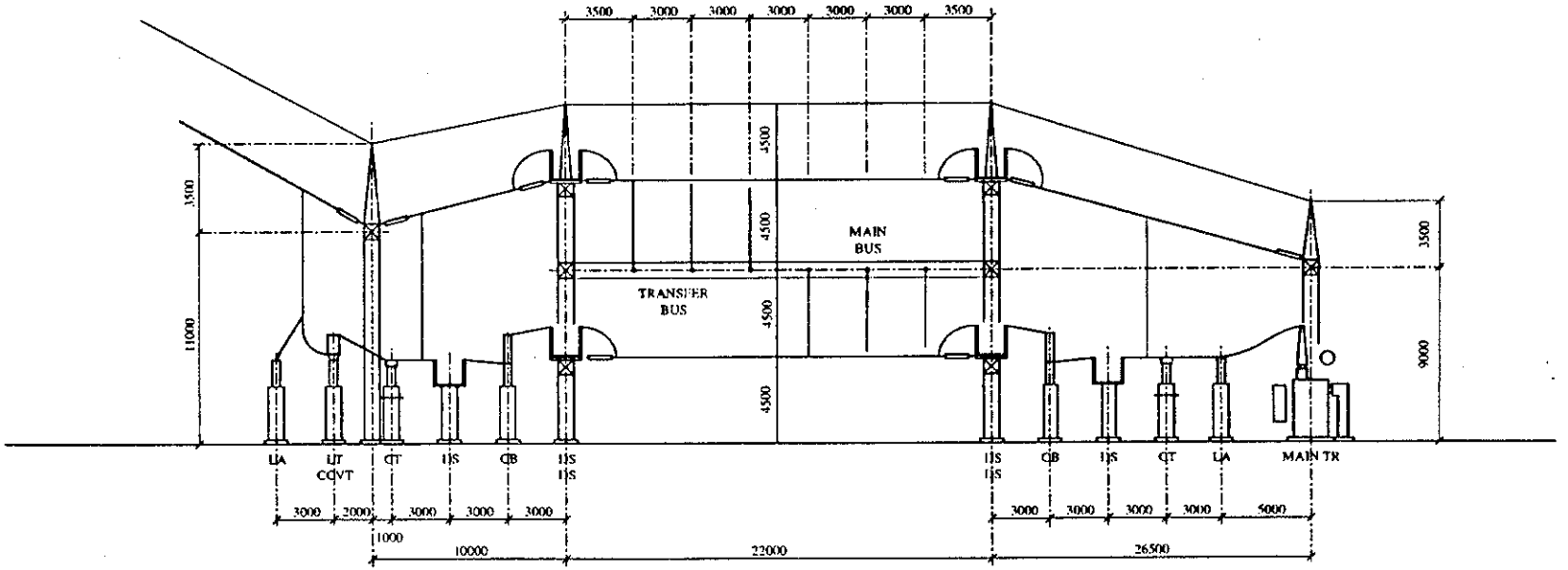
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.19 Sectional Layout for 110kV Phan Thiet Substation



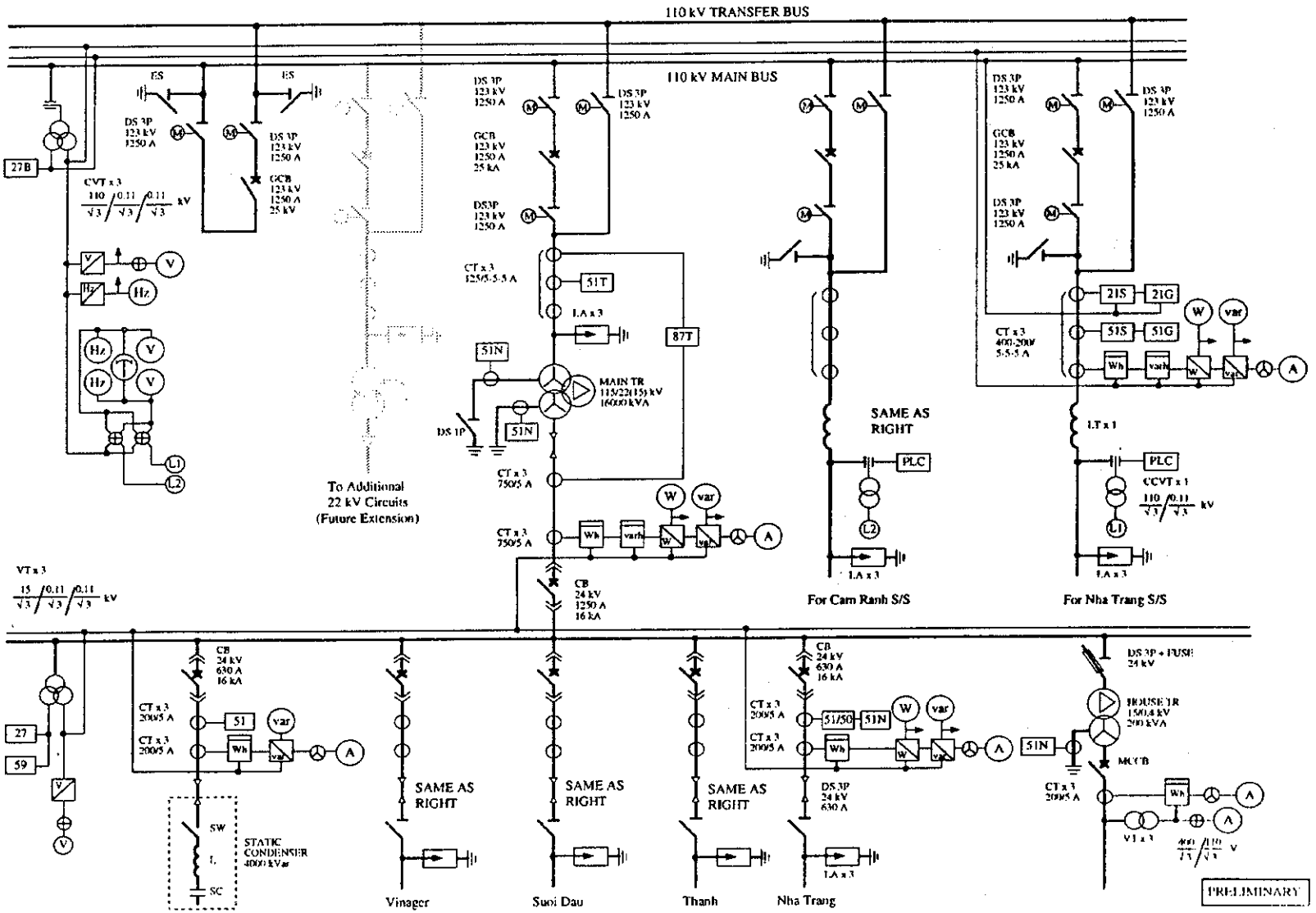
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.20 Single Line Diagram of Main Circuit for 110kV Cam Ranh Substation



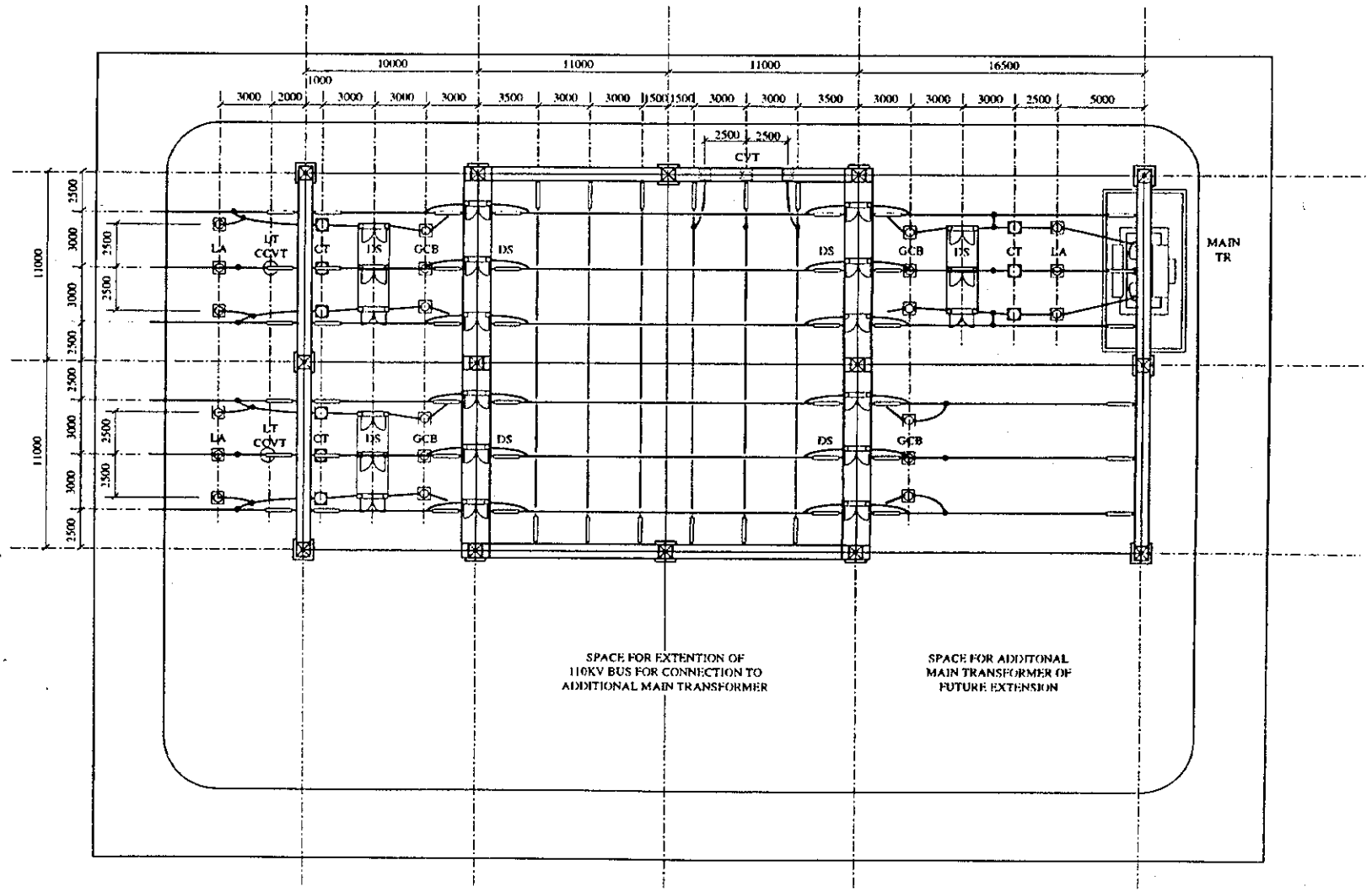
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.21 General Layout for 110kV Cam Ranh Substation



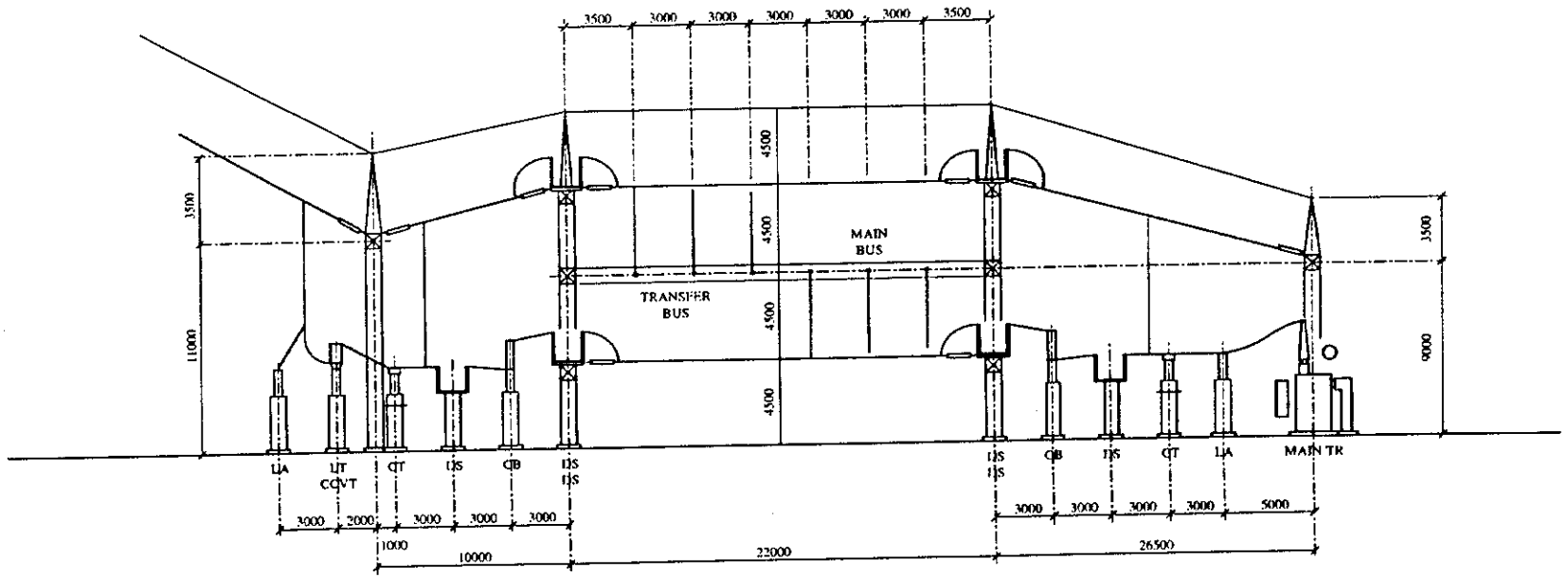
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.22 Sectional Layout for 110kV Cam Ranh Substation



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.23 Single Line Diagram of Main Circuit for 110kV Dien Kanh Substation



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY	Figure 10.24 General Layout for 110kV Dien Kanh Substation
	JAPAN INTERNATIONAL COOPERATION AGENCY	



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 10.25 Sectional Layout for 110kV Dien Kanh Substation

CHAPTER 11

IMPLEMENTATION SCHEDULE AND COST ESTIMATE OF PROJECT

CHAPTER 11 IMPLEMENTATION SCHEDULE AND COST ESTIMATE OF PROJECT

11.1 General

This Chapter summarizes the estimated implementation schedule of the Project and the cost estimate for the project implementation of the urgent rehabilitation of the Da Nhim 230 kV power system and the upgrading of the Da Nhim 66 kV transmission system recommended in the foregoing chapters.

