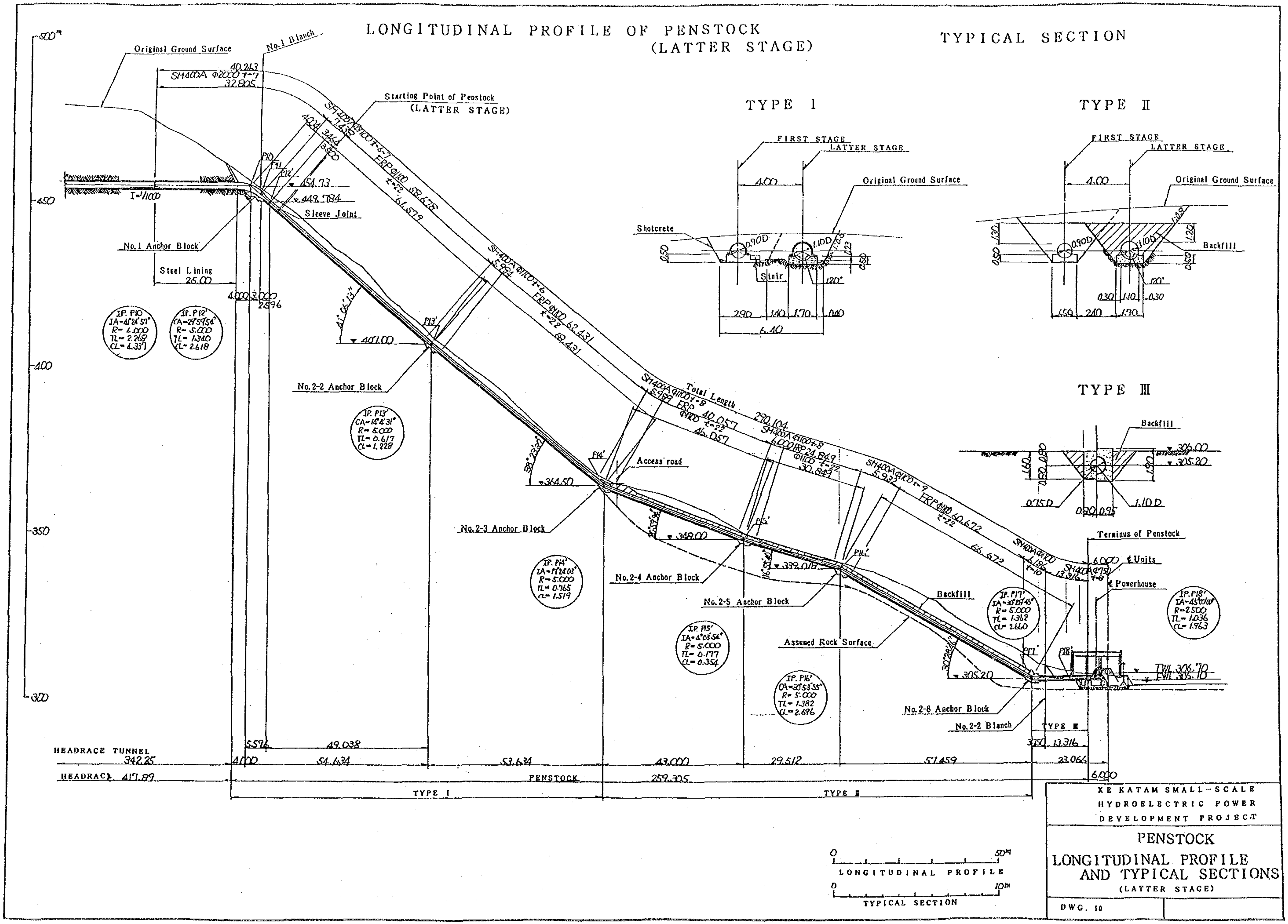
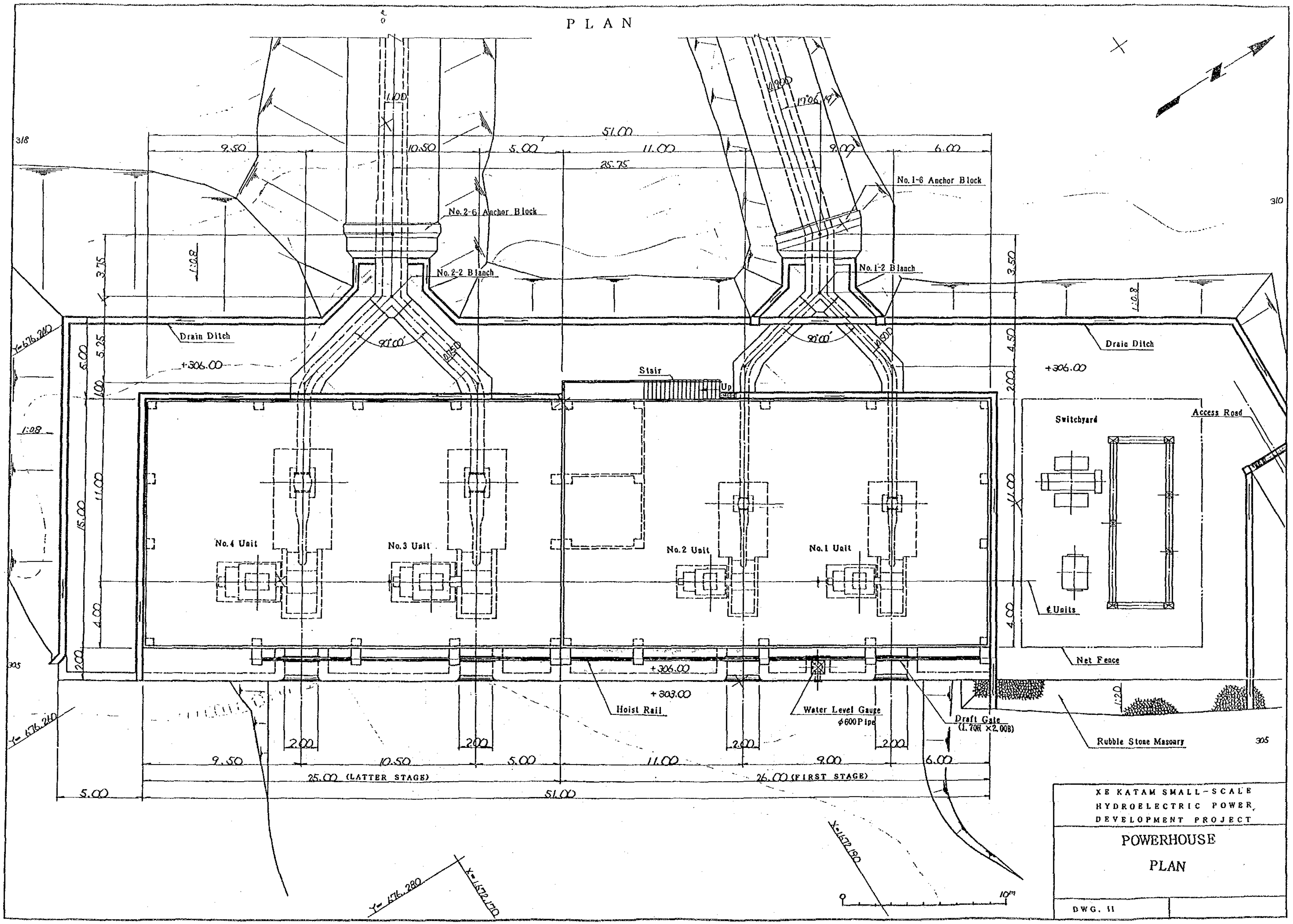


LONGITUDINAL PROFILE OF PENSTOCK
(LATTER STAGE)
TYPICAL SECTION
TYPE I
TYPE II
TYPE III
FIRST STAGE
LATTER STAGE
Original Ground Surface
Shotcrete
Stair
Backfill
No.1 Blanch
Starting Point of Penstock (LATTER STAGE)
Sleeve Joint
No.1 Anchor Block
Steel Lining
No.2-2 Anchor Block
No.2-3 Anchor Block
No.2-4 Anchor Block
No.2-5 Anchor Block
No.2-6 Anchor Block
No.2-2 Blanch
Access road
Assumed Rock Surface
Terminus of Penstock
℄ Units
℄ Powerhouse
Total Length 290.104
TWL 306.70
HEADRACE TUNNEL 342.25
HEADRACE 417.89
PENSTOCK 259.305
TYPE I
TYPE II
TYPE III
LONGITUDINAL PROFILE
TYPICAL SECTION
XE KATAM SMALL-SCALE
HYDROELECTRIC POWER
DEVELOPMENT PROJECT
PENSTOCK
LONGITUDINAL PROFILE
AND TYPICAL SECTIONS
(LATTER STAGE)
DWG. 10