The project implementation schedule is prepared for the preparatory stage and the project implementation stage. The preparatory stage covers the period from the detailed design to the conclusion of the supply contracts for the various facilities. The works will be carried out by the executing agencies and the consultants. The works in the implementation stage are for manufacturer's design, manufacturing, fabrication and procurement of the equipment and materials as well as for the site erection works. The period is estimated from the actual experience of the similar projects and in consideration of the working capacity of the executing agencies.

The cost is estimated on the assumption that almost all the major equipment and materials required for the Project will be imported into Vietnam while all the local works required at the site will be executed mainly by the working forces of PC-2 or PC-3 under assistance of expatriate experts. The costs of the imported equipment and materials are estimated for the costs in 1997 referring to the recent international competitive bid prices of the similar projects. The costs for the local works to be executed by PC-2 and PC-3 are estimated by the Study Team in accordance with information collected during its field investigation stage. New substation buildings for the 110 kV substations for the upgrading project are assumed to be constructed by PC-2 and PC-3 using locally available materials.

It is also assumed that all taxes, duties and other levies are exempted by the Vietnamese Government for the imported goods and the expatriate experts for the Project.

11.2 Implementation Schedule

The estimated time schedule of the Project is shown in Figure 11.1. The schedule is prepared for the preparatory works, the urgent rehabilitation works, the upgrading works, and the additional study for the civil structures.

The preparatory works are for the detailed design of the facilities to be rehabilitated, preparation of tender documents for procurement of the equipment and materials, tender floating, tender evaluation, negotiation with successful tenderers, and conclusion of contracts as well as review of the design, documents, evaluation and contracts by the project executing agencies of Viet Nam and the fund source. The period of the preparatory stage is estimated to be 12 months. The consulting engineers will perform all the works in this stage together with the executing agencies.

After the conclusion of the contracts, each contractor will carry out his manufacturing design and fabrication of the contracted equipment and materials. Upon site arrival of the fabricated equipment and materials, the executing agencies will start the rehabilitation works with assistance of the consulting engineers. The critical path of the project execution will be on the rehabilitation of the generators and their ancillary facilities. Four units of the turbine generator sets will be completed within 3 years after the contracts. While, the rehabilitation of the Saigon substation, 230 kV transmission line, and the hydrological acquisition system is expected within 19 months after the contracts.

The upgrading works of the existing 66 kV system will be completed within 17 months after the contracts under the assumption that construction of all the new 110 kV substations and works for the transmission lines will be executed in parallel at the same time by the executing agencies.

The additional detailed study for the civil structures related to the Da Nhim dam will immediately start after the project fund will become available. It will take about 18 months to submit the final report to the agency of the project.

11.3 Summary of Project Cost

The project cost includes the cost of the imported goods, the local works, the expatriate experts, the engineering services for detailed design and construction supervision and the provisional sums and is summarized below. The Foreign Currency covers the C.I.F. price of the imported goods and the cost of the expatriate experts and the engineering services, while the Local Currency covers the cost of the inland transportation of the imported goods and the direct and indirect cost for the local works executed under the responsibilities of PC-2 and PC-3. The provisional sum is assumed at 5 % of the total amount for the foreign currency portion and 10 % of the total amount for the local currency portion.

Exchange rate between Japanese Yen and US Dollars is assumed at Yen 100 per US$ 1.00.

Further details for the estimated cost of each work are shown in Tables 11.1 to 11.11.

(1) Rehabilitation Works of Da Nhim Power Station, Saigon Substation and 230 kV Line

	Work Items	Cost Estimate		
		Foreign Portion (J.¥ 1,000)	Local Portion (J.¥ 1,000)	Total (J.¥ 1,000)
1.	Water Turbines and Ancillaries	1,510,000	7,000	1,517,000
2.	Generators and Ancillaries	1,596,000	20,000	1,616,000
3.	Waterway and Ancillaries	497,000	23,000	520,000
4.	Dam and Civil Structures	0	46,000	46,000
5.	Hydrological Data Acquisition	363,000	34,000	397,000
6.	Da Nhim Substation	741,000	8,000	749,000
7.	Saigon Substation	850,000	36,000	886,000
8.	230 kV Transmission Line (*)	163,000	16,000	179,000
9.	Sub-total of Items 1 to 8	5,720,000	190,000	5,910,000
10.	Engineering Service	351,000	0	351,000
11.	Sub-total of Items 9 and 10	6,071,000	190,000	6,261,000
12.	Price Contingency (5% & 10%)	303,000	19,000	322,000
	Total for Rehabilitation	6,374,000	209,000	6,583,000

(*) Including tools and appliances for maintenance works

(2) Upgrading Works of 66 kV Transmission System

	Work Items	Cost Estimate		
		Foreign Portion (J.¥ 1,000)	Local Portion (J.¥ 1,000)	Total (J.¥ 1,000)
1.	Da Nhim 110 kV Switchyard	183,000	2,000	185,000
2.	Thap Cham Substation (*)	256,000	46,000	302,000
3.	Phan Ri Substation (*)	212,000	46,000	258,000
4.	Phan Thiet Substation (*)	193,000	46,000	239,000
5.	Transmission Lines (*)	67,000	17,000	84,000
6.	Sub-total of Items 1 to 5	911,000	157,000	1,068,000
7.	Engineering Service	69,000	0	69,000
8.	Sub-total of Items 6 and 7	980,000	157,000	1,137,000
9.	Price Contingency (5% & 10%)	49,000	16,000	65,000
	Total for Upgrading in PC-2	1,029,000	173,000	1,202,000
10.	Cam Ranh Substation	301,000	47,000	348,000
11.	Dien Khanh Substation	251,000	46,000	297,000
12.	Testing Equipment	78,000	1,000	79,000
13.	Transmission Lines (*)	249,000	78,000	327,000
14.	Sub-total of Items 10 to 13	879,000	172,000	1,051,000
15.	Engineering Service	69,000	0	69,000
16.	Sub-total of Items 14 and 15	948,000	172,000	1,120,000
17.	Price Contingency (5% & 10%)	47,000	17,000	64,000
	Total for Upgrading in PC-3	995,000	189,000	1,184,000
	Grand Total for Upgrading Plan	2,024,000	362,000	2,386,000

(*) Including tools and appliance for maintenance works

(3) Additional Study for Dam and Civil Structures

Work Items	Cost Estimate		
	Foreign Portion (J.¥ 1,000)	Local Portion (J.¥ 1,000)	Total (J.¥ 1,000)
Additional Study	282,000	104,000	386,000

(4) Total Project Cost

	Work Items	Cost Estimate		
		Foreign Portion (J.¥ 1,000)	Local Portion (J.¥ 1,000)	Total (J.¥ 1,000)
1.	Rehabilitation Works	5,720,000	190,000	5,910,000
2.	Upgrading Works	1,790,000	329,000	2,119,000
3.	Engineering Service	489,000	0	489,000
4.	Price Contingency	399,000	52,000	451,000
5.	Add. Study for Civil Structures	282,000	104,000	386,000
	Total Project Cost	8,680,000	675,000	9,355,000

11.4 Project Phasing

As shown in the above cost estimates, the total project cost will amount approximately to Japanese ¥ 9,355,000,000. This total project cost is estimated for all the recommended works for the urgent rehabilitation plan and the upgrading plan. As seen in the total project cost, the project scale is rather big for the rehabilitation project and it may be difficult to finance the total amount of the project cost for implementation of all the works at once. Therefore it is proposed that the Project should be implemented by phasing into two stages for smooth financing of the project fund.

(1) Criteria for project phasing

A plan of the project phasing is formulated in accordance with the following criteria.

1) The urgent rehabilitation of the facilities that were seriously deteriorated and aged should be given top priority and should be carried out in the first phase.

2) In case the deterioration and ageing were not so serious and will not cause the fatal damage to the facilities even though they will be left as they are for the time being, the urgent rehabilitation of such facilities should be carried out in the second stage.

3) The urgent rehabilitation of the facilities, such as the urgent rehabilitation of the hydrological data acquisition system and the modernization of the control system, which are not essential to the operation of the Da Nhim Power Station and the Saigon Substation, should be carried out in the second stage.

4) The upgrading plan of the existing 66 kV power system should be implemented in the second stage.

5) In order to avoid unnecessary complications due to the phased implementation of the Project, all the works in the same facilities should in principle be done in the same phase.

(2) Plan of Project Phasing

Referring to the above criteria, the project phasing is proposed as follows:

1) First Phase

a) Urgent rehabilitation of water turbines, generators and substation facilities for the Da Nhim Power Station (except substation facilities listed for second phase)

b) Urgent rehabilitation of substation facilities for the Saigon Substation (except substation facilities listed for second phase)

c) Urgent rehabilitation of 230 kV transmission line

2) Second Phase

a) Urgent rehabilitation of water way, dam and civil structures, hydrological data acquisition system and the following substation facilities for the Da Nhim Power Station

i) Rehabilitation of 230 kV circuit breakers and disconnecting switches

ii) Rehabilitation of 13.2 kV switchgear
iii) Rehabilitation of 6.6 kV switchgear
iv) Introduction of supervisory computer system to power station control system
iii) Rehabilitation of surge tank water level measuring equipment

b) Urgent rehabilitation of the following substation facilities for the Saigon Substation

i) Rehabilitation of 66 kV circuit breakers and disconnecting switches
ii) Additional installation of 66 kV static condenser bank
iii) Introduction of computer system to substation control system

c) Upgrading of the existing 66 kV power system

d) Additional study for dam and civil structures

(3) Cost Estimate for Project Phasing

On the basis of the above proposed plan of the project phasing, the project cost for each phase is as tabulated below.

	Work Items	Cost Estimate		
		Foreign Portion (J.¥ 1,000)	Local Portion (J.¥ 1,000)	Total (J.¥ 1,000)
	FIRST PHASE			
1.	Da Nhim Power Station			
	(a) Water Turbines and Ancillaries	1,510,000	7,000	1,517,000
	(b) Generators and Ancillaries	1,596,000	20,000	1,616,000
	(c) Substation Facilities	487,000	5,000	492,000
	Sub-total	3,593,000	32,000	3,625,000
2.	Saigon Substation	661,000	35,000	696,000
3.	230 kV Transmission Line	163,000	16,000	179,000
4.	Engineering Service	212,000	0	212,000
5.	Price Contingency (5% & 10%)	229,000	9,000	238,000
	Total for First Phase	4,858,000	92,000	4,950,000
	SECOND PHASE			
1.	Da Nhim Power Station			
	(a) Waterway and Ancillaries	497,000	23,000	520,000
	(b) Dam and Civil Structures	0	46,000	46,000
	(c) Hydrological Data Acquisition	363,000	34,000	397,000
	(d) Substation Facilities	254,000	3,000	257,000
	Sub-total	1,114,000	106,000	1,220,000
2.	Saigon Substation	189,000	1,000	190,000
3.	Upgrading of 66 kV power system	1,790,000	329,000	2,119,000
4.	Engineering Service	277,000	0	277,000
5.	Price Contingency (5% & 10%)	170,000	43,000	213,000
6.	Add. Study of Civil Structures	282,000	104,000	386,000
	Total for Second Phase	3,822,000	583,000	4,405,000

Table 11.1 Cost Estimate for Water Turbines and Ancillaries

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Replacement of Runners (4 sets)	400,000	23,200	-	-	423,200
Rehabilitation of Housings (4 sets)	18,720	1,080	-	-	19,800
Rehabilitation of Turbine Main Parts (4 sets)	147,420	8,540	-	-	155,960
Rehabilitation of Jet Brakes (4 sets)	20,000	1,160	-	-	21,160
Rehabilitation of Deflector Servomotors (4 sets)	5,940	340	-	-	6,280
Replacement of Inlet Valves (4 sets)	320,000	18,560	-	-	338,560
Replacement of High Pressure Valves and Pipes	59,300	3,440	-	-	62,740
Replacement of Drain Valves and Pipes	4,320	240	-	-	4,560
Replacement of Copper Pipes	360	20	-	-	380
Rehabilitation of Water Supply System	7,640	440	-	-	8,080
Replacement of Water Supply Valves	2,880	160	-	-	3,040
Replacement of Governor Actuators (4 sets)	186,200	10,800	-	-	197,000
Replacement of Regulators (4 sets)	98,460	5,700	-	-	104,160
Replacement of Speed Sensing Devices (4 sets)	11,240	640	-	-	11,880
Replacement of Turbine Control Panels (4 sets)	37,260	2,160	-	-	39,420
Instruments for Main Control Boards	800	40	-	-	840
Replacement of Oil Pressure Pump-Motors	10,000	580	-	-	10,580
Replacement of Unloader Pilot Valves	25,640	1,480	-	-	27,120
Instruments for Oil Tanks	9,440	540	-	-	9,980
Replacement of Air Compressors	7,920	460	-	-	8,380
Other Materials	40,000	2,320	-	-	42,320
Inland Tranportation and Local Works	-	-	3,000	4,000	7,000
(Sub-total)	(1,413,540)	(81,900)	(3,000)	(4,000)	(1,502,440)
Expatriate Specialists	15,000	-	-	-	15,000
Total	1,428,540	81,900	3,000	4,000	1,517,440

Total Foreign Currency	1,510,440
Total Local Currency	7,000
Total	1,517,440

Table 11.2 Cost Estimate for Generators and Ancillaries

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Renewal of Stators (4 sets)	617,550	37,050	-	-	654,600
Renewal of Excitation System with AVR (4 sets	258,940	16,060	-	-	275,000
Renewal of Bearing Metals (4 sets)	110,920	6,680	-	-	117,600
Renewal of Air Coolers (4 sets)	70,280	4,220	-	-	74,500
Renewal of Oil Coolers (4 sets)	19,520	1,180	-	-	20,700
Renewal of Oil Pumps (4 sets)	3,120	180	-	-	3,300
Renewal of Oil Lifting Pumps (4 sets)	2,360	140	-	-	2,500
Renewal of Cooling Water Pipes (4 sets)	13,680	820	-	-	14,500
Renewal of Pipes for Lubricating Oil (4 sets)	9,340	560	-	-	9,900
Renewal of Pipes for Oil Lift (4 sets)	7,840	460	-	-	8,300
Rehabilitation of Air Housing and End-bells	56,200	3,400	-	-	59,600
Improvement of Lifting Device of Rotor	11,330	670	-	-	12,000
Renewal of Electrical Equipment and Wiring	48,000	2,900	-	-	50,900
Renewal of Oil Seals for Bearings (4 sets)	46,880	2,820	-	-	49,700
Renewal of Air Seals (4 sets)	6,240	360	-	-	6,600
Spare Parts and Other Materials	78,300	4,700	-	-	83,000
Inland Tranport and Local Works	-	-	5,000	15,000	20,000
(Sub-total)	(1,360,500)	(82,200)	(5,000)	(15,000)	(1,462,700)
Expatriate Specialists	153,300	-	-	-	153,300
Total	1,513,800	82,200	5,000	15,000	1,616,000

Total Foreign Currency	1,596,000
Total Local Currency	20,000
Total	1,616,000

Table 11.3 Cost Estimate for Waterway and Ancillaries

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Spillway Radial Gates & Gates					
Wire Rope Hangers	19,368	65	30	85	19,548
Repair Painting of Skin Plates	6,259	380	211	360	7,210
Seal Rubbers with Clamps	4,352	148	68	420	4,988
E & M Parts of Hoists	406	51	50	35	542
Control Panel & Cables	14,000	358	133	100	14,591
(Sub-total)	(44,385)	(1,002)	(492)	(1,000)	(46,879)
Spillway Irrigation Outlet					
Outlet Valves and Control	17,383	428	209	100	18,120
Water Supply Pump	3,300	104	96	35	3,535
(Sub-total)	(20,683)	(532)	(305)	(135)	(21,655)
Movable Trash Rack					
Upstream Trash Rack	1,000	51	192	500	1,743
E & M Parts of Hoist	3,633	14	10	30	3,687
Control Panel & Cables	4,394	35	20	15	4,464
(Sub-total)	(9,027)	(100)	(222)	(545)	(9,894)
Intake Caterpillar Gate & Hoist					
Seal Rubbers with Clamps	933	78	44	110	1,165
Repair Painting of Skin Plate	265	22	12	36	335
E & M Parts of Hoist	605	20	10	5	640
Control Panel & Cables	4,000	35	20	10	4,065
(Sub-total)	(5,803)	(155)	(86)	(161)	(6,205)
Surge Tank Drain Facilities	5,205	150	85	300	5,740
(Sub-total)	(5,205)	(150)	(85)	(300)	(5,740)
Butterfly Valves					
Seal Rubbers with Clamps	1,654	30	20	165	1,869
Auxiliary Facilities	4,041	42	17	50	4,150
Control Panel, Oil Pipes & Cables	16,500	255	106	225	17,086
Detailed Inspection of Valves	-	-	-	160	160
(Sub-total)	(22,195)	(327)	(143)	(600)	(23,265)
Penstocks					
Painting at Upstream of Butterfly Valves	52,045	3,182	1,800	5,000	62,027
Penstock Maintenance Equipment	210,000	8,637	5,000	5,910	229,547
Painting & Repair of No. 1 Penstock	3,535	155	74	650	4,414
Painting & Repair of No. 2 Penstock	3,535	155	74	650	4,414
(Sub-total)	(269,115)	(12,129)	(6,948)	(12,210)	(300,402)

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Spare Parts & Tools	5,000	155	150	-	5,305
Expatriate Specialists	101,125	-	-	-	101,125
Total	482,538	14,550	8,431	14,951	520,470

Total Foreign Currency	497,088
Total Local Currency	23,382
Total	520,470

Table 11.4 Cost Estimate for Dam and Civil Structures

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Preparatory Works	-	-	-	9,200	9,200
Rehabilitation of Spillway	-	-	-	500	500
Repair of Intake Structures	-	-	-	1,100	1,100
Repair of Civil Structures along Penstocks	-	-	-	34,900	34,900
Repair of Powerhouse	-	-	-	300	300
Total	0	0	0	46,000	46,000

Total Foreign Currency	0
Total Local Currency	46,000
Total	46,000

Table 11.5 Cost Estimate for Hydrogical Data Aquisition System

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Rainfall Gauging Stations	28,996	2,029	289	2,899	34,213
Water Level Gauging Stations	19,830	1,388	198	1,983	23,399
Warning Stations	18,772	1,314	187	1,877	22,150
Central Station	94,031	6,582	940	9,403	110,956
Repeater Stations	59,024	4,131	590	5,902	69,647
Central Radio Station in Power Station	56,280	3,939	562	5,628	66,409
Spare Parts	27,693	1,938	276	2,769	32,676
Radio Propagation Test	10,660	-	-	-	10,660
Expatriate Specialists for Installation and Tests	22,200	-	-	-	22,200
Expartiate Specialists for O&M Instruction	3,900	-	-	-	3,900
Total	341,386	21,321	3,042	30,461	396,210

Total Foreign Currency	362,707
Total Local Currency	33,503
Total	396,210

Table 11.6 Cost Estimate for Da Nhim Switchyard

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Transformers					
Rehabilitation of Main Transformers	89,677	6,277	897	866	97,717
Renewal of House-Service Transformers	6,360	445	64	70	6,939
Renewal of 31.5 kV Transformer	12,300	861	123	186	13,470
Rehabilitation of 66 kV Transformer	1,220	85	12	5	1,322
(Sub-total)	(109,557)	(7,668)	(1,096)	(1,127)	(119,448)
Switchgear					
Rehabilitation of 230 kV Switchgear	12,000	840	120	15	12,975
Repair of 13.2 kV & 6.6 kV Switchgear	70	5	1	1	77
Replacement of Air Compressors	11,750	823	118	34	12,725
Spare Parts & Miscellaneous Materials	1,150	81	12	0	1,243
(Sub-total)	(24,970)	(1,749)	(251)	(50)	(27,020)
Control and Protection Equipment					
Main Control Board	58,000	4,060	580	41	62,681
Protective Relay Board	85,000	5,950	850	55	91,855
Supervisory Computer System	200,000	14,000	2,000	81	216,081
Others	147,900	10,353	1,479	200	159,932
(Sub-total)	(490,900)	(34,363)	(4,909)	(377)	(530,549)
Surge Tank Water Level Measuring Equipment	3,500	245	35	87	3,867
(Sub-total)	(3,500)	(245)	(35)	(87)	(3,867)
Expatriate Specialists	68,340	-	-	-	68,340
Total	697,267	44,025	6,291	1,641	749,224

Total Foreign Currency	741,292
Total Local Currency	7,932
Total	749,224

Table 11.7 Cost Estimate for Saigon Substation

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Transformers					
Rehabilitation of Main Transformer 1T	30,792	2,155	154	388	33,489
Renewal of Main Transformer 2T	115,000	8,050	575	321	123,946
Renewal of House-Service Transformers	2,520	176	13	181	2,890
Renewal of 66 kV Transformers	102,180	7,153	511	355	110,199
(Sub-total)	(250,492)	(17,534)	(1,253)	(1,245)	(270,524)
Switchgear					
Rehabilitation of 66 kV Switchgear	28,500	1,995	143	55	30,693
Replacement of 15 kV Switchgear	1,980	139	10	11	2,140
Replacement of Air Compressors	3,000	210	15	3	3,228
Renewal of Static Condenser Bank	36,400	2,548	182	57	39,187
Foundation Works	-	-	-	399	399
Others	2,740	192	14	-	2,946
(Sub-total)	(72,620)	(5,084)	(364)	(525)	(78,593)
Control and Protection Equipment					
Main Control Board	88,000	6,160	440	64	94,664
Protective Relay Board	101,000	7,070	505	64	108,639
Supervisory Computer System	100,000	7,000	500	87	107,587
Others for Saigon Substation	71,200	4,984	357	30,253	106,794
Long Binh Substation	29,400	2,058	147	27	31,632
(Sub-total)	(389,600)	(27,272)	(1,949)	(30,495)	(449,316)
Overhead Traveling Crane	900	63	5	14	982
(Sub-total)	(900)	(63)	(5)	(14)	(982)
PLC Telephone System					
Modification in Saigon Substation	9,360	655	48	23	10,086
Modification in Long Binh Substation	19,560	1,369	98	46	21,073
Modification in Da Nhim Power Station	10,560	739	54	23	11,376
(Sub-total)	(39,480)	(2,763)	(200)	(92)	(42,535)
Expatriate Specialists	44,640	-	-	-	44,640
Total	797,732	52,716	3,771	32,371	886,590

Total Foreign Currency	850,448
Total Local Currency	36,142
Total	886,590

Table 11.8 Cost Estimate for 230 kV Transmission Line

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Conductors and Overhead Earthwires	38,285	2,488	900	5,340	47,013
Insulators and Accessories	44,400	2,886	420	-	47,706
Towers	11,755	764	900	7,480	20,899
Tools and Appliances	58,290	3,789	600	-	62,679
Total	152,730	9,927	2,820	12,820	178,297

Total Foreign Currency	162,657
Total Local Currency	15,640
Total	178,297

Note:

Cost of the local works for the insulator replacement is included in the cost for the conductors and overhead earthwires.

Table 11.9 Cost Estimate for Upgrading of Substations

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Da Nhim Power Station					
Transformer	115,000	8,050	1,150	103	124,303
Switchgear	25,700	1,799	257	307	28,063
PLC Telephone System	22,693	1,585	227	37	24,542
Expatriate Specialists	7,860	-	-	-	7,860
(Sub-total)	(171,253)	(11,434)	(1,634)	(447)	(184,768)
Thap Cham Substation					
Transformer	30,700	2,149	308	65	33,222
110 kV Switchgear	56,330	3,946	566	107	60,949
22 kV Switchgear	23,100	1,617	231	18	24,966
Control and Protection Equipment	65,930	4,615	659	131	71,335
PLC Telephone System	33,420	2,340	334	90	36,184
Miscellaneous Materials	10,470	733	105	62	11,370
Civil and Building Works	-	-	-	43,500	43,500
Expatriate Specialist	20,760	-	-	-	20,760
(Sub-total)	(240,710)	(15,400)	(2,203)	(43,973)	(302,286)
Phan Ri Substation					
Transformer	30,700	2,149	308	65	33,222
110 kV Switchgear	43,940	3,077	441	81	47,539
22 kV Switchgear	18,380	1,287	184	15	19,866
Control and Protection Equipment	58,210	4,075	582	128	62,995
PLC Telephone System	21,870	1,531	219	62	23,682
Miscellaneous Materials	8,660	606	87	62	9,415
Civil and Building Works	-	-	-	43,500	43,500
Expatriate Specialist	17,850	-	-	-	17,850
(Sub-total)	(199,610)	(12,725)	(1,821)	(43,913)	(258,069)
Phan Thiet Substation					
Transformer	36,360	2,545	363	65	39,333
110 kV Switchgear	29,660	2,078	298	53	32,089
22 kV Switchgear	19,010	1,331	190	15	20,546
Control and Protection Equipment	50,490	3,534	505	125	54,654
PLC Telephone System	15,600	1,092	156	34	16,882
Miscellaneous Materials	15,110	1,058	151	62	16,381
Civil and Building Works	-	-	-	43,500	43,500
Expatriate Specialist	15,120	-	-	-	15,120
(Sub-total)	(181,350)	(11,638)	(1,663)	(43,854)	(238,505)

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Cam Ranh Substation					
Transformer	30,700	2,149	308	65	33,222
110 kV Switchgear	72,560	5,082	729	151	78,522
22 kV Switchgear	23,940	1,676	239	15	25,870
Static Condenser	12,000	840	120	19	12,979
Control and Protection Equipment	81,920	5,734	819	141	88,614
PLC Telephone System	26,490	1,855	265	65	28,675
Miscellaneous Materials	12,380	867	124	62	13,433
Civil and Building Works	-	-	-	43,500	43,500
Expatriate Specialist	22,860	-	-	-	22,860
(Sub-total)	(282,850)	(18,203)	(2,604)	(44,018)	(347,675)
Dien Khanh Substation					
Transformer	30,700	2,149	308	65	33,222
110 kV Switchgear	57,280	4,011	574	119	61,984
22 kV Switchgear	23,940	1,676	239	15	25,870
Static Condenser	12,000	840	120	19	12,979
Control and Protection Equipment	65,380	4,577	654	131	70,742
PLC Telephone System	17,250	1,208	173	37	18,668
Miscellaneous Materials	10,330	723	103	62	11,218
Civil and Building Works	-	-	-	43,500	43,500
Expatriate Specialist	18,900	-	-	-	18,900
(Sub-total)	(235,780)	(15,184)	(2,171)	(43,948)	(297,083)
Testing Equipment for Substations	73,299	5,132	733	0	79,164
Total	1,384,852	89,716	12,829	220,153	1,707,550

Total Foreign Currency	1,474,568
Total Local Currency	232,982
Total	1,707,550

Table 11.10 Cost Estimate for Upgrading to 110 kV Transmission Lines

(Unit: ¥ 1,000)