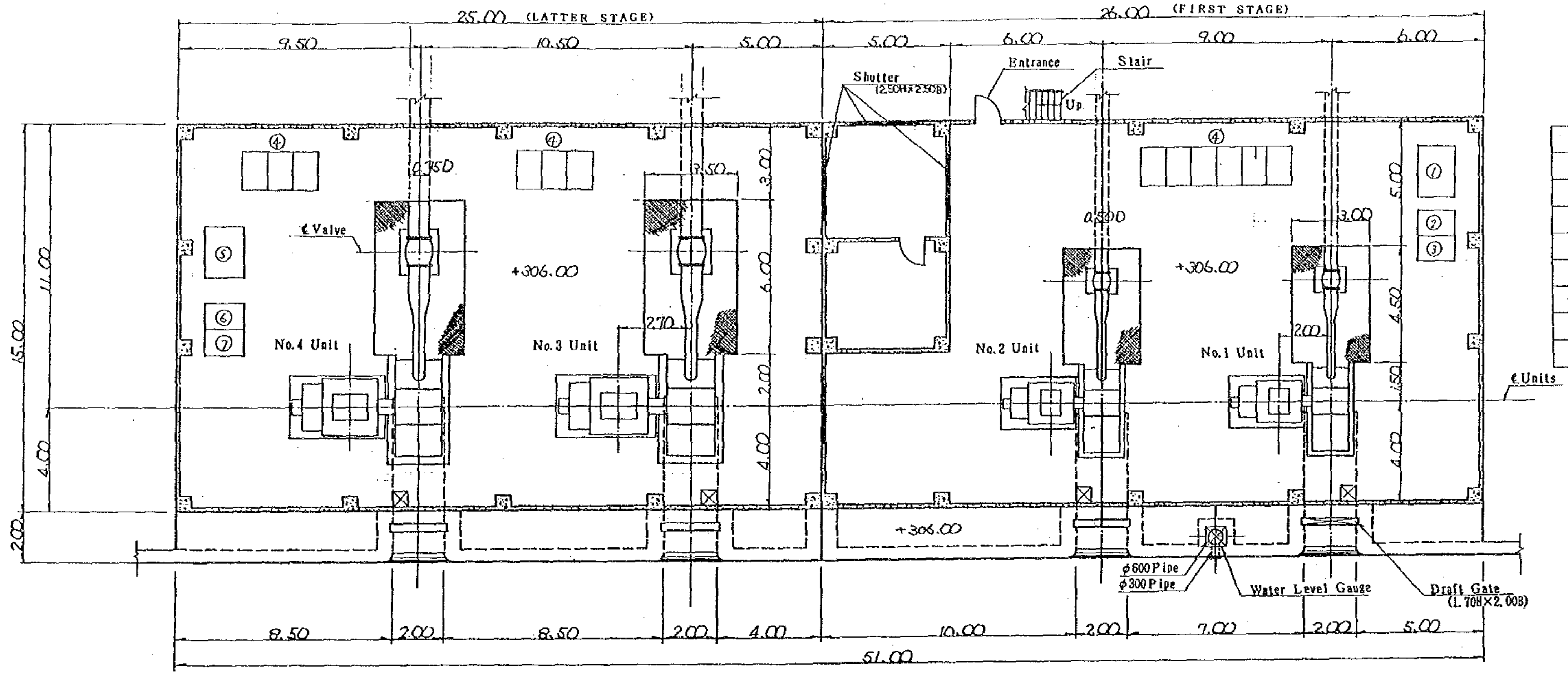


XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

POWERHOUSE PLAN

DWG. 11

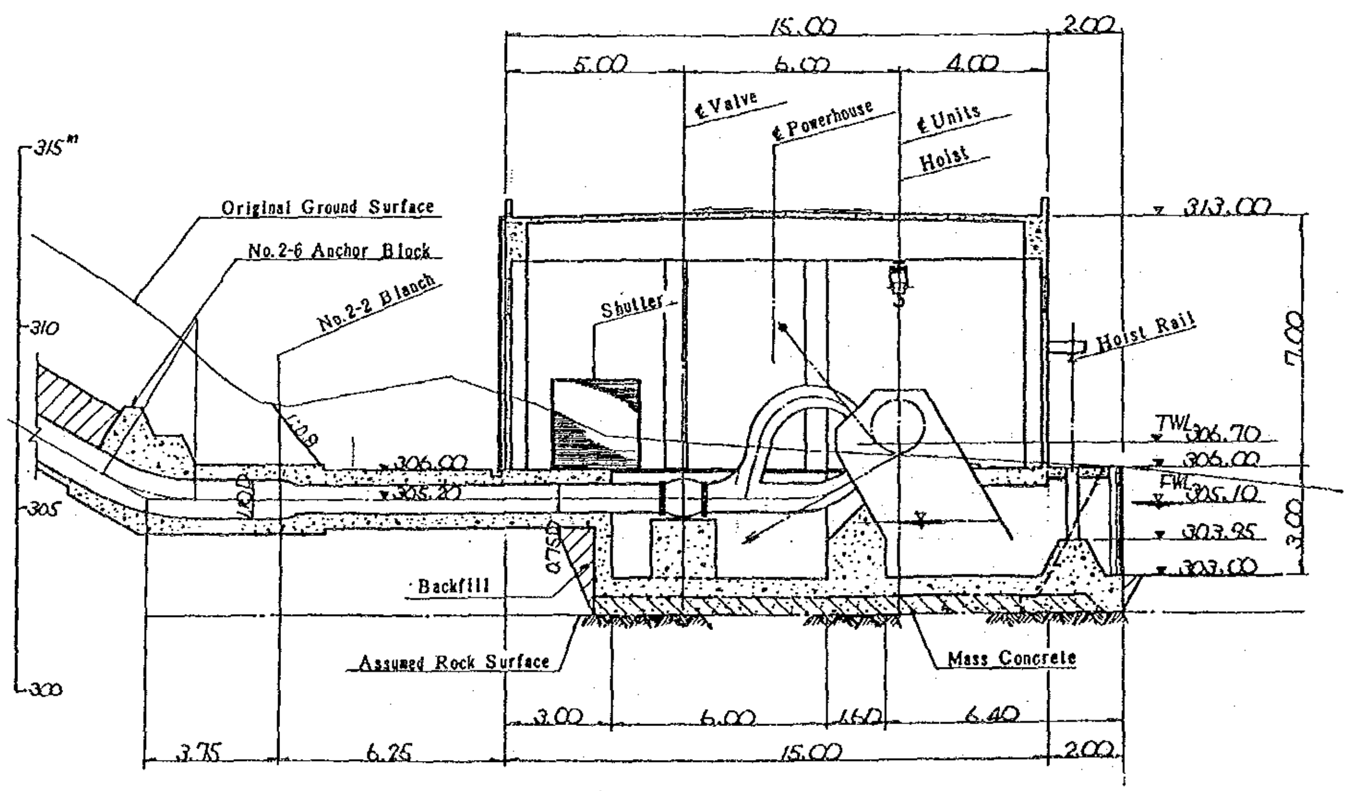
PLAN AT EL306.00



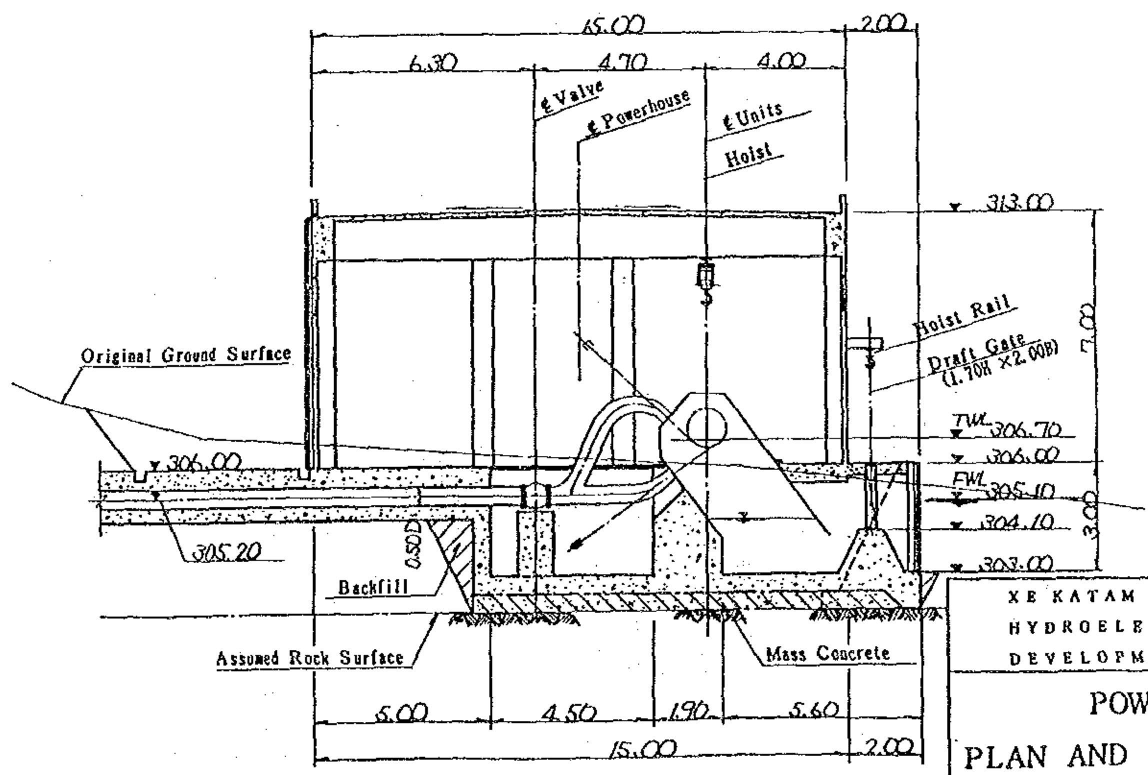
LEGEND

No	DESCRIPTION
①	Pressure Oil Supply
②	Switching Board
③	D. C Supply
④	Turbine Generator Control Board
⑤	Pressure Oil Supply
⑥	Switching Board
⑦	D. C Supply

TRANSVERSAL SECTION (LATTER STAGE)



TRANSVERSAL SECTION (FIRST STAGE)



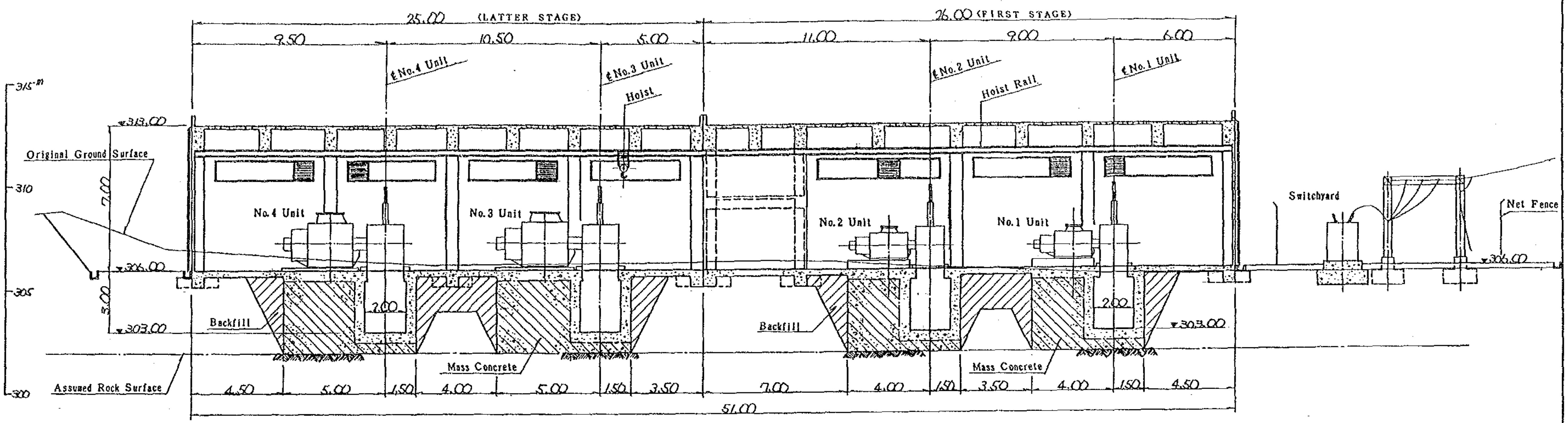
0 10m

XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

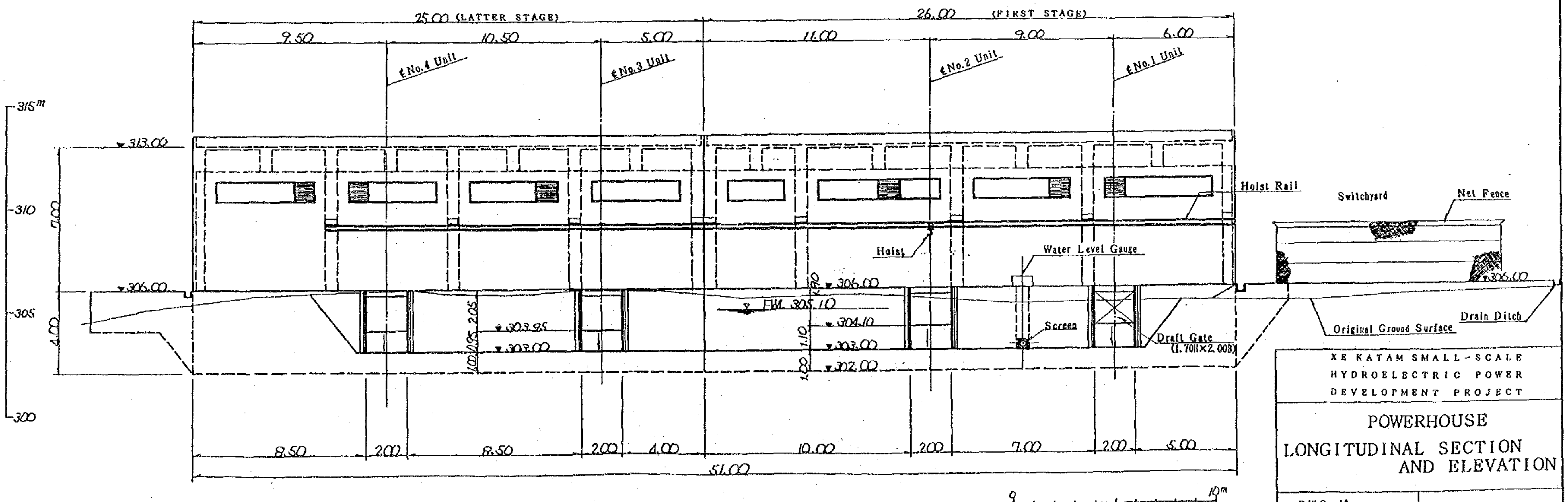
POWERHOUSE PLAN AND TRANSVERSAL SECTIONS

DWG. 12

LONGITUDINAL SECTION



ELEVATION OF OUTLET



XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

POWERHOUSE LONGITUDINAL SECTION AND ELEVATION

DWG. 13

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2. Construction Plan and Construction Cost

Chapter IV 2. Construction Plan and Construction Cost

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2. Construction Plan and Construction Cost

2.1 Construction Schedule

2.1.1 General

The construction schedule of Xe Katam Project is such as detailed in Chapter III, Section 4. That is, the plant output of 2,000 kW to be constructed in the First Stage will be commissioned by 1995, and then the plant output will be increased to 6,000 kW at the completion of the Project.

The construction work of the First Stage will be started by the beginning March of 1994. The construction schedule of the First Stage is planned as presented in Fig. IV-2-1, so that the power generation will be started by the beginning of August, 1995, or in 17 months.

It is required to conduct the basic design survey, develop the detailed design, and produce specifications, and then complete the procedures of bidding and award of contract before the construction work is started. We assumed that 2 years of period from 1992 to 1993 will be required to the above works.