Particulars	FOB	Insurance & Freight	Inland Transport	Local Works	Total Amount
Da Nhim - Thap Cham - Phan Thiet (PC-2)					
Conductors and Overhead Earthwires	4,108	267	180	6,436	10,991
Insulators and Accessories	14,500	943	240	0	15,683
Poles and Accessories	6,959	452	1,800	6,436	15,647
Tools and Appliances	37,522	2,439	1,800	0	41,761
(Sub-total)	(63,089)	(4,101)	(4,020)	(12,872)	(84,082)
Thap Cham - Cam Ranh (PC-3)					
Conductors and Overhead Earthwires	30,600	1,989	1,800	2,547	36,936
Insulators and Accessories	26,500	1,723	720	0	28,943
Poles and Accessories	4,490	292	240	637	5,659
Tools and Appliances	47,057	3,059	900	0	51,016
(Sub-total)	(108,647)	(7,063)	(3,660)	(3,184)	(122,554)
Cam Ranh - Dien Khanh (PC-3)					
Conductors and Overhead Earthwires	32,951	2,142	1,800	17,726	54,619
Insulators and Accessories	44,500	2,893	720	0	48,113
Poles and Accessories	640	42	240	49,302	50,224
Tools and Appliances	47,057	3,059	900	0	51,016
(Sub-total)	(125,148)	(8,136)	(3,660)	(67,028)	(203,972)
Total	296,884	19,300	11,340	83,084	410,608

Total Foreign Currency	316,184
Total Local Currency	94,424
Total	410,608

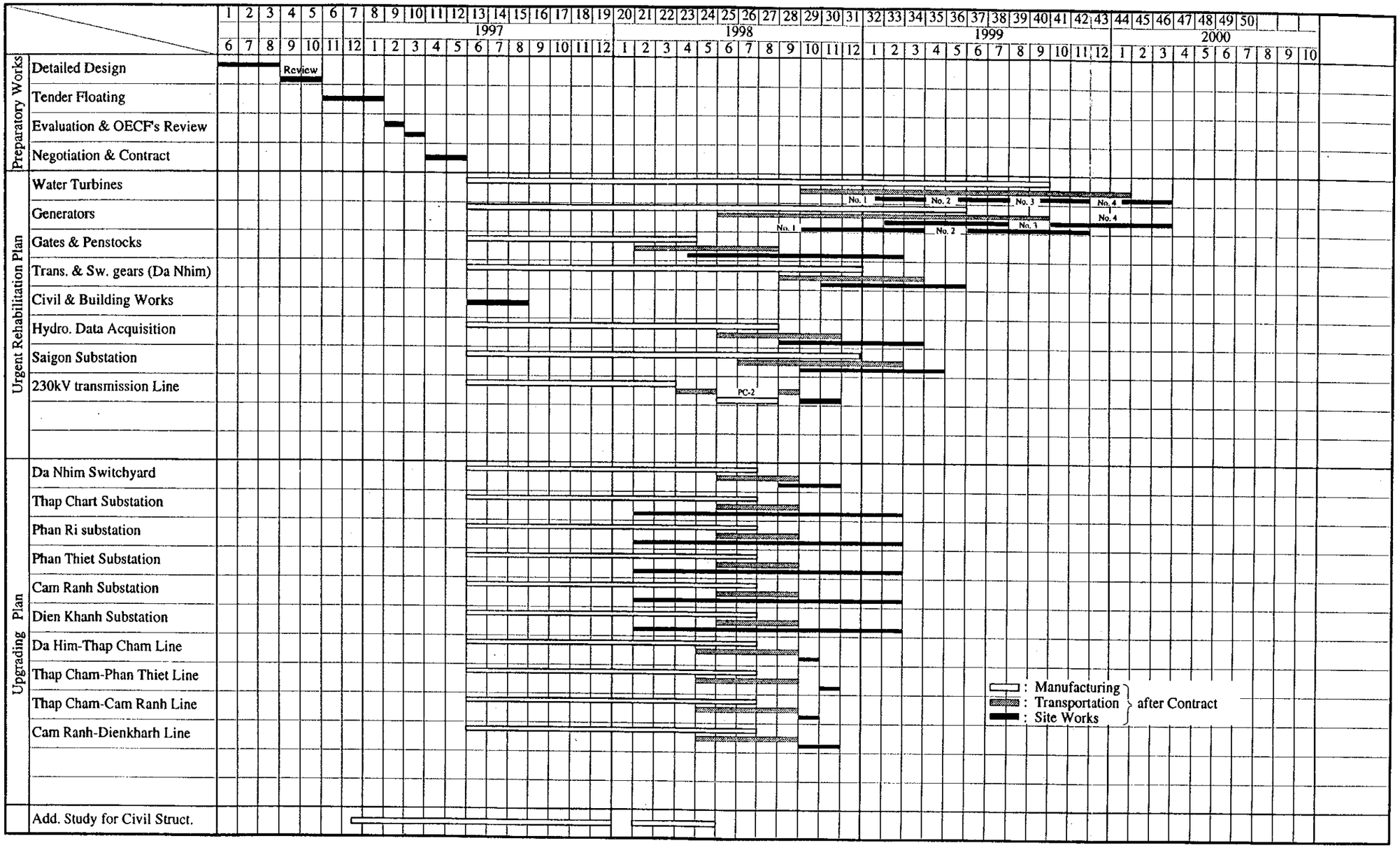
Note:
Cost for the local works for insulators are included in the cost for the conductors and overhead earthwires.

Table 11.11 Cost Estimate for Additional Study for Dam and Civil Structures

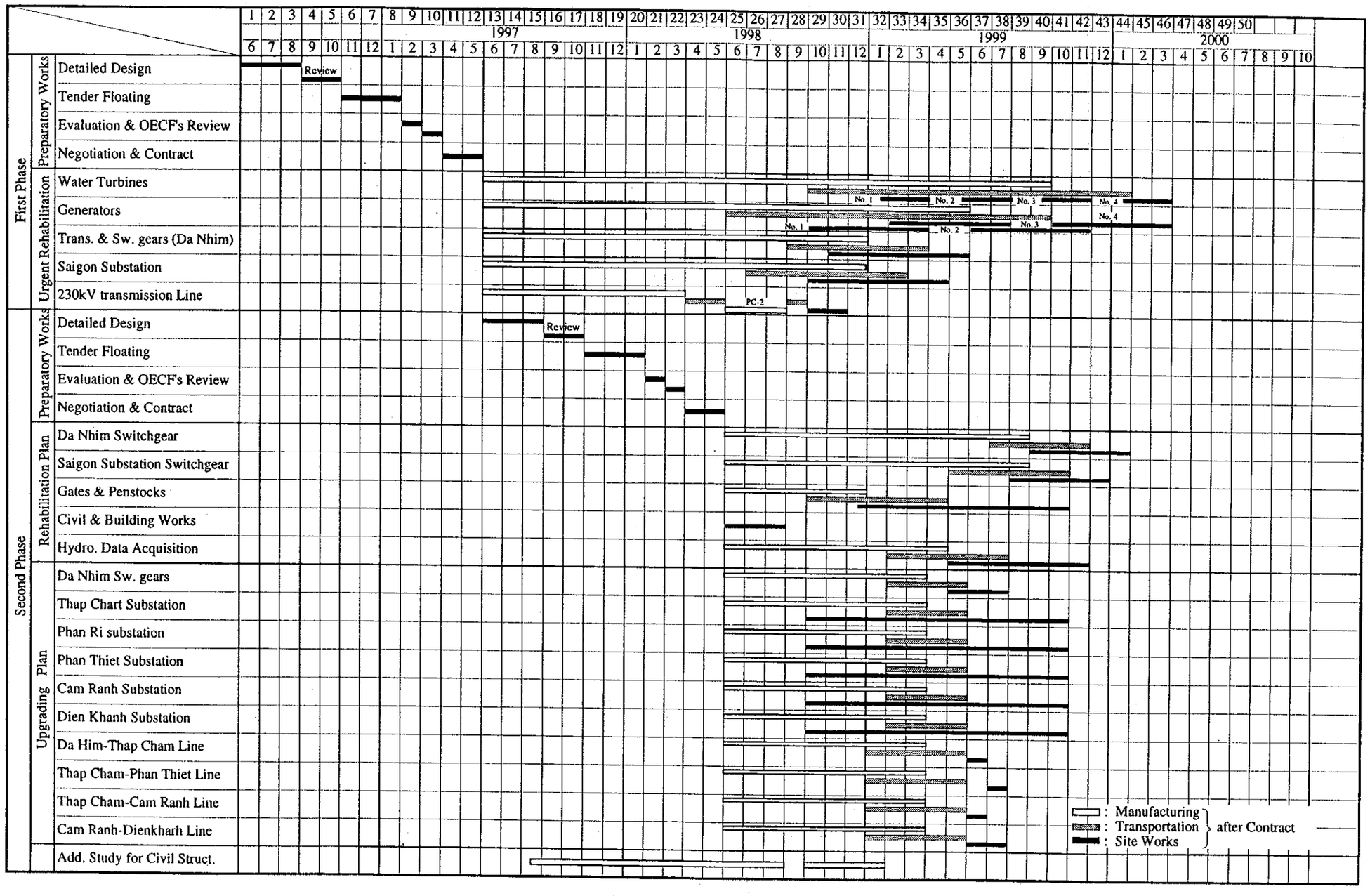
(Unit: ¥ 1,000)

Particulars	Unit	Q'ty	Foreign Currency	Local Currency	Total Amount
Study on Dam and A Part of Spillway	Lot	1	9,382	3,668	13,050
Study on Conservation of Upper Da Nhim	Lot	1	25,000	3,200	28,200
Study on Flood Mitigation and Enviroment	Lot	1	900	44,910	45,810
Cost of Instrument for Investigation	Lot	1	25,982	0	25,982
Cost of Vehicles	Lot	1	0	22,116	22,116
Personnel Expenses	Lot	1	219,780	29,260	249,040
Traveling Expenses	Lot	1	1,008	600	1,608
Printing of Reports	Lot	1	0	565	565
Total			282,052	104,319	386,371

Total Foreign Currency	282,052
Total Local Currency	104,319
Total	386,371



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 11.1 (1) Implementation Schedule of Rehabilitation of Da Nhim Power System



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 11.1 (2) Implementation Schedule of Rehabilitation of Da Nhim Power System (Alternative)

CHAPTER 12

PROJECT ASSESSMENT

CHAPTER 12 PROJECT ASSESSMENT

12.1 General

Both the urgent rehabilitation and the 66 kV system voltage upgrade plans formulated in the foregoing chapters were evaluated in the method of Economic and Financial Internal Rate of Return (FIRR and EIRR). The economic viability of the plans was analyzed from the point of view of the whole national economy, while the financial analysis was made from the point of view of the project executing agency.

The project evaluations were conducted under the following criteria.

(1) The project costs are allocated in the foreign currency and the local currency. The foreign currency is for the procurement of materials and equipment and the engineering services together with the project contingency. While, the local currency is for procurement of some items of the materials and equipment, inland transportation of the materials and equipment and erection costs as well as the project contingency.

(2) The foreign currency for the project implementation is assumed to be funded by a loan. Conditions of the loan are assumed as follow:

1) Repayment period to be 30 years including the grace period of 5 years
2) Annual interest to be 2 %

(3) Energy cost for the financial evaluation is assumed at 0.07 US$/kWh, which is referred to the Long Run Marginal Cost in the least cost expansion plan of the Vietnamese electricity system mentioned in the Report No.1084-VN "Viet Nam Energy Sector Investment and Policy Review" June 18, 1993 of the World Bank and based on instruction of EVN.

(4) Energy cost for economic evaluation is also assumed at 0.07 US US$/kWh for the Long Run Marginal Cost in the least cost expansion plan of the Vietnamese electricity system, which is analyzed in the same report as the above World Bank.

12.2 The Urgent Rehabilitation Project and The 66 kV System Voltage Upgrade Project

12.2.1 Generated Energy and Outage Factor of Generating Facilities

Table 12.1 shows the operation records of generation, availability and outage factors of the facilities in the period of 1979 to 1993. The availability factor is the ratio of the actual operating hours of the facilities to the whole hours in a year regardless of the production of the generating facilities of four (4) units. While, the outage factor is the ratio of total hours of outage of the facilities to whole hours in a year. It is understood from the 15 years' records such tendency that the energy production is decreasing and the outage factor is increasing.

The outage of the facilities is originated from the system operation condition, the water level of the reservoir, the facility trouble, the scheduled periodical inspection to the facilities, or the scheduled repairing of the facilities. However, the definite outage hours caused by each origin are not obtained because of no available records in the power station and shortage of the site investigation period. The energy production may be seasonally variable due to the system operational condition and the periodical inspection for the facilities, but the total annual energy production will not be normally affected by those origins. It is rather influenced by the water level on the beginning of the year (1st January) and the water inflow into the reservoir in the year.

The relation of the annual energy production against the outage factor is obtained from analyses of the available data and shown as the scatter diagram and the regression line in Figure 12.1. The correlation coefficient is high as much as 0.84. On the other hand, Figure 12.1.(4) shows the scattered diagram of the energy production to the water inflow into the reservoir. The correlation coefficient obtained from the diagram is 0.19. These two coefficients disclose that the declining tendency of energy production in the Da Nhim power station is not caused by the water inflow but more by the outage of the generating facilities.

As seen in Figure 12.1 (2), the outage factor of the generating facilities has increased year by year. An approximate equation mentioned in the Figure is formed in a slower rise of the outage factor due to an influence of the sharply jumped factor (23.3%) recorded in 1983 than the actual rise. The jumped factor was not caused by troubles or repairing works of the generating facilities, but mainly by the low water level reaching to the lowest level in the period of January to July in 1983. Precipitation in the rainy seasons in 1982 and 1983 was extremely less. Such less precipitation was easily understood from such a fact that most of the reservoirs in Indonesia were empty in the same years. However, in this examination, the slower rise of the outage factor is adopted for safer evaluation.

12.2.2 Cost of the Project

Costs of the urgent rehabilitation project and the 66 kV system voltage upgrade project include those (CIF, ocean freight, and insurance) for procurement of the equipment and materials, rehabilitation cost (inland transportation, engineering services, civil and building works, and personnel expenses), minus benefit due to reduction of energy production caused by outage of the facility operation, cost of operation and maintenance of the facilities, etc.

(1) Cost of rehabilitation

Costs for the rehabilitation works are estimated in Chapter 11, and the following is its summary of those subjected to the evaluation.

(Unit : J ¥ 1,000)

Particulars	Rehabilitation			Renewal		
	Foreign Portion	Local Portion	Total	Foreign Portion	Local Portion	Total
a) Power station	3,847,000	35,000	3,882,000	5,131,000	40,000	5,171,000
b) Waterways	497,000	23,000	520,000	497,000	23,000	520,000
c) Civil & Building	0	46,000	46,000	0	46,000	46,000
d) Hydro. Data Acqu.	363,000	34,000	397,000	363,000	34,000	397,000
e) 230kV Line	163,000	16,000	179,000	163,000	16,000	179,000
f) Saigon Substation	850,000	36,000	886,000	1,795,000	36,000	1,831,000
g) Eng. Services	351,000	0	351,000	351,000	0	351,000
h) Contingency	303,000	19,000	322,000	415,000	20,000	435,000
Total	6,374,000	209,000	6,583,000	8,715,000	215,000	8,930,000

It is noted that costs for renewal of the waterways, civil and building works, and 230 kV transmission line are appropriated with the same amount for the rehabilitation works, since the facility is technically judged unnecessary to be renewed.

(2) Energy loss due to outage of generating facilities for rehabilitation and upgrade

Operation of the turbine and generator set related should be stopped for the rehabilitation or renewal, which is to reduce energy production of the power station. The following energy reduction due to the stoppage is considered for the evaluation purpose.

1) Reduction of energy due to the implementation of the rehabilitation project is estimated at 100.61 Gwh (=943.3 Gwh x 8% / 0.75) in the year 1999 considering the following conditions.

i) Minimum possible annual operating ratio (AP1) for annual production energy of 943.3 Gwh in the past 15 years of 1979 to 1993

- Annual capacity factor of power station : 67.3%
- Minimum rate of operation of generating unit required to produce the energy of 943.3 GWh : 67.3 %

Therefore, AP1 = 67.3 % x 10% (allowance) = approx. 75%

ii) Average annual possible operating ratio (AP2) during the rehabilitation

As a result of the calculation based on total stoppage duration of the generating units of the year 1999 shown in Figure 12.1, (AP2) is assumed to be approx.67 %.

iii) Reduction of energy (AP) due to the rehabilitation

(AP) = 943.3 GWh x ((AP1) - (AP2))

= 943.3 GWh x 8 % / 0.75 = 100.62 GWh

2) Energy loss production due to the implementation of the 66 kV system voltage upgrade project is estimated at 64 GWh for 2 months power interruption in the year 1998 referring to Table 12.5.

(3) Operation and maintenance cost

The cost for operation and maintenance of the rehabilitated or renewed facilities is assumed at 2% of the cost for the rehabilitation or renewal of the facilities as the value adopted generally for the hydropower plants. However, that for the facilities not rehabilitated or renewed is assumed at 5% in consideration of more frequent maintenance works.

The cost for operation and maintenance of the upgraded facilities is also assumed at 2% of the cost for the construction of the facilities.

(4) Adjustment of cost for economical evaluation

For the economical evaluation, all the cost for the rehabilitation or renewal of the facilities will be converted into the economical cost with opportunity cost or the cost of the actual resources. Adjustment of the economical cost of goods is done considering increase of import, decrease of export, increase of the domestic production or diversion from others. Normally, the financial cost is converted into the economical cost at the rate determined for group of the goods or category of the works. In this evaluation, the standard conversion factors are assumed at 1.0 for both foreign currency and the local currency portions on the basis of the instruction of EVN.

12.2.3 Benefit

(1) Increase of energy due to improvement of the generating facilities

Energy production of the power station is to increase by improvement of the outage factor due to rehabilitation or renewal of the facilities. The increase of energy production is one of the benefits of the project. The possible energy production on the basis of calculation of the increased energy production after the project is considered to be 1,070 GWh/year recorded in the period of 1980 to 1982 or more, while an average annual energy production is assumed as 943.3 GWh.

The increased energy production after rehabilitation or renewal of the facilities is obtained as follow:

1) The outage factor (I) in the year (i) is calculated applying an approximate equation of the outage factor stated in the aforementioned Subsection 12.2.1.

2) The energy (Wi) in the year (i) is obtained from the regression equation noted in Figure 12.1(2).

3) Then, the energy additionally generated (Wi) in the year (i) is obtained from the equation below.

$$\Delta Wi = 943.3 - Wi \ (GWh)$$

The additional energy is assumed to be 50% in the year 1999 in the progressing of the works and 100% thereafter.

(2) Additional energy sales due to 66 kV system voltage upgrade project are estimated from the balance between the transmission capacities of the upgraded 66kV system and

the existing 66kV system. The transmission line capacities of the 110kV and 66kV systems are computed as 695 GWh/year and 417 GWh/year from the power conductors used. The energy additionally sold will be constant after the year when the total energy demand in the system will reach the 695 GWh/year of the maximum capacity of the upgraded facilities.

Since the demand forecasts of the project area were conducted by PC-2 and PC-3 till the year 2000, those after the year were prepared by the Study Team as seen in Table 12.5.

(3) Units of benefits

The following unit cost is adopted to examination of the benefit from the rehabilitation or renewal of the facilities

1) 0.07 US$/kWh of the energy unit cost stated in the foregoing Section 12.1 is considered 19% of energy loss and adopted to economic evaluation of the Project.

2) 0.07 US$ /kWh of the energy unit cost stated in the foregoing Section 12.1 is considered 19 % of energy loss, 2% of water resource tax and 8% of sales tax of revenue and adopted to financial evaluation of the Project.

(4) Costs of operation and maintenance of the existing facilities

Without rehabilitation or renewal, the cost required for the operation and maintenance of the existing facilities should be more than that for the normal hydropower plants. It is obviously understood that the continuous operation of the system will cause the technical troubles without improvement of the generators, synchronous condensers, and others. Since the partial improvement of the facilities is not the project purpose, such condition will not be considered in the evaluation. The cost for operation and maintenance of the existing facilities without the project is assumed to be 5% equivalent to 2.5 times the cost for the improved facilities.

(5) Complete renewal of the facilities

The existing facilities should become inoperative condition sometime in the future without any improvement even if the minimum repairing works would be done. It is assumed that the complete renewal of the facilities concerned will be carried out in the year 2010 when the outage factor of the facilities will come down to 25%.

12.2.4 Economic Evaluation

The economic evaluation was made provided that both cases of the rehabilitation plan and the 66 kV system upgrade plan will be implemented at the same time.

The annual disbursement of investment due to the rehabilitation plan and the 66 kV system upgrade plan is assumed as below.

(unit :J¥ 1,000)

	Rehabilitation Plan			66 kV System Upgrade Plan			
Year	Foreign Portion	Local Portion	Total Amount	Foreign Portion	Local Portion	Total Amount	(Total)
1996	110,100	0	110,100	45,000	0	45,000	(155,100)
1997	856,300	59,000	915,300	212,600	59,000	271,600	(1,186,900)
1998	4,166,900	125,000	4,291,900	1,766,400	303,000	2,069,400	(6,361,300)
1999	1,240,700	25,000	1,265,700	0	0	0	(1,265,700)
Total	6,374,000	209,000	6,583,000	2,024,000	362,000	2,386,000	(8,969,000)

The annual disbursement of investment due to the complete renewal of the facilities is assumed as below.

(unit : J¥ 1,000)

Year	Foreign Portion	Local Portion	Total Amount
1 st	76,500	0	76,500
2 nd	1,998,000	46,900	2,044,900
3 rd	6,467,000	130,400	6,597,400
4 th	150,300	33,400	183,700
5 th	23,200	4,300	27,500
Total	8,715,000	215,000	8,930,000

Table 12.3 shows the result of the economic evaluation. The EIRR of the project is calculated as 21.69 %. The EIRR is further analyzed for the sensitivity for variation of the components in the evaluation. The EIRRs in the sensitivity analyses are as follows;

(Variation)	- 10 %	+ 10 %	+ 15 %	+ 20 %
Project Costs	23.57 %	20.05 %	19.31 %	18.60 %
Energy Rate	20.13 %	23.19 %	23.92 %	24.64 %
O & M Cost	22.17 %	21.22 %	20.99 %	20.77 %

The economic evaluation results that the project is appropriate, because the EIRR is much above the assumed interest of the fund and the opportunity cost of capital (generally 8 to 10%).

In addition to the above, economic sensitive analyses (EIRR) was made on the basis of the project phasing proposed in Subsection 11.4 (2) and assumptions of implementation time of second phase.

As seen in the following table, the EIRRs for each assumption show that the project is recommendable to implement second phase after one (1) year of commencement of the first phase as the EIRR is 22.82%.

Time Delay of Implementation of Second Phase	0 year	1 year	2 years	3 years	4 years
EIRR	21.69 %	22.82 %	22.20 %	21.64 %	21.15 %

12.2.5 Financial Evaluation

Similarly to the economic evaluation, the financial evaluation was also made provided that both cases of the rehabilitation plan and the 66 kV system upgrade plan will be implemented at the same time.

The annual disbursement of investment due to the rehabilitation plan and the 66 kV system upgrade plan is assumed as below.

(unit :J¥ 1,000)

	Rehabilitation Plan			66kV System Upgrade Plan			
Year	Foreign Portion	Local Portion	Total Amount	Foreign Portion	Local Portion	Total Amount	(Total)
1996	110,100	0	110,100	45,000	0	45,000	(155,100)
1997	856,300	59,000	915,300	212,600	59,000	271,600	(1,186,900)
1998	4,166,900	125,000	4,291,900	1,766,400	303,000	2,069,400	(6,361,300)
1999	1,240,700	25,000	1,265,700	0	0	0	(1,265,700)
Total	6,374,000	209,000	6,583,000	2,024,000	362,000	2,386,000	(8,969,000)

The annual disbursement of investment due to the complete renewal of the facilities is assumed as below.

(unit : J¥ 1,000)

Year	Foreign Portion	Local Portion	Total Amount
1 st	76,500	0	76,500
2 nd	1,998,000	46,900	2,044,900
3 rd	6,467,000	130,400	6,597,400
4 th	150,300	33,400	183,700
5 th	23,200	4,300	27,500
Total	8,715,000	215,000	8,930,000

Table 12.4 shows the result of the financial evaluation. The FIRR of the project is calculated as 20.13 %. The FIRR is also further analyzed for the sensitivity for variation of the components in the evaluation. The FIRRs in the sensitivity analyses are as follows;

(Variation)	- 10 %	+ 10 %	+ 15 %	+ 20 %
Project Costs	21.93 %	18.56 %	17.84 %	17.16 %
Energy Rate	18.67 %	21.54 %	22.22 %	22.90 %
O & M Cost	20.60 %	19.68 %	19.45 %	19.23 %

The financial evaluation results that the project is appropriate, because the FIRR is much above the assumed interest of the fund and the opportunity cost of capital.

In addition to the above, financial sensitive analyses (FIRR) is also made on the basis of the project phasing proposed in Subsection 12.4 (2) and assumptions for implementation of time delay of second phase.

As seen in the following table, the EIRRs for each assumption show that the project is recommendable to implement second phase after one (1) year of commencement of the first phase as the FIRR is 21.12%.

Time Delay of Implementation of Second Phase	0 year	1 year	2 years	3 years	4 years
FIRR	20.13%	21.12 %	20.59 %	20.11 %	19.68 %

Table 12.1 Operating Data in Da Nhim Power Station

YEAR	GENERATED ENERGY (GWh)	AVAILABILITIES FACTOR (%)	OUTAGE FACTOR (%)	WATER INFLOW (10^6m3)
1979	926.5	95.4	4.6	592.2
1980	1,094.2	99.1	0.9	702.6
1981	1,022.1	92.9	7.1	742.0
1982	1,098.3	94.9	5.1	484.1
1983	815.7	76.7	23.3	704.2
1984	1,145.3	96.3	3.7	658.4
1985	1,067.6	92.6	7.4	554.7
1986	902.5	89.0	11.0	585.6
1987	998.4	92.3	7.7	473.4
1988	839.9	88.3	11.7	587.2
1989	781.1	83.0	17.0	626.6
1990	774.4	86.2	13.8	642.4
1991	806.8	82.0	18.0	382.8
1992	917.7	90.7	9.3	663.1
1993	958.3	90.5	9.5	746.5
Average	943.3	90.0	10.0	609.7