Concerning the timing of commissioning of 4,000 kW output of the Latter Stage, there are various points of view, but the plant output of 2,000 kW will be constructed to divide into two to meet Sekong and Attapeu needs of electricity. In this study, it was tentatively assumed that first 2,000 kW output will be commissioned by the beginning of October of 2001, later 2,000 kW output will be commissioned by the beginning of October to 2011, with the construction period being 17 months and 16 months, as illustrated in Fig. IV-2-2 and Fig. IV-2-3. Any construction works will be carryout centering around in the dry seasons.

2.1.2 Construction Works to be Implemented in Each Fiscal Year

(1) First Stage of Project

a) Starting Year (1994)

As soon as the construction work is started at the beginning of March, 1994, the transportation of the construction materials and equipment to the site will be started (for the transportation route, refer to Paragraph 2.2.1). As the construction materials and equipments arrive at the local depot, the existing road from Ban Houaykong to the construction site will be expanded in width and repaired, and bridges will be constructed rapidly. Then, as soon as the working systems at the construction site are prepared, the construction works for electric power supply, concrete production facility, excavation facility, provisional buildings and other provisional facilities will be started. The construction work of the new roads as described in the preceding close (1.10) will be started before the rainy season and will be nearly completed. As the road leading to the power plant is as long as 2,600 km, and runs along steep mountain slopes, the construction work of this road, together with the construction work of the power plant, are the critical paths in this Project. Therefore, the construction work of the road will be continued throughout the rainy season, and the road will be completed by the end of October when the next dry season starts (with the construction period being about 8 months).