Table 12.2 Operationg Time and Generated Energy per Unit in Monthly

Year	Mon.	Operating Time (hour)										Generated Energy	
		No.1		No.2		No.3		No.4		Total			
		Hour	(%)	Hour	(%)	Hour	(%)	Hour	(%)	Hour	(%)	(MWh)	(%)
1979	1	542	72.8	744	100.0	744	100.0	744	100.0	2,774	93.2	74,735	62.8
	2	346	51.5	358	53.3	671	99.9	590	87.8	1,965	73.1	56,220	52.3
	3	744	100.0	722	97.0	730	98.1	737	99.1	2,933	98.6	77,045	64.7
	4	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	82,652	71.7
	5	744	100.0	617	82.9	744	100.0	744	100.0	2,849	95.7	79,623	66.9
	6	720	100.0	720	100.0	484	67.2	489	67.9	2,413	83.8	53,525	46.5
	7	744	100.0	730	98.1	744	100.0	737	99.1	2,955	99.3	80,546	67.7
	8	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	85,126	71.5
	9	720	100.0	717	99.6	720	100.0	720	100.0	2,877	99.9	83,537	72.5
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	87,120	73.2
	11	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	86,168	74.8
	12	704	94.6	744	100.0	744	100.0	744	100.0	2,936	98.7	80,180	67.4
Total		8,192	93.5	8,280	94.5	8,509	97.1	8,433	96.3	33,414	95.4	926,477	66.1
1980	1	735	98.8	744	100.0	744	100.0	744	100.0	2,967	99.7	85,471	71.8
	2	696	100.0	696	100.0	696	100.0	696	100.0	2,784	100.0	77,346	69.5
	3	744	100.0	738	99.2	744	100.0	744	100.0	2,970	99.8	90,866	76.3
	4	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	82,778	71.9
	5	744	100.0	654	87.9	744	100.0	744	100.0	2,886	97.0	78,083	65.6
	6	610	84.7	657	91.3	720	100.0	707	98.2	2,694	93.5	85,102	73.9
	7	744	100.0	742	99.7	744	100.0	744	100.0	2,974	99.9	98,670	82.9
	8	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	99,675	83.7
	9	720	100.0	702	97.5	720	100.0	720	100.0	2,862	99.4	98,128	85.2
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	106,374	89.4
	11	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	104,308	90.5
	12	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	87,396	73.4
Total		8,665	98.6	8,605	98.0	8,784	100.0	8,771	99.9	34,825	99.1	1,094,197	77.9
1981	1	740	99.5	539	72.4	744	100.0	744	100.0	2,767	93.0	98,781	83.0
	2	668	99.4	668	99.4	526	78.3	672	100.0	2,534	94.3	85,258	79.3
	3	744	100.0	744	100.0	730	98.1	744	100.0	2,962	99.5	109,420	91.9
	4	632	87.8	629	87.4	629	87.4	629	87.4	2,519	87.5	88,263	76.6
	5	744	100.0	744	100.0	618	83.1	744	100.0	2,850	95.8	68,222	57.3
	6	717	99.6	717	99.5	668	92.8	498	69.2	2,599	90.3	67,828	58.9
	7	744	100.0	566	76.0	625	84.0	348	46.8	2,283	76.7	55,890	47.0
	8	744	100.0	735	98.8	596	80.1	744	100.0	2,819	94.7	81,463	68.4
	9	589	81.8	703	97.6	370	51.4	720	100.0	2,382	82.7	61,168	53.1
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	98,109	82.4
	11	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	100,922	87.6
	12	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	106,804	89.7
Total		8,530	97.4	8,252	94.2	7,714	88.1	8,051	91.9	32,548	92.9	1,022,128	72.9
1982	1	744	100.0	737	99.1	738	99.2	744	100.0	2,963	99.6	93,937	78.9
	2	672	100.0	672	100.0	635	94.5	672	100.0	2,651	98.6	83,976	78.1
	3	744	100.0	744	100.0	744	100.0	682	91.7	2,914	97.9	86,898	73.0
	4	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	103,796	90.1
	5	689	92.6	744	100.0	555	74.6	740	99.5	2,728	91.7	94,834	79.7
	6	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	104,628	90.8
	7	744	100.0	722	97.0	744	100.0	679	91.3	2,889	97.1	103,177	86.7
	8	480	64.5	581	78.1	744	100.0	744	100.0	2,549	85.7	92,911	78.1
	9	682	94.7	720	100.0	720	100.0	693	96.3	2,815	97.7	94,349	81.9
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	106,790	89.7
	11	679	94.3	581	80.7	679	94.3	658	91.4	2,597	90.2	84,018	72.9
	12	744	100.0	441	59.3	473	63.6	744	100.0	2,402	80.7	49,014	41.2
Total		8,362	95.5	8,126	92.8	8,216	93.8	8,540	97.5	33,244	94.9	1,098,328	78.4
1983	1	744	100.0	67	9.0	152	20.4	744	100.0	1,707	57.4	39,174	32.9
	2	672	100.0	7	1.0	59	8.8	672	100.0	1,410	52.5	23,830	22.2
	3	624	83.9	119	16.0	157	21.1	442	59.4	1,342	45.1	29,374	24.7
	4	719	99.9	461	64.0	262	36.4	18	2.5	1,460	50.7	29,168	25.3
	5	188	25.3	0	0.0	650	87.4	744	100.0	1,582	53.2	35,683	30.0
	6	387	53.8	82	11.4	720	100.0	720	100.0	1,909	66.3	69,635	60.4
	7	744	100.0	744	100.0	706	94.9	744	100.0	2,938	98.7	89,685	75.3
	8	744	100.0	707	95.0	707	95.0	712	95.7	2,870	96.4	95,520	80.2
	9	720	100.0	704	97.8	720	100.0	720	100.0	2,864	99.4	107,236	93.1
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	113,063	95.0
	11	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	106,829	92.7
	12	744	100.0	711	95.6	744	100.0	744	100.0	2,943	98.9	76,479	64.2
Total		7,750	88.5	5,066	57.8	6,341	72.4	7,724	88.2	26,881	76.7	815,676	58.2

Table 12.2 Operationg Time and Generated Energy per Unit in Monthly

Year	Mon.	Operating Time (hour)										Generated Energy	
		No.1		No.2		No.3		No.4		Total			
		Hour	(%)	Hour	(%)	Hour	(%)	Hour	(%)	Hour	(%)	(MWh)	(%)
1984	1	744	100.0	743	99.9	744	100.0	744	100.0	2,975	100.0	88,145	74.0
	2	686	98.6	684	98.3	663	95.3	692	99.4	2,725	97.9	77,592	69.7
	3	647	86.9	742	99.7	744	100.0	744	100.0	2,877	96.7	80,864	67.9
	4	555	77.1	720	100.0	720	100.0	491	68.2	2,486	86.3	75,603	65.6
	5	439	59.0	744	100.0	744	100.0	720	96.8	2,647	88.9	91,781	77.1
	6	720	100.0	527	73.2	502	69.8	720	100.0	2,470	85.7	75,264	65.3
	7	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	113,910	95.7
	8	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	114,199	95.9
	9	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	110,294	95.7
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	114,604	96.3
	11	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	102,549	89.0
	12	744	100.0	743	99.9	744	100.0	744	100.0	2,975	100.0	100,466	84.4
Total		8,207	93.4	8,575	97.6	8,533	97.1	8,527	97.1	33,842	96.3	1,145,271	81.5
1985	1	744	100.0	744	100.0	645	86.7	645	86.7	2,778	93.4	97,377	81.8
	2	672	100.0	672	100.0	0	0.0	225	33.5	1,569	58.4	61,079	56.8
	3	728	97.9	744	100.0	544	73.1	744	100.0	2,761	92.8	93,573	78.6
	4	720	100.0	716	99.4	720	100.0	720	100.0	2,876	99.9	94,312	81.9
	5	744	100.0	744	100.0	744	100.0	461	62.0	2,693	90.5	101,030	84.9
	6	550	76.4	720	100.0	720	100.0	720	100.0	2,710	94.1	101,855	88.4
	7	658	88.4	741	99.6	744	100.0	744	100.0	2,887	97.0	101,617	85.4
	8	744	100.0	634	85.2	744	100.0	744	100.0	2,866	96.3	81,943	68.8
	9	431	59.8	720	100.0	720	100.0	639	88.7	2,509	87.1	57,113	49.6
	10	736	98.9	744	100.0	744	100.0	744	100.0	2,968	99.7	104,651	87.9
	11	716	99.4	720	100.0	720	100.0	720	100.0	2,876	99.9	82,468	71.6
	12	744	100.0	744	100.0	742	99.7	740	99.5	2,970	99.8	90,601	76.1
Total		8,187	93.5	8,643	98.7	7,787	88.9	7,846	89.6	32,463	92.6	1,067,619	76.2
1986	1	609	81.9	741	99.6	744	100.0	744	100.0	2,838	95.4	70,431	59.2
	2	672	100.0	672	100.0	672	100.0	672	100.0	2,688	100.0	60,776	56.5
	3	572	76.9	673	90.5	744	100.0	744	100.0	2,733	91.8	74,535	62.6
	4	700	97.3	609	84.6	575	79.8	662	92.0	2,546	88.4	69,547	60.4
	5	744	100.0	485	65.2	651	87.5	429	57.6	2,309	77.6	55,052	46.2
	6	577	80.1	176	24.4	298	41.4	500	69.4	1,551	53.9	32,853	28.5
	7	631	84.8	247	33.2	701	94.2	381	51.2	1,960	65.9	38,975	32.7
	8	744	100.0	744	100.0	725	97.4	744	100.0	2,957	99.4	93,069	78.2
	9	705	97.9	720	100.0	698	96.9	720	100.0	2,843	98.7	88,260	76.6
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	116,869	98.2
	11	705	97.9	696	96.7	720	100.0	684	95.0	2,805	97.4	89,230	77.5
	12	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	112,854	94.8
Total		8,147	93.0	7,251	82.8	8,016	91.5	7,768	88.7	31,182	89.0	902,451	64.4
1987	1	737	99.1	740	99.5	744	100.0	744	100.0	2,965	99.6	97,088	81.6
	2	672	100.0	672	100.0	672	100.0	672	100.0	2,688	100.0	92,046	85.6
	3	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	101,576	85.3
	4	720	100.0	718	99.7	720	100.0	720	100.0	2,878	99.9	96,959	84.2
	5	277	37.2	302	40.6	682	91.7	659	88.6	1,920	64.5	61,442	51.6
	6	716	99.4	582	80.8	664	92.2	713	99.0	2,675	92.9	70,000	60.8
	7	489	65.7	582	78.2	744	100.0	603	81.1	2,417	81.2	52,292	43.9
	8	600	80.6	744	100.0	565	75.9	744	100.0	2,653	89.1	74,211	62.3
	9	531	73.8	720	100.0	720	100.0	457	63.5	2,428	84.3	80,385	69.8
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	102,375	86.0
	11	706	98.1	720	100.0	669	92.9	703	97.6	2,798	97.1	89,050	77.3
	12	744	100.0	744	100.0	744	100.0	737	99.1	2,969	99.8	81,022	68.1
Total		7,680	87.7	8,012	91.5	8,412	96.0	8,240	94.1	32,343	92.3	998,446	71.2
1988	1	744	100.0	744	100.0	712	95.7	744	100.0	2,944	98.9	76,198	64.0
	2	683	98.1	696	100.0	681	97.8	696	100.0	2,756	99.0	56,134	50.4
	3	730	98.1	723	97.2	672	90.3	672	90.3	2,797	94.0	60,587	50.9
	4	555	77.1	371	51.5	278	38.6	644	89.4	1,848	64.2	33,613	29.2
	5	252	33.9	504	67.7	44	5.9	744	100.0	1,544	51.9	25,357	21.3
	6	381	52.9	720	100.0	69	9.6	720	100.0	1,890	65.6	35,206	30.6
	7	707	95.0	744	100.0	656	88.2	744	100.0	2,851	95.8	83,685	70.3
	8	744	100.0	744	100.0	744	100.0	553	74.3	2,785	93.6	91,652	77.0
	9	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	96,121	83.4
	10	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	99,368	83.5
	11	720	100.0	720	100.0	678	94.2	671	93.2	2,789	96.8	84,057	73.0
	12	738	99.2	744	100.0	744	100.0	744	100.0	2,970	99.8	97,970	82.3
Total		7,718	87.9	8,174	93.1	6,742	76.8	8,396	95.6	31,030	88.3	839,948	59.8