As soon as the approach road to the sediment discharge tunnel portal is completed, the excavation facilities of the headrace tunnel will be installed in the portal, and the sediment discharge tunnel and headrace tunnel will be excavated. The excavation will be completed within that year, and some part of concrete lining will be completed.

Excavation works to be performed on the ground, including those of intake dam, intake, sand stilling basin, culvert, penstock, and power station will be performed as soon as the dry season arrives, and some concrete placing works will be performed within that year.

The design and manufacture of the FRP pipes, steel pipes, manifolds, etc. of the penstock will be started at the same time with the main construction work, and these components will be transported to the construction site within that year.

The design and manufacture of the hydraulic turbine and the generator will be started at the same time with the main construction work, and the transportation of these equipments will be started within that year.

The procurement of materials of the transmission line will be started at the same time with the start of the main construction work. The transmission line components will be transported to the site within that year, and the construction work of the transmission line will be started.

b) Completing Year (1995)

The concrete placement for the intake dam, intake, sand stilling basin, culvert, headrace tunnel, penstock and power station will be continued from the preceding year, and the work will be completed by April or May.

The installation of FRP pipes, steel pipes, manifolds, etc. of the penstock will be conducted in parallel with the concrete placement of foundation, and works will be completed by May.

The construction work of the power station building will be started, and completed by May.

The installation work of the hydraulic turbine and the generator will be started as soon as they are transported to the site. The 2,000 kW generating unit will be completed in June. The test operation will be conducted in July, and the power transmission will be started by the beginning of August.

The construction work of the transmission line will be continued from the preceding year, and the line will be completed by the time when the generating unit starts power transmission.

(2) Latter Stage (First) of Project

a) Starting Year (year 2000)

In May, 2000, as soon as the construction work of the Latter Stage is started, the transportation of construction materials and equipments to the site will be started. The provisional facilities will be constructed as soon as materials and equipments arrive, which will be completed by the end of the rainy season. The excavation work for the penstock and the power station will be started as soon as the dry season is entered, and will be practically completed by the end of the year.

The design and manufacture of FRP pipes, steel pipes and manifolds will be started at the time of the start of construction work, and will be completed within that year. The design and manufacture of the hydraulic turbine and the generator will also be started.

b) Completing Year (2001)

The concrete placement for the penstock and the power station foundation will be started by the end of the preceding year. A part of concrete of the power station foundation will be placed at the time when the hydraulic turbine generator is installed.

The installation of FRP pipes, steel pies and manifolds will be conducted in parallel with concrete placement of the foundations, and will be completed before the rainy season comes (in May).

The construction work of the power stations building will be started as soon as the foundation is set, and the building will be completed before the rainy season comes (in May)

The manufacture of the hydraulic-turbine and the generator will be completed by January, and it will be transported to the site by March or April. The installation will be worked out as soon as it is transported. The generating unit will be subjected to test operation in September, and power transmission of 2,000 kW will be started by the beginning of October.

(3) Latter Stage (Second) of Project

The construction work of the Latter Stage (Second) will be design, manufacture and installation of the only hydraulic turbine and the generator.

The construction period being 16 months as presented in Fig. IV-2-3. The design and manufacture of the hydraulic turbine and the generator will be started at the time of the start of construction work (by the beginning June of 2010), and will be completed by the January of 2011.

The installation work of the hydraulic turbine and the generator will be started as soon as they are transported to the site by March or April.

The generating unit will be subjected to test operation in September, and power transmission of 2,000 kW will be started by the beginning of October.

2.2 Construction Plan

2.2.1 Location of Project and Transportation Route

(1) Location of Project

The Xe Katam Project is located in Attapeu Province, which is one of southern provinces of the Lao People's Democratic Republic, at a location 106°38' longitude east and 15°07' latitude north. This location is approximately 100 km to the east of Pakse City which is the capital city of Champasak Province, approximately 50 km to the east of Paksong city, approximately 25 km to the southwest of Sekong City which is the capital city of Sekong Province, and approximately 40 km north-to-north west to Attapeu city.

The location of this Project is at the most downstream site of the Xe Katam River, which is a small tributary flowing into the Xe Nomnoy River, which is against a tributary of the Xe Kong River of the Mekong River System. This Xe Katam River flows to the southeast along the foot of a mountain range located in the northeastern part of Bolaven Plateau, and joins the Xe Namnoy River. The Project Site is located at an elevation between 300 m to 500 m.

(2) Transportation Route

The normal way of transporting personnel, machinery and material to the Project Site is along the route which passes through Vientiane. The trip distance from Vientiane to Pakse is around 800 km by land, or 1.5 hours by air.

The construction machines and other materials required for this construction work are as presented in Table IV-2-1. It is being planned to transport these items to Pakse from Bangkok via Chong Mek in the Thailand side of the border, which is the route specified as described in the basic condition of cost estimation clause 2.3.2 (Figure IV-2-4).

The marine transportation from Japan to Thailand will take approximately 1 month, including the time required for custom clearance and other procedures.

The road distance for the inland transportation from Bangkok to Chong Mek on the boarder by inland is approximately 750 km, and heavy items can be transported by this road. The span of approximately 35 km from Chong Mek to the Mekong river is completely paved, and there are 7 bridges in this section of the road. The features of these bridges are presented below.

(From Chong Mek)	Width (of Traffic Lane) (m)	Height of Handrail from Traffic Surface (m)	Design Weight (t)
No. 1	4.0	1.1	40
No. 2	3.2	0	40
No. 3	2.9	0	40
No. 4	3.8	0.8	40
No. 5	4.3	1.1	40
No. 6	4.4	1.1	40
No. 7	3.25	1.7	20 (possibly 30)

Heavy articles can be transported by this route.

The transportation capacity (3 lorries) of the ferry boat on the Mekong River has been verified by the transportation of heavy equipment in the Xe Set Project, and the transportation of heavy items for this Project across the river is possible.

National Route 23 from Pakse to Paksong is approximately 40 km long. The section of 30 km nearer to Pakse is provided with simplified asphalt pavement, but the remaining 10 km nearer to Paksong is paved by gravel, and this section has considerable undulation. There is one bridge on this road (4 m width, 27 m length, double main girder Beiley steel bridge), which can support traffic of heavy items. Laos plans to improve this section by 1994.

The section of approximately 30 km from Paksong to Ban Houaykong (which is a village nearest to the Project Site; 16 km away) is an unpaved road, which is 4 to 8 m in width having poor road surface. In a rainy season, it is impossible for vehicles except trucks to pass this section of the road. Heavy materials can be transported in dry seasons, although the road surface has undulation. There is one bridge in this section of the road (a 4 m width, 24 m length, one main girder Beliley steel bridge), which can not carry heavy items. The heavy items will be directly transported across the river water at this section. To perform this, the river banks must be modified. Laos plans to implement this improvement in 1994 to 1996.

An approximately 16 km section from Ban Houaykong to the Project Site is an unpaved road having 4 to 5 m width, on which small four wheel drive cars can drive. In this section, five wooden bridges (9 m, 23 m, 7 m, 18 m and 5 m), and a ford (river crossing without bridge, with river width of 38 m) are used. These places must be repaired or provided with bridges in an early period of the main construction work. The repair and bridge building costs for these sections are included in the Project Cost.

The approximately 70 km section of National Route 16 from Sekong to Attapeu is being its road width expanded since 1990, and this improvement work is scheduled to be completed by 1994. From this Route 16 to the Project Site, only a path traveled by men exists today (for approximate distance of 17 km). This section is included in the road improvement plan (from 1994 to 1996) of Laos.

2.2.2 Provisional Facilities for Construction Work

(1) Construction Road

The completion of the transportation road controls the schedule of the construction work of this Project. In particular, the 16 km section from Ban Houaykong to the Project Site, which may pose problems on the feasibility of transporting the construction materials/equipments, must be improved and provided with temporary bridges. The improved road must be 4 m in width and provided with gravel road, and the temporary bridges must have H-form steel main girder covered with steel plate, and equipped with side railing. For the First Stage of Project, the roads will be repaired and maintained for the purpose of securing easy transportation. In the Latter Stage, roads must be fundamentally repaired and improved.

(2) Electric Power for Construction Work

For the First Stage construction work, a diesel generator set of 250 kVA capacity and two sets of 75 kVA capacity, which one is used in night and another is used in spare, as well as associated substation facility, will be installed at the construction site. Electric power will be supplied to switchboards located at relevant locations (aggregate plant, dam, tunnel, penstock and power station) by high voltage distribution line, and then from switchboards to loads by low voltage lines. In the Latter Stage, the power required for the construction work will be supplied by the power plant already completed.

(3) Concrete Facilities

The each total amount of concrete used and gravel road used will be approximately 6,500 m^3 and 7,000 m^3 for the First Stage, and approximately 1,300 m^3 and 1,000 m^3 for the Latter Stage. The total amount of aggregate will be approximately 17,000 m^3 for the First Stage, and approximately 3,000 m^3 for the Latter Stage. As there is no concrete plant near the Site, and aggregate plant and a concrete plant will be installed on the construction work ground on Xe Katam Plateau.

For the gravel and sand used for concrete, the muck from tunnel excavation, open cut excavation, the stones on the river bed to the upstream of intake dam, the stone hill on the right bank, and stones collected from the center shoal of Xe Namnoy river will be collected and crushed to secure the aggregates. The capacity of each plant will be determined based on the concrete placing schedule, and they will be 18 m^3/h and 20 ton/h classes for the First Stage construction work, and 10 m^3/h and 10 tons/h for the Latter Stage.

The concrete placement will be performed basically by fixed concrete pumps, but chute placing shall also be employed.

(4) Excavation Facilities

a) Air Supply Facility

The compressed air required for the construction work will be supplied from a stationary compressor stations, which will be located at three points, the dam, the tunnel and the power station in the First Stage. In the Latter Stage, one compressor station will be provided at the power station. The air will be supplied by piping from the stations to the loads.

b) Water Supply Facility

In the First Stage, the water supply will be secured by the Xe Katam River and the Xe namnoy River, and water storage tanks will be provided at three locations, the dam, the tunnel and the power station. Water supply pipes will be provided from each water storage tank to the places of work.

In Latter Stage, the Xe namnoy River will be used as water supply source, and a water storage tank will be provided at the power station. The water will be supplied from the tank to the penstock by providing piping.

c) Drainage Facility

In First Stage, drain pumps and drain piping will be provided at the quarry site, the dam site, the tunnel and the power station to facilitate the construction work.

In Latter Stage, drainage facilities will be provided at the power station.

d) Ventilation Facility

To assure the safety of construction work inside tunnels, propeller fans will be installed at the portal and inside of tunnels, and they will be connected (inside tunnels) by air ducts.

e) Muck Discharge Facility

The mucks generated in tunnels will be discharged to outside by rail system (15 kg rails), and the necessary tracks will be installed inside tunnels.

f) Care of Rivers

For temporary closing of the river, only one half of the river will be closed off alternately by embanking sandbags to divert river water and perform dry works. First, the approximately 50 m length of the right bank, where the intake and sand flush gate are to be constructed, will be closed off in a dry season, to complete the sand flush gate and intake. The river water is let to flow the left bank side during this construction work. When they are completed, the approximately 30 m length on the left bank of the river will be temporarily closed off to let the river water flow switched to the sand flush gate, and remaining part of the intake dam on the left bank will be completed.

During the construction work of the power station, sandbags will be embanked along the left bank of the Xe Namnoy River near the power station for a length of approximately 40 m, to prevent overflow of the river water.

(5) Temporary Building Facilities

The temporary building facilities required for the First Stage and Latter Stage (administration building, supervisor's dormitory, labor camp, and ancillary facilities such as warehouse and repair shop) will be built near the central approach road located at the central part of Xe katam Plateau.

(6) Other Facilities

Communication facilities and cable facilities are required in the First Stage, and cable facilities will be required in the Latter Stage.

Communication equipment capable of providing communication between Vientiane, Pakse and Ban Houaykong will be installed.

The cable facilities will include the 2-ton rating cable crane to be provided to the span of approximately 300 m for the whole length of the penstock, and an incline equipment.

As for other items, the illumination facility inside tunnels will consist of 100 W incandescent lamps located with 2.5 m intervals (plus 20 W emergency lights located with 20 m intervals), and the cutting face will be equipped with several projector lamps of no less than 100 W rating to assure safety.

2.2.3 Construction Method of Each Structure

(1) Intake Dam

The care of river flow is closed off by the half-close off method. As there is no soil or sedimentation on the river bed of the dam site and the rock is exposed, the excavation will be performed by drilling with a 30-kg class leg hammer and by blasting, and then scraped with a 15-ton class bulldozer equipped with ripper. A large breaker will also be employed for supporting excavation. The hard rocks excavated will be transported to the aggregate plant, and other mucks will be transported by 11-ton dump trucks to be disposed of at "A" disposal area.

After excavation is completed, concrete placement will be performed without foundation treatment. Concrete will be transported from the concrete plant by 3 to 3.2 m^3 class truck mixer, and will be placed by employing chute or pump appropriately. Placement will be 15 m per block, and each lift will be 2 to 3 m as in standard.

The lower part structure of the sand flush gate will be completed before the care of river is switched from the right bank to the left bank. The true form of the sand flush gate will be installed after the care of river is switched and structure will be completed.

(2) Intake

The excavation will be performed by the ripper cutting employing explosive (leg hammer)method, similarly to the excavation of the intake dam. The hard rocks excavated will be transported to the aggregate plant, and other muck will be transported by 11-ton dump trucks to be disposed of at "A" disposal area.

The concrete placement will also be performed similarly to the intake dam, and the concrete transported from the concrete plant by truck mixer will be placed by employing pump and chute.

As the intake will be constructed right upstream to the sand flush gate, making right angle with the dam and near the right bank, it is hoped that all construction works including the installation of water control gate will completed before the care of river is switched from the right bank to the left bank, but it is available after the care of river.

(3) Sand Stilling Basin and Culvert

The excavation and loading of the surface soil is performed by 0.6 m^3 back hoe, and all excavated soil is transported by 11-ton class dump trucks to "A" disposal area. The cutting of rocks is performed by ripper excavation employing explosive (leg hammer) similarly to the cases of intake dam and intake. The hard rocks excavated will be transported to the aggregate plant, and other mucks will be transported by 11-ton dump trucks to be disposed of at "A" disposal area except those used for embankment and backfill.

When excavation is completed, reinforcing bars are assembled and concrete is placed. The concrete placement will be performed similarly to the case of intake.

After the concrete structures of sand stilling basing and culvert are completed, the backfill is performed by 0.6 m^3 class back hoes, and the embankment by back hoes, bulldozers and tampers.

(4) Headrace Tunnel and Sediment Discharge Tunnel

a) Excavation

The tunnels will be excavated by the full face excavation method employing blasting, and the sand flush tunnel will used as the construction tunnel. The excavation will proceed from the portal toward upstream direction.

In locations where the rock conditions are poor, timbering of steel arches made of H-form steels (H - 100 x 100 x 6 x 8) will be installed with standard interval of 1.5 m.

The drilling will be performed by employing simplified scaffolds and wet type leg hammer, and pit hammers will be used to remove loose stones and projections.

Removal of mucks will be performed by a rial system consisting of a 0.2 m^3 class muck loading machine, a 4-ton battery locomotive, and two steel carts, which travels back and forth to carry mucks to the outside of the tunnel (refer to Fig. IV-2-5). Hard rocks contained in the mucks thereby recovered will be transported to the aggregate plant, and other portions to the "A" disposal area by 11-ton class dump trucks.

b) Lining Concrete

As the cross section of the tunnel is small, the lining concrete will be placed after all excavation is completed. Starting from the final excavation face to the tunnel portal, the arch sector will be placed by means of a sliding form, and the invert sector will be worked after the arch is completed. The concrete for lining will be transported by truck mixers from the concrete plant to the tunnel portal, where it is directly transferred to the concrete placer (2 m^3 capacity), which will be transported the inside of the tunnel by a battery locomotive.

c) Injection of Mortar Back-filling and Grouting Work

Injection of mortar backfilling will be made to sufficiently fill up gaps between rear-side of lining and excavated tunnel section, through an injection tube which is to be laid at arch portion.

Grouting work will be performed more than 2 weeks after mortar is injected. The grouting pressure will be 15 kg/cm^2 at maximum at the injection port. When the injection flow drops below 15 to 20 liters per second with the maximum pressure, injection is stopped while keeping the pressure as it is. The standard mix is 6:1 to 1:1 in the ratio of water to cement. Grouting work may be replaced by mortar injection depending on the geological condition.

(5) Penstock

In construction works of both First Stage and Latter Stage, the excavation of steep slope at the upstream part will be performed by means of human power and small sized back hoe, from upstream side toward downstream side. For the part having gentle slope at the downstream, the soils will be excavated by 0.6 m^3 class back hoe, and rocks will be excavated by combination of a 0.6 m^3 class back hoe and a large breaker. The excavated soils, except those used for back-fill, will be transported to "B" disposal area by 11-ton class dump trucks.

After the excavation work is completed, the concrete of anchor blocks and the continuous foundation will be placed. In placing concrete at the upstream part, a combination of pump placement, chute placement and bucket placement employing cable crane will be used. For the downstream part, the concrete transported from the concrete plant by truck mixers will be placed by combined use of pump and chute.