Table 12.2 Operationg Time and Generated Energy per Unit in Monthly

Year	Mon.	Operating Time (hour)										Generated Energy	
		No.1		No.2		No.3		No.4		Total			
		Hour	(%)	Hour	(%)	Hour	(%)	Hour	(%)	Hour	(%)	(MWh)	(%)
1989	1	740	99.5	730	98.1	744	100.0	744	100.0	2,958	99.4	93,606	78.6
	2	672	100.0	672	100.0	669	99.6	672	100.0	2,685	99.9	66,437	61.8
	3	744	100.0	744	100.0	729	98.0	744	100.0	2,961	99.5	84,147	70.7
	4	655	91.0	654	90.8	720	100.0	425	59.0	2,454	85.2	70,485	61.2
	5	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	79,503	66.8
	6	720	100.0	417	57.9	649	90.1	389	54.0	2,175	75.5	55,174	47.9
	7	744	100.0	400	53.8	780	104.8	711	95.6	2,635	88.5	90,541	76.1
	8	207	27.9	697	93.7	342	46.0	595	80.0	1,841	61.9	34,014	28.6
	9	439	60.9	190	26.4	588	81.6	265	36.8	1,481	51.4	19,325	16.8
	10	232	31.2	621	83.5	86	11.6	744	100.0	1,683	56.6	25,345	21.3
	11	720	100.0	426	59.2	445	61.8	720	100.0	2,311	80.2	63,872	55.4
	12	702	94.4	744	100.0	744	100.0	722	97.0	2,912	97.9	98,606	82.8
Total		7,319	83.6	7,039	80.4	7,240	82.7	7,475	85.3	29,074	83.0	781,055	55.7
1990	1	744	100.0	744	100.0	585	78.6	744	100.0	2,817	94.7	100,383	84.3
	2	672	100.0	672	100.0	672	100.0	672	100.0	2,688	100.0	98,940	92.0
	3	744	100.0	706	94.9	709	95.3	742	99.7	2,901	97.5	82,325	69.2
	4	629	87.4	720	100.0	615	85.4	720	100.0	2,684	93.2	60,521	52.5
	5	736	98.9	506	68.0	658	88.4	465	62.5	2,365	79.5	54,907	46.1
	6	594	82.5	720	100.0	299	41.5	701	97.4	2,314	80.3	63,409	55.0
	7	421	56.6	564	75.8	742	99.7	503	67.6	2,230	74.9	57,350	48.2
	8	443	59.5	361	48.5	736	98.9	744	100.0	2,284	76.7	35,875	30.1
	9	695	96.5	118	16.4	720	100.0	720	100.0	2,253	78.2	33,281	28.9
	10	159	21.3	655	88.0	738	99.2	704	94.6	2,256	75.8	34,047	28.6
	11	305	42.4	720	100.0	720	100.0	720	100.0	2,465	85.6	54,568	47.4
	12	734	98.6	726	97.6	736	98.9	742	99.7	2,938	98.7	98,775	83.0
Total		6,875	78.5	7,212	82.3	7,930	90.5	8,177	93.3	30,194	86.2	774,381	55.2
1991	1	737	99.1	728	97.8	737	99.1	744	100.0	2,946	99.0	81,760	68.7
	2	672	100.0	658	97.9	670	99.7	666	99.1	2,666	99.2	67,491	62.8
	3	689	92.6	729	98.0	744	100.0	744	100.0	2,906	97.6	96,602	81.2
	4	720	100.0	694	96.4	368	51.1	196	27.2	1,978	68.7	69,504	60.3
	5	700	94.1	744	100.0	744	100.0	744	100.0	2,932	98.5	92,681	77.9
	6	353	49.0	617	85.7	720	100.0	720	100.0	2,410	83.7	57,305	49.7
	7	275	37.0	309	41.5	315	42.3	744	100.0	1,643	55.2	35,931	30.2
	8	119	16.0	504	67.7	336	45.2	744	100.0	1,703	57.2	32,803	27.6
	9	418	58.1	505	70.1	171	23.8	715	99.3	1,809	62.8	32,852	28.5
	10	744	100.0	227	30.5	268	36.0	729	98.0	1,968	66.1	41,235	34.6
	11	720	100.0	673	93.5	720	100.0	720	100.0	2,833	98.4	94,145	81.7
	12	743	99.9	725	97.4	744	100.0	744	100.0	2,956	99.3	104,510	87.8
Total		6,890	78.7	7,113	81.2	6,537	74.6	8,210	93.7	28,750	82.0	806,819	57.6
1992	1	689	92.6	509	68.4	744	100.0	744	100.0	2,686	90.3	70,982	59.6
	2	241	34.6	696	100.0	696	100.0	696	100.0	2,329	83.7	55,049	49.4
	3	668	89.7	689	92.5	744	100.0	744	100.0	2,844	95.6	58,277	49.0
	4	632	87.8	600	83.3	81	11.3	104	14.4	1,417	49.2	32,560	28.3
	5	737	99.1	743	99.9	743	99.9	743	99.9	2,967	99.7	90,595	76.1
	6	714	99.2	714	99.2	717	99.6	720	100.0	2,865	99.5	108,970	94.6
	7	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	116,885	98.2
	8	744	100.0	743	99.9	743	99.9	743	99.9	2,974	99.9	93,276	78.4
	9	478	66.4	546	75.8	720	100.0	720	100.0	2,464	85.6	48,758	42.3
	10	332	44.6	744	100.0	744	100.0	744	100.0	2,564	86.2	49,919	41.9
	11	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	99,413	86.3
	12	744	100.0	682	91.7	744	100.0	744	100.0	2,914	97.9	93,048	78.2
Total		7,443	84.7	8,130	92.6	8,141	92.7	8,167	93.0	31,880	90.7	917,732	65.3
1993	1	661	88.9	744	100.0	744	100.0	739	99.4	2,889	97.1	51,866	43.6
	2	205	30.5	672	100.0	672	100.0	644	95.8	2,193	81.6	56,159	52.2
	3	287	38.6	334	44.9	734	98.6	730	98.1	2,085	70.1	68,764	57.8
	4	416	57.8	396	55.0	688	95.6	720	100.0	2,220	77.1	87,087	75.6
	5	738	99.2	744	100.0	744	100.0	744	100.0	2,970	99.8	112,588	94.6
	6	720	100.0	720	100.0	720	100.0	720	100.0	2,880	100.0	113,048	98.1
	7	744	100.0	732	98.4	744	100.0	744	100.0	2,964	99.6	109,815	92.3
	8	744	100.0	383	51.5	744	100.0	744	100.0	2,615	87.9	44,601	37.5
	9	705	97.9	307	42.6	713	99.0	713	99.1	2,438	84.7	46,714	40.6
	10	447	60.1	652	87.6	744	100.0	744	100.0	2,587	86.9	60,890	51.2
	11	720	100.0	720	100.0	720	100.0	717	99.5	2,877	99.9	89,347	77.6
	12	744	100.0	744	100.0	744	100.0	744	100.0	2,976	100.0	117,386	98.6
Total		7,132	81.4	7,148	81.6	8,711	99.4	8,703	99.4	31,694	90.5	958,265	68.4

Table 12.3 Economic Internal Rate of Return

EIRR= 21.69%

Year	Cost: Rehabilitation Invest. (₩1,000)	Cost: Rehabilitation O & M (₩1,000)	Cost: Upgrade Invest. (₩1,000)	Cost: Upgrade O & M (₩1,000)	Cost: Total (₩1,000)	Benefit due to Additional Energy: Rehabilitation Add.Engy (GWh)	Rehabilitation Add.Sales (₩1,000)	Upgrade Add.Engy (MWh)	Upgrade Add.Sales (₩1,000)	Energy Loss (₩1,000)	Benefit of Renewal: Rehabilitation Renewal Benefit (₩1,000)	Benefit of Renewal: O & M Benefit (₩1,000)	Total Benefit (₩1,000)	Balance of Benefit and Cost (₩1,000)	Present Worth Value (₩1,000)	PWV Discount Rate 21.69%
1996	110,100	424,735	45,000	0	579,835							424,735	424,735	-155,100	-155,100	-155,100
1997	915,300	424,735	271,600	23,860	1,635,495							424,735	424,735	-1,210,760	-1,187,020	-994,946
1998	4,291,900	297,315	2,069,400	47,720	6,706,335			6,750	38,273	359,400		424,735	103,608	-6,602,727	-6,346,335	-4,458,683
1999	1,265,700	297,315		47,720	1,610,735	69.06	391,585	13,500	76,545	704,331		424,735	188,534	-1,422,200	-1,340,171	-789,198
2000		169,894		47,720	217,614	148.75	843,398	70,400	399,168			424,735	1,667,301	1,449,687	1,339,287	661,060
2001		169,894		47,720	217,614	159.37	903,627	130,540	740,162			424,735	2,068,524	1,850,910	1,676,426	693,575
2002		169,894		47,720	217,614	169.99	963,856	197,970	1,122,490			424,735	2,511,081	2,293,467	2,036,533	706,224
2003		169,894		47,720	217,614	180.61	1,024,085	269,790	1,529,709			424,735	2,978,529	2,760,915	2,403,543	698,626
2004		169,894		47,720	217,614	191.24	1,084,314	278,000	1,576,260			424,735	3,085,309	2,867,695	2,447,550	596,302
2005		169,894		47,720	217,614	201.86	1,144,543	278,000	1,576,260			424,735	3,145,538	2,927,924	2,449,956	500,305
2006		169,894		47,720	217,614	212.48	1,204,772	278,000	1,576,260			424,735	3,205,767	2,988,153	2,451,326	419,584
2007		169,894		47,720	217,614	223.10	1,265,001	278,000	1,576,260		76,500	424,735	3,342,496	3,124,882	2,513,227	360,572
2008	113,000	169,894		47,720	330,614	233.73	1,325,230	278,000	1,576,260		2,044,900	424,735	5,371,125	5,040,511	3,974,408	477,941
2009	1,472,000	169,894		47,720	1,689,614	244.35	1,385,459	278,000	1,576,260		6,597,400	297,315	9,856,433	8,166,819	6,313,217	636,347
2010	699,300	169,894		47,720	916,914	254.97	1,445,687	278,000	1,576,260		183,700	297,315	3,502,962	2,586,048	1,959,901	165,584
2011		169,894		47,720	217,614	265.59	1,505,916	278,000	1,576,260		27,500	169,894	3,279,570	3,061,956	2,275,079	161,110
2012		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	1,113,459	66,091
2013		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	1,091,626	54,311
2014		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	1,070,222	44,630
2015	1,498,100	169,894		47,720	1,715,714			278,000	1,576,260			169,894	1,746,154	30,440	20,895	730
2016		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	1,028,664	30,138
2017		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	1,008,494	24,766
2018		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	988,719	20,351
2019		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	969,333	16,724
2020		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	950,326	13,743
2021		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	931,692	11,293
2022		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	913,424	9,280
2023		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	895,514	7,626
2024		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	877,954	6,267
2025		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	860,740	5,150
2026		169,894		47,720	217,614			278,000	1,576,260		1,498,100	169,894	3,244,254	3,026,640	1,670,920	8,379
2027		169,894		47,720	217,614			278,000	1,576,260			169,894	1,746,154	1,528,540	827,316	3,478
2028		169,894		47,720	217,614							169,894	169,894	-47,720	-25,322	-89
2029		169,894		47,720	217,614							169,894	169,894	-47,720	-24,825	-73
2030	1,498,100	169,894		47,720	1,715,714							169,894	169,894	-1,545,820	-788,412	-1,952
2031		169,894		47,720	217,614							169,894	169,894	-47,720	-23,861	-50
2032		169,894		47,720	217,614							169,894	169,894	-47,720	-23,393	-41
2033		169,894		47,720	217,614							169,894	169,894	-47,720	-22,935	-33
2034		169,894		47,720	217,614							169,894	169,894	-47,720	-22,485	-27
2035		169,894		47,720	217,614							169,894	169,894	-47,720	-22,044	-23
2036		169,894		47,720	217,614							169,894	169,894	-47,720	-21,612	-19
2037		169,894		47,720	217,614							169,894	169,894	-47,720	-21,188	-15
2038		169,894		47,720	217,614							169,894	169,894	-47,720	-20,773	-13
2039		169,894		47,720	217,614							169,894	169,894	-47,720	-20,365	-10
2040		169,894		47,720	217,614							169,894	169,894	-47,720	-19,966	-8
2041		169,894		47,720	217,614						1,498,100	169,894	1,667,994	1,450,380	594,941	211
2042		169,894		47,720	217,614							169,894	169,894	-47,720	-19,191	-6
2043		169,894		47,720	217,614							169,894	169,894	-47,720	-18,814	-5
2044		169,894		47,720	217,614							169,894	169,894	-47,720	-18,446	-4
2045	1,498,100	169,894		47,720	1,715,714							169,894	169,894	-1,545,820	-585,802	-103
															36,926,630	0

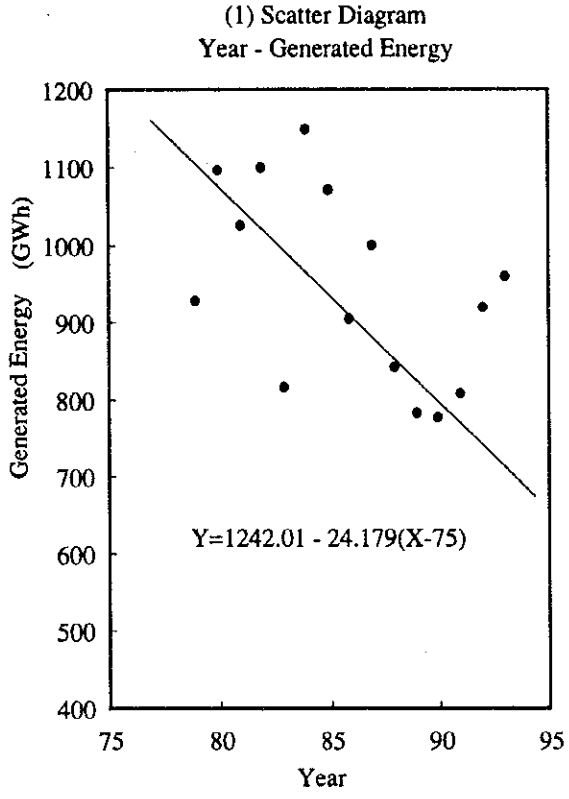
Table 12.4 Financial Internal Rate of Return