The installation work of penstock is divided into four different operations; the installation into the lining of headrace tunnel end, installation at the steep slope of upstream section, installation at the gentle slope of downstream section, and installation of the penstock end to the power plant.

a) To install the penstock to the headrace tunnel end lining, rails will be installed after the concrete lining is completed, and the penstock section is lifted from the penstock construction road to a cart by means of a cable crane, and it is moved to the specified position by human power. The cart is equipped with jacks to adjust the penstock position. After the penstock is properly positioned, the filling concrete will be placed by a concrete pump. Installation of penstock to the tunnel lining and the installation of the manifolds above the ground will be completed in the First Stage.

b) In installing the penstock on the steep slop of the upstream part, the penstock is directly pulled up to the installation position from the power station construction road by means of a cable crane. First, the curved pipes (steel pipes) will be installed on each anchor block, and then straight pipes (FRP pipes) will be installed from lower locations toward upper locations. The joint between curved pipes and straight pipes will be connected by sleeve joints, and the straight pipes and straight pipes will be connected by T-joints.

c) The installation on the gentle slope at downstream part will be performed by pulling up the penstock from the power station construction road by means of cable crane or incline cart, and the method of installation will be the same as the installation at steep, upstream part.

d) The lower end of the penstock will be installed to the power station by lifting the penstock from the construction road to the specified position by means of 15 to 16 ton crane truck.

(6) Power Station and Tailrace

The excavation of power station and tailrace will be performed by 0.6 m^3 class back hoes. The operation will proceed from ground surface to downward with a lift of 2.0 m. The excavated soil will be transported to "B" disposal area by 11-tons class dump trucks.

The concrete placement will be performed from the construction road by combined use of pump placement, chute placement, and bucket placement by track crane, and the foundation concrete for the power station and tailrace will be place first. Then, the power station side walls, slabs, etc. will be constructed in sequence.

The installation of the generator will be performed by first installing the overhead traveling crane, which will be used to install the hydraulic turbine, the generator, etc.

(7) New Roads

The new roads will be newly constructed in 5,530 m total length, 8 m width and 4 m width of the new gravely roads, as described in the preceding Section (Section 1, Preliminary Design). For the construction of this road, the primeval forest will be cleared by bulldozers, then the ground will be leveled by motor graders, on which gravels will be placed for a thickness of 20 cm, and compacted by rollers. The shaping of the side slopes will be performed by mechanized operation employing back-hoes, to complete the road in a short period. Maintenance and repair works will be required for the period of First Stage construction work. The construction road will have to be repaired again for the Latter Stage construction work.

2.3 Construction Cost

2.3.1 Summary of Estimated Construction Cost

The total construction cost (including interest during construction·IDC) is 25,775 x 10^3 US$ (15,679 x 10^3 US$ for the 2,000 kW First Stage, and 10,096 x 10^3 US for the 4,000 kW of the Latter Stage). The breakdown of this total construction cost for each construction item, and the year-wise phasing of expenditure are presented in Table IV-2-2 - IV-2-4.

2.3.2 Basic Conditions of Cost Estimation

The construction cost was obtained by adding up all cost items based on the standard material/labor rates and standard calculation methods prevailing in Japan, and according to the following basic conditions. The calculations were performed by taking into account the unit construction costs of hydroelectric power projects in Laos, such as Xeset, Selaban, etc., as well as the cost data of hydroelectric power plant construction projects of similar scale in Japan and South East Asia, and considering the natural conditions, regional conditions, the scale of construction work and results of site survey, based on the assumption that the project will be consider a special fund allowance.

The construction costs are calculated based on a 1991 prices level, and the price escalation in the future is not taken into account.

(1) Exchange Rate

The exchange rates of the local currency of Kip and Thai Bahts to US dollars are assumed to be 1 US$ = 700 Kip and 1 US$ = 25.71 Bahts, which are the rates effective in June 1991 when the site survey was conducted. The exchange rate between US dollars and Yen is 1 US$ = 136 Yen (TTS rate issued by the Bank of Tokyo) which is the average exchange rates from January 1991 to June 1991 (Table IV-2-5).

(2) Escalation

As for the items included in the cost estimates of which prices in 1991 are unknown, the 1991 prices were calculated as described below:

The price escalation in Laos has been determined by referring to the price indices of Xeset (Table IV-2-6). For items to be procured in Japan and Thailand, the prices have been estimated by reference to the trends in the past three years and the recent demand/supply balance.

(3) Procurement of Materials and Equipment

Construction materials will be locally procured in principle, and in case they are not available, they are to be procured in Japan or in third nations (such as Thailand).

According to the above rule, the reinforcing bars, cement, light oil and concrete poles will be procured in Laos, dynamite, detonating fuses, and electric conductors will be procured in Thailand, and all other items will be procured in Japan.

(4) Cost Calculation Method

The method of cost calculation is based on the official standard of Japan, and the prices are estimated based on the data obtained during the site survey (material unit price, labor unit price, etc.).

a) Unit Price

Concerning the prices of items to be locally procured, the following unit prices were used mainly by referring to the official prices specified by the government agencies and also referring to the unit prices in other projects in Laos.

Item	Unit	Price (US$)	Place of Procurement
Reinforcing bar	ton	645.0	Laos
Cement	ton	125.0	Laos
Light oil	liter	0.43	Laos
Dynamite	kg	4.7	Thailand
Detonating fuse	piece	0.6	Thailand
Electric conductor	meter	0.03	Thailand
Concrete pole (12 m length)	a pole	150.0	Laos
Concrete pole (8m length)	a pole	50.0	Laos

For items to be procured in Japan, the construction prices in Japan and the prices listed in the standard cost estimation document were used.

The labor unit price of the foreman was quoted from the standard price set by the three Ministries (the Ministry of Construction, the Ministry of Agriculture and Forestry and Fisheries, and the Ministry of Transportation) of Japan for fiscal year 1991. Other labor unit prices were quoted from the unit prices in Laos (Table IV-2-7).

The standard salaries and associated costs of technical personnel to be dispatched from Japan is quoted from standards applicable ODA projects in Japan.

b) Rates

The material rates of civil works were quoted from the efficiency value used in Japan, and the labor rates were calculated by multiplying the rate values in Japan by an incremental coefficient of 3. The working capacity of civil work machines was assumed to be 50% of the working capacity (efficiency) in Japan.

(5) Transportation Plan

All materials and equipment to be imported were assumed to be transported from Japan or Bangkok, and the transportation costs are included in the cost calculation. The transportation route to the construction site of this project is illustrated below.

Japan --> Bangkok -----> Chong Mek | -----> Mekong River --> Pakse --> Project Site

Japan --> Bangkok	-----> Chong Mek	-----> Mekong River	--> Pakse --> Project Site
		(ferry transportation)	
(marine transportation)	(truck transportation)	(truck transportation)	(truck transportation)
	[Thailand]	[Laos]	

The operations involved in the transportation depicted above are as presented below, and it will take approximately 3 months for the whole trip.

* Material/equipment procurement
* Marine transportation (Japan to Bangkok, including customs clearance, mooring, unloading)
* Inland transportation (Inside Thailand; from Bangkok to Thailand-Laos border)
* Thailand-Laos border: customs clearance, loading
* Inland transportation (Inside Laos; from Thailand-Laos border to Mekong River)
* Ferry boat transportation (Mekong River)
* Inland transportation (Mekong River --> Pakse --> Project Site)

It is assumed that any customs duties, levies and tax are not imposed when the supplies pass the Thailand-Laos border.

(6) Total Working Days in a Year

The holidays of Laos are as listed below.

January 1	:	New Year's Day
March 8	:	International Women's Day (for females only)
April 14 through 16	:	Laos' New Year's Day
May 1	:	May Day
October (an indefinite day)	:	The last day of Buddhists Lent
December 2	:	Independence Day

In addition to the above holidays, local holidays are observed in the area including the Project Site, and work is not done similarly to national holidays.

May (an indefinite day)
July (an indefinite day)
August (an indefinite day)
September (an indefinite day)
November (an indefinite day): Tat Alun Temple's Festival
Total 5 days

As described above, there are 13 holidays which are to be taken into account in cost calculation, and the total number of resting days including holidays is 65 days for year.

The number of work stoppage days during which works are suspended during rain and after rain depends on the soil condition, working conditions, topography and the condition of drainage. In this cost estimation, reference is made to the "Document for Operation/Management of Construction Machines and Cost Calculation" edited by the Construction Price Survey Association, in which the number of work suspension days are defined in relation to soil conditions and amount of precipitation, and defined the working conditions during rainfall and after rainfall as described below.

Daily Precipitation	Working Condition
No rain	All day work
0 - 3 mm	All day work
3 - 10 mm	0.5 days work
10 - 30 mm	1 day off
More than 30 mm	2 days off

The number of idle days due to rain is calculated to be 80.5 days by means of precipitation data dealing with the average values from 1980 through 1990 at Nonghin site on the above-mentioned conditions.