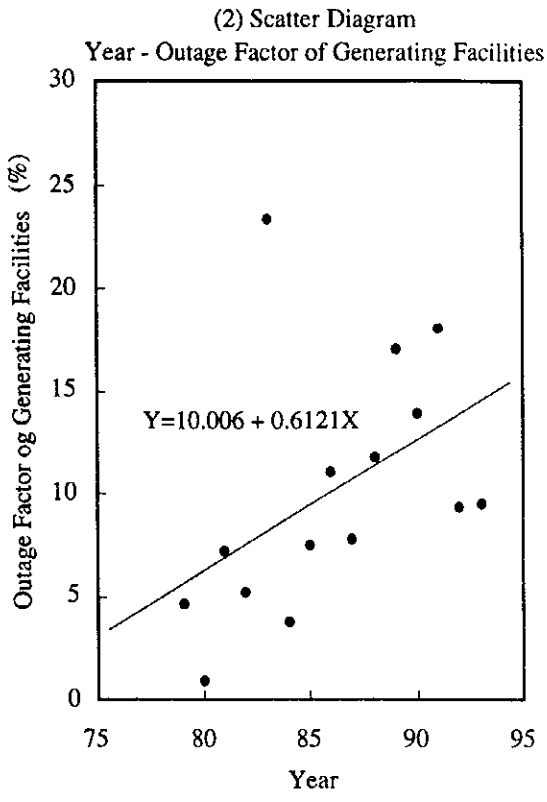
FIRR= 20.13%

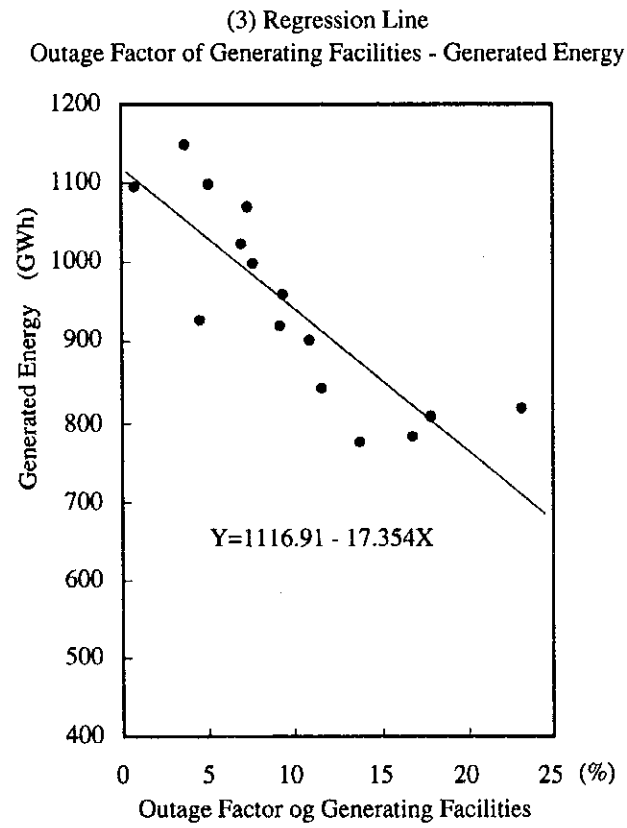
Year	Cost: Rehabilitation Invest. (N'000)	Cost: Rehabilitation O & M (N'000)	Cost: Upgrade Invest. (N'000)	Cost: Upgrade O & M (N'000)	Cost: Tax (N'000)	Cost: Total (N'000)	Benefit due to Additional Energy: Rehabilitation Add.Engy (GWh)	Benefit due to Additional Energy: Rehabilitation Add.Sales (N'000)	Benefit due to Additional Energy: Upgrade Add.Engy (MWh)	Benefit due to Additional Energy: Upgrade Add.Sales (N'000)	Energy Loss (N'000)	Benefit of Renewal: Rehabilitation Renewal Benefit (N'000)	Benefit of Renewal: Rehabilitation O & M Benefit (N'000)	Total Benefit (N'000)	Balance of Benefit and Cost (N'000)	Present Worth Value (N'000)	PWV Discount Rate 20.13%
1996	110,100	424,735	45,000	0	0	579,835							424,735	424,735	-155,100	-155,100	-155,100
1997	915,300	424,735	271,600	23,860	0	1,635,495							424,735	424,735	-1,210,760	-1,187,020	-1,007,854
1998	4,291,900	297,315	2,069,400	47,720	3,827	6,710,162			6,750	38,273	359,400		424,735	103,608	-6,606,554	-6,350,014	-4,577,770
1999	1,265,700	297,315		47,720	46,813	1,657,547	69.06	391,585	13,500	76,545	704,331		424,735	188,534	-1,469,013	-1,384,284	-847,314
2000		169,894		47,720	124,257	341,871	148.75	843,398	70,400	399,168			424,735	1,667,301	1,325,431	1,224,493	636,378
2001		169,894		47,720	164,379	381,993	159.37	903,627	130,540	740,162			424,735	2,068,524	1,686,531	1,527,543	674,049
2002		169,894		47,720	208,635	426,249	169.99	963,856	197,970	1,122,490			424,735	2,511,081	2,084,832	1,851,272	693,598
2003		169,894		47,720	255,379	472,993	180.61	1,024,085	269,790	1,529,709			424,735	2,978,529	2,505,536	2,181,220	693,868
2004		169,894		47,720	266,057	483,671	191.24	1,084,314	278,000	1,576,260			424,735	3,085,309	2,601,638	2,220,473	599,739
2005		169,894		47,720	272,080	489,694	201.86	1,144,543	278,000	1,576,260			424,735	3,145,538	2,655,844	2,222,291	509,633
2006		169,894		47,720	278,103	495,717	212.48	1,204,772	278,000	1,576,260			424,735	3,205,767	2,710,050	2,223,185	432,884
2007		169,894		47,720	284,126	501,740	223.10	1,265,001	278,000	1,576,260		76,500	424,735	3,342,496	2,840,756	2,284,715	377,718
2008	113,000	169,894		47,720	290,149	620,763	233.73	1,325,230	278,000	1,576,260		2,044,900	424,735	5,371,125	4,750,362	3,745,628	525,776
2009	1,472,000	169,894		47,720	296,172	1,985,786	244.35	1,385,459	278,000	1,576,260		6,597,400	297,315	9,856,433	7,870,647	6,084,266	725,143
2010	699,300	169,894		47,720	302,195	1,219,109	254.97	1,445,687	278,000	1,576,260		183,700	297,315	3,502,962	2,283,853	1,730,875	175,154
2011		169,894		47,720	308,218	525,832	265.59	1,505,916	278,000	1,576,260		27,500	169,894	3,279,570	2,753,739	2,046,068	175,798
2012		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	998,637	72,852
2013		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	979,055	60,643
2014		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	959,858	50,480
2015	1,498,100	169,894		47,720	157,626	1,873,340			278,000	1,576,260			169,894	1,746,154	-127,186	-87,304	-3,898
2016		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	922,586	34,978
2017		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	904,496	29,117
2018		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	886,761	24,237
2019		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	869,373	20,175
2020		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	852,327	16,794
2021		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	835,614	13,980
2022		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	819,230	11,637
2023		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	803,166	9,687
2024		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	787,418	8,063
2025		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	771,979	6,712
2026		169,894		47,720	157,626	375,240			278,000	1,576,260		1,498,100	169,894	3,244,254	2,869,014	1,583,899	11,693
2027		169,894		47,720	157,626	375,240			278,000	1,576,260			169,894	1,746,154	1,370,914	742,002	4,651
2028		169,894		47,720	0	217,614							169,894	169,894	-47,720	-25,322	-135
2029		169,894		47,720	0	217,614							169,894	169,894	-47,720	-24,825	-112
2030	1,498,100	169,894		47,720	0	1,715,714							169,894	169,894	-1,545,820	-788,412	-3,025
2031		169,894		47,720	0	217,614							169,894	169,894	-47,720	-23,861	-78
2032		169,894		47,720	0	217,614							169,894	169,894	-47,720	-23,393	-65
2033		169,894		47,720	0	217,614							169,894	169,894	-47,720	-22,935	-54
2034		169,894		47,720	0	217,614							169,894	169,894	-47,720	-22,485	-45
2035		169,894		47,720	0	217,614							169,894	169,894	-47,720	-22,044	-37
2036		169,894		47,720	0	217,614							169,894	169,894	-47,720	-21,612	-31
2037		169,894		47,720	0	217,614							169,894	169,894	-47,720	-21,188	-26
2038		169,894		47,720	0	217,614							169,894	169,894	-47,720	-20,773	-22
2039		169,894		47,720	0	217,614							169,894	169,894	-47,720	-20,365	-18
2040		169,894		47,720	0	217,614							169,894	169,894	-47,720	-19,966	-15
2041		169,894		47,720	0	217,614						1,498,100	169,894	1,667,994	1,450,380	594,941	377
2042		169,894		47,720	0	217,614							169,894	169,894	-47,720	-19,191	-10
2043		169,894		47,720	0	217,614							169,894	169,894	-47,720	-18,814	-9
2044		169,894		47,720	0	217,614							169,894	169,894	-47,720	-18,446	-7
2045	1,498,100	169,894		47,720	0	1,715,714							169,894	169,894	-1,545,820	-585,802	-193
																32,790,214	0

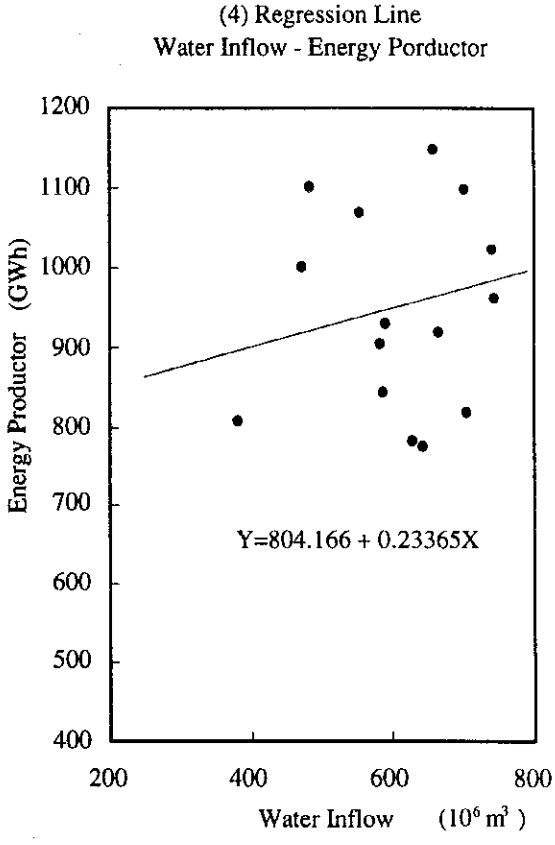
Table 12.5 Demand Forecast in Upgrading Areas

		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ninh Son	(GWh)	2.20	2.50	4.90	5.70	6.50	7.40	8.50	10.20	0.00									
	(MW)	0.70	0.80	1.40	1.60	1.80	2.10	2.40	2.80	0.00									
Thap Cham	(GWh)	31.60	40.50	49.80	51.40	65.00	79.30	90.00	101.30	113.46	127.07	141.05	156.56	172.22	189.44	206.49	225.08	245.33	264.96
	(MW)	8.00	10.30	11.90	13.60	16.00	18.80	21.00	24.00	26.88	30.11	33.42	37.09	40.80	44.88	48.92	53.33	58.12	62.77
Phan Ri	(GWh)	6.90	8.80	10.70	13.20	16.00	19.50	24.00	28.70	33.87	39.62	45.57	51.95	58.70	65.74	72.97	80.27	87.50	95.37
	(MW)	2.30	2.80	3.40	4.20	5.00	6.20	7.50	9.10	10.01	11.01	12.11	13.32	14.66	16.05	17.57	19.15	20.88	22.76
Phan Thiet	(GWh)	31.10	34.40	38.60	39.40	46.00	53.20	60.00	67.40	74.81	83.04	92.18	101.40	111.54	122.69	133.73	145.77	158.89	173.19
	(MW)	7.90	8.80	9.80	10.00	11.50	13.50	15.00	16.80	18.65	20.70	22.98	25.27	27.80	30.58	33.33	36.33	39.60	43.17
Cam Ranh	(GWh)	19.20	20.00	45.00	60.00	82.00	105.00	116.50	130.00	143.00	157.30	173.03	190.33	209.37	228.21	248.75	271.14	292.83	316.25
	(MW)	4.00	5.50	8.00	10.00	12.00	14.50	15.00	16.00	16.80	17.64	18.52	19.45	20.42	21.44	22.51	23.64	24.82	26.06
Dien Khanh	(GWh)	16.50	22.00	66.00	80.00	100.00	120.00	140.00	160.00	182.40	207.94	234.97	263.16	292.11	321.32	350.24	381.76	412.30	445.29
	(MW)	4.30	10.00	12.00	15.00	16.00	18.00	19.00	20.00	21.00	22.05	23.15	24.31	25.28	26.29	27.35	28.44	29.58	30.76
Total	(GWh)	107.50	128.20	215.00	249.70	315.50	384.40	430.50	487.40	547.54	614.97	686.79	763.40	843.93	927.41	1,012.19	1,104.01	1,196.85	1,295.06
	(MW)	27.20	38.20	46.50	54.40	62.30	73.10	77.50	85.90	93.34	101.51	110.18	119.45	128.96	139.25	149.69	160.89	173.00	185.52









FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 12.1 Scatter Diagram and Regression Line

CHAPTER 13

CONCLUSION AND RECOMMENDATION

CHAPTER 13 CONCLUSION AND RECOMMENDATION

The Da Nhim power system has been operated over 30 years since its commission in 1964. Facilities in the system are remarkably deteriorated and facing the serious declination of the proper functions due to the long run operation without genuine spare parts. Since the system still stands on an important position in the country's power sector, rehabilitation of the system is urgently required.

Recent power demand in the towns of Phan Rang, Phan Ri, Phan Thiet, Cam Ranh, and Dien Khanh supplied through 66kV facilities from the Da Nhim power plant is rapidly increasing and resulting in the needs of urgent capacity increase of the power facilities in those areas.

The Government of Viet Nam requested the Government of Japan to study the actual situation of the system and to formulate the rehabilitation plan of the facilities as well as an upgrade plan of the existing 66kV power facilities. The Study Team was dispatched to the site under the agreement of both governments for the requested study.

Investigation and analyses for the facilities of the Study Team resulted that

(1) the existing facilities are remarkably deteriorated and some of them are operated in the critical technical condition,

(2) the continuous operation of those facilities without rehabilitation will lead to further serious troubles, and

(3) the present power demand is reaching the limit of capacity of the existing 66kV power facilities.

From the results of investigation and analyses, the Study Team technically concluded that the rehabilitation and upgrade of the facilities should be urgently implemented for stabilization of the country's power sector and restoration and development of the infrastructure in the country, and formulated the implementation plans for the rehabilitation and upgrade of the existing facilities. Besides, the Study Team also formulated alternative implementation plan of the Project that the Project should be implemented by phasing into two stages for financing facilely the project fund.

In addition to the technical evaluation, the Study Team carried out the economical and financial evaluation in the manners of the internal rate of return.

The economic and financial internal rate of returns (EIRR and FIRR) for the urgent rehabilitation Project of the Da Nhim power system and the 66 kV system voltage upgrade Project are 21.69 % and 20.13 %, respectively. While, as a result of the analysis of the economic viability of the project phasing, it is recommended that the Project of second phase should be implemented after one (1) year of commencement of the first phase. Thus, the formulated plans are considered to be adequate both economically and financially.

Accordingly, the Study Team recommends the plans of the rehabilitation and upgrade to be urgently implemented.