The total number of working days throughout the year is calculated to be 219.5 days and the average number of working days per month will result in about 20 days.

The working hours of construction work per day (during day time) as 8 hours have been set up in principle, and the working hours on Saturdays is also 8 hours as in weekdays. The standard of tunnel excavation work has been worked out on assumption that the work is to be performed by two shifts per day (with one shift working 12 hours).

2.3.3 Estimated Construction Cost

(1) Civil Construction Costs

The constitution of civil construction costs as follows (Table IV-2-8).

a) Direct Costs

The direct construction unit cost has been calculated by adding up all unit prices according to the standard rates and calculation standard of Japan, under the basic conditions stipulated in the preceding Paragraph (2.3.2) (Table IV-2-9). The unit costs added up consists of the labor cost, material cost, machinery cost and administration costs, and the depreciation charges of the construction machinery was included in the machinery cost.

The direct construction cost consists of the construction costs of the intake dam, intake, sand stilling basin, culvert, headrace tunnel, sediment discharge tunnel, penstock, powerhouse, tailrace, switchyard, disposal area (A and B), new road and powerhouse building, and each construction cost was calculated by multiplying the work amount (Table IV-2-10) with the added up unit prices discussed above. The standard construction price in Japan was applied to the powerhouse building.

Expenses required for the conservation of the Xe Katam river basin and other expenses which will be described in the Clause IV-5, "Environmental Influences" are mainly included in this clause.

b) Provisional Facility Costs

The provisional facility costs consists of the costs of excavation facilities, concrete facility, transportation facility, electric communication facility, temporary building, depreciation charge of construction machines, transportation of machines, expenses for common equipment, and cost of safety measures, and the installation cost, removal cost, depreciation and maintenance/repair cost of each facility were added up in the same way as the calculation of the direct construction cost.

i) Excavation Facilities

The excavation facilities consisted of air supply facility, water supply facility, drainage and ventilation facility, tunnel muck discharge facility and the care of river for dam and powerhouse construction.

ii) Concrete Facility

The concrete facility included in the calculation of the temporary facility cost was the concrete placement facility (including forms) only. Other facilities, such as aggregate plant, concrete plant, water supply facility, mortar injection facility and grouting facility were calculated in terms of corresponding construction unit price of the direct construction cost.

iii) Transportation Facilities

The transportation facilities consist of the repair of the construction road (the 16 km section from the Site to Ban Houaykong), temporary bridge construction, maintenance and repair cost of the new roads and cable way facilities.

iv) Electrical Communications Facilities

The electrical communications facilities consist of the power generation facility, transformer, switchboards, distribution lines, lighting facilities and communication equipment.

v) Temporary Building Facilities

The temporary building facilities consist of ground preparation, temporary buildings (administration office, supervisor's dormitory, labor camps) and ancillary facilities (warehouse, repair shop, etc.).

vi) Construction Machinery Depreciation Charge

All construction machines (Table IV-2-1) required for this Project will be brought from Japan, and the depreciation charges of such construction machines were calculated by reference to the depreciation charge calculation methods defined by the "Japan Construction Mechanization Association".

In calculating the depreciation charge of construction machines, a period of 2 months required to transport machines from Japan to the Site, and another period of 2 months for bringing back the machines to Japan, or a total of 4 months were added.

vii) Transportation of Machines

The cost of transportation of construction machines was calculated based on the following items based on assumption that all construction machines required for this Project (Table IV-2-1) are to be transported from Japan.

The unit cost are used based on the 1991 prices in Japan, Thailand and Laos.

* Crating cost: 66.2 US$/$m^3$
* Cost of loading in Japan (including inland transportation cost in Japan): 3 US$/$m^3$
* Marine transportation fee (including all costs from Japan to Bangkok): 105.8 US$/$m^3$

* Inland transportation cost in Thailand: 117 US$/t for reinforcing bars, 78 US$/$m^3$ for other items.
* Inland transportation cost in Laos: 0.07 US$/t-km
* Insurance premium

viii) Expenses on Common Equipment

As expensed on common equipment, the cost of 100% depreciation was included for each of following equipment.

Item	Number
Light van	1
Jeep	3
Microbus	2
Light truck	1

ix) Cost of Safety Measures

1% of the temporary facility costs (the sum of items "i" through "viii" above) was counted as the cost for taking safety measures required for the construction work.

Beside, expenses related to inhabitant's safety measures which will be discussed in the Clause IV-5 "Environmental Influences" are to be included in this clause.

x) Others

10% of the above temporary facility costs, "i" through "ix", was counted as other temporary facility costs.

c) Overhead Costs

The overhead costs consisted of the technical personnel dispatching cost, expenses at construction site, and administrative.

i) Technical Personnel Dispatching Cost

This Cost is expenses for sending technical personnel of specific discipline (Japanese nationals directly involved in construction works at the Project side) — who are not available in Laos — from Japan. The Technical Personnel Dispatching Cost consists of a Direct personnel Cost, Air-fare (round trip from Japan to Bangkok to Vientiane to Pakse and vice versa), lodging/boarding expenses and per-diem.

These standards were duly referred to actual cases for other ODA projects of Japan, except for provision of air-tickets (intermediate class). When dispatched technical personnel stay at the same location for a long period, the lodging/boarding cost and per-diem were discounted by 10% from the standard from the 31st day after the next day of arrival, and by 20% after the 61st day.

ii) Expenses at Construction Site

The direct personnel costs of Japanese technical personnel belonging to contractors who are stationed at the construction site or temporarily engaged in supervisory work, and locally hired personnel (technicians, typists, drivers, laborers), the associated direct expenses (air travel cost, lodging/boarding cost, per-diem), and the expenses incurred on the site office (office equipment, miscellaneous expenses, communications expenses, sundries, etc.) have been included.

iii) Administrative Expense

10% of the direct construction cost plus technical personnel dispatching cost was counted.

d) Equipment for Civil Works and Associated Job

It was assumed that all gates, screens and valves are imported from Japan as completed products, and the 1991 prices of these equipment, transportation costs (in the same manners as the machine transportation cost) and the installation costs have been included.

e) Penstock

The FRP pipes and steel pipes (including lining steel pipes) have been assumed to be imported as completed products from Japan, similarly to the equipment for civil works and associated job, and the 1991 prices of these equipment, transportation costs (in the same manner as the machine transportation cost) and the installation costs have been included.

(2) Electro-Mechanical Equipment Construction Cost

a) All components of electro-mechanical equipments such as turbines generators, main transformers, switching gears and control and protective equipments were assumed to be imported as completed products from Japan.

The cost of these facilities was estimated by what was referred to actual market price for them used in electricity utility in Japan.

b) Transportation Cost and Insurance

These costs consist of two items, one is marine transportation and another one is inland transportation.

Marine transportation cost was estimated as 6% of FOB value and it includes all transportation insurance from Japan to construction site.

Inland transportation cost was estimated based on trucking.

c) Erection Cost

All installment and adjustment cost are included in each facility price. Therefore erection cost consists of; 2 man-months of Japanese engineer for performance tests; 30 man-month of foreign engineer for construction work; 120 man-months of Laotian engineer for construction work.

In addition, unit cost ($/kW) of this project is high due to small-scale hydroelectric power station, therefore in order to reduce this cost ordinary facilities available were fully chosen.

(3) Transmission Construction Cost

a) Material Cost as Cables (Conductors), Insulators, Arms, Overhead Ground Wire, etc.

These material cost were assumed to be imported as completed products of 1991 price from Japan transportation cost was estimated base on same condition of 2.3.2(5).

b) Material Cost of Concrete Pole produced and procured in Lao PDR

Concrete poles as transmission supports will be procured in Pakse, and transportation cost from there to construction sites are estimated based on trucking.

c) Installation Cost

Installation cost was assumed based on the conditions as; one group consists of 22 engineers and/or skilled workers; it would spend 4 days for 1 km distribution line; labour cost was estimated by actual data in Lao PDR.

In addition, the road of 20 km distance from Xe Katam Hydro Power Station to the Xe Kong River will be completed by the time of beginning of this work.

(4) Costs of Detailed Design and Construction Supervision

This Cost includes all costs to be incurred in preparation of tender documents including contract forms, technical specifications, drawings, etc., evaluation of bid proposals, checking of manufacturer's drawings, attendance at shop tests and construction supervision. The said Cost has been calculated as 15% of the above-mentioned cost of Civil Construction Cost, Generation Equipment Installation Cost and Transmission Line Construction Cost in the foreign currency portion and 10% of the same items in the local currency portion.

(5) Contingency

10% of the civil construction cost, power generation equipment construction cost and transmission line construction cost are counted as contingency.

(6) Interest During Construction

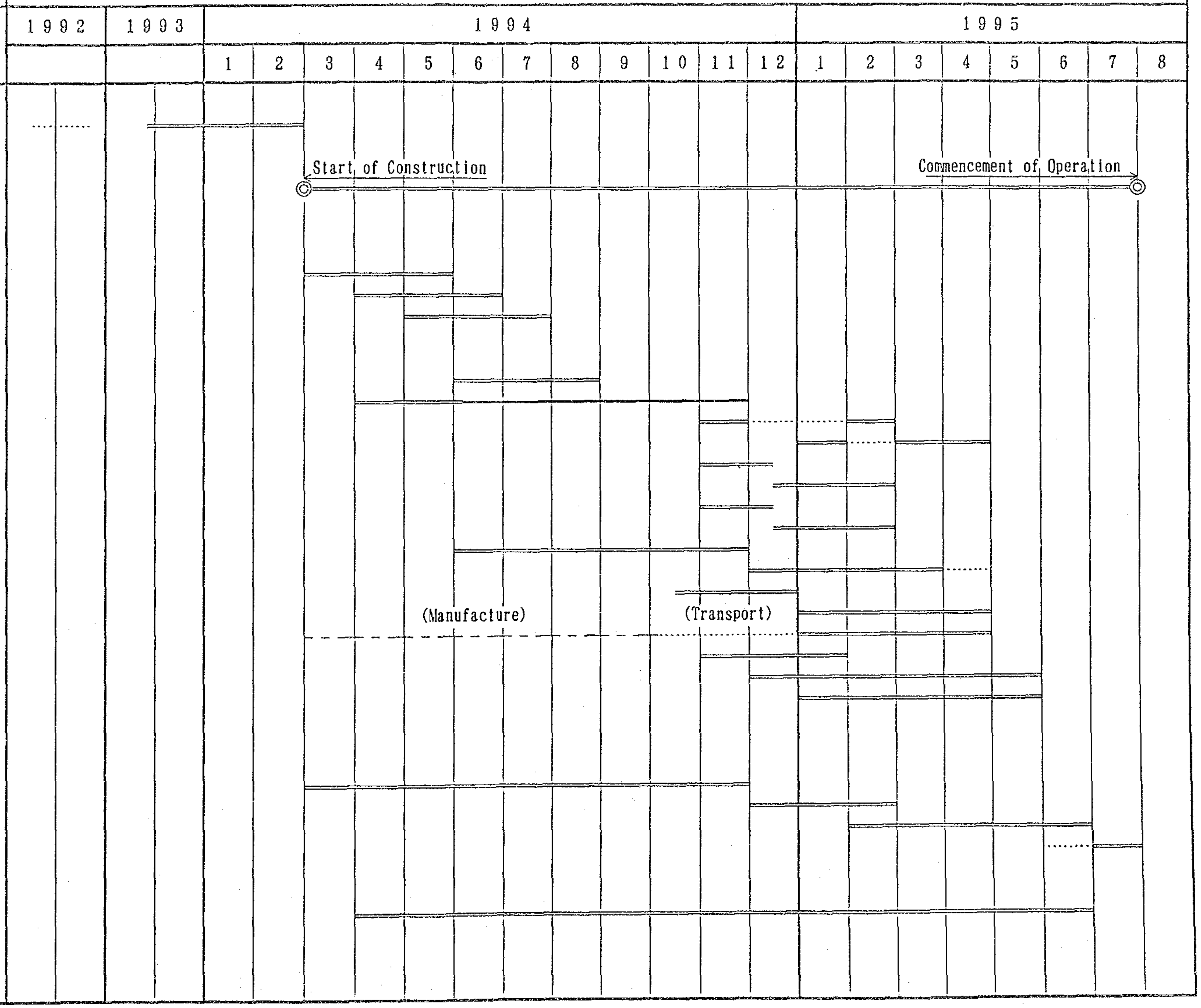
The cost estimate has been calculated by assuming that the annual rates of interests payable on the investments in each year during the construction period are 0.75% in the First Stage and 6.6% in the Latter Stage in the foreign currency portion, and 6.30% in the First Stage and 7.0% in the Latter Stage in the local currency portion.

Nationality : Lao People's Democratic Republic

Name of Project : Xe Katam

Fig. IV-2-1 Construction Schedule (First Stage) 1,000kW × 2

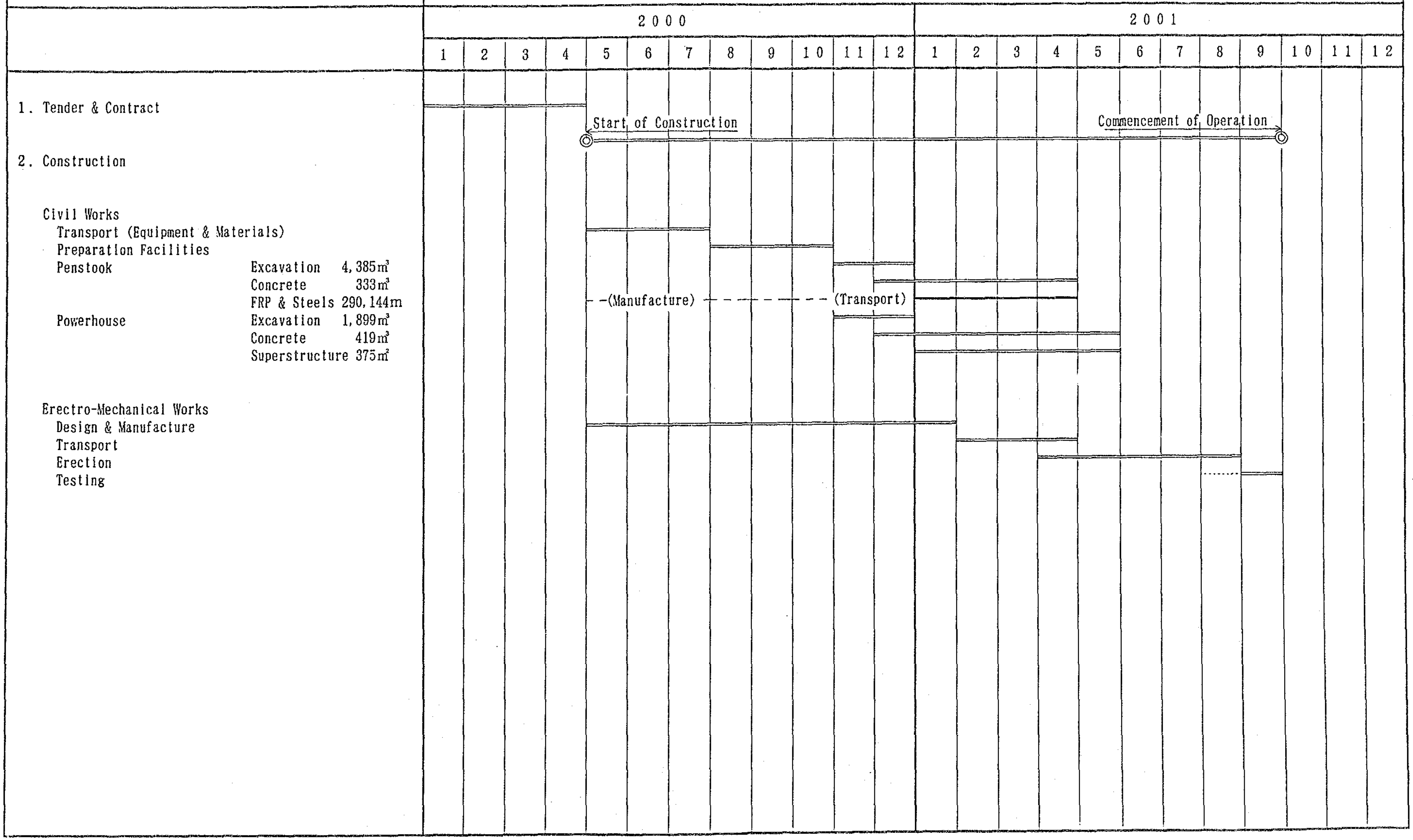
1. Detailed Design Study (Tender & Contract)		
2. Construction		
Preparation Works		
Transport (Equipment & Materials)		
Access Roads (Spread, Repair, Bridges)		
Camp Facilities and others		
Civil Works		
Aggregate & Concreate Plant		
Roads		
Dam & Intake	Excavation	2,530m³
	Concrete	2,630m³
Sand Stilling Basin	Excavation	954m³
	Concrete	754m³
Culvert	Excavation	969m³
	Concrete	411m³
Headrace Tunnel	Excavation	2,370m³
	Concrete	1,057m³
Penstock	Excavation	4,005m³
	Concrete	470m³
	FRP&Steel	336.788m
Powerhouse	Excavation	386m³
	Concrete	370m³
	Superstructure	390m²
Erectro-Mechanical Works		
Design & Manufacture		
Transport		
Erection		
Testing		
Transmission Line		



Nationality : Lao People's Democratic Republic

Name of Project : Xe Katam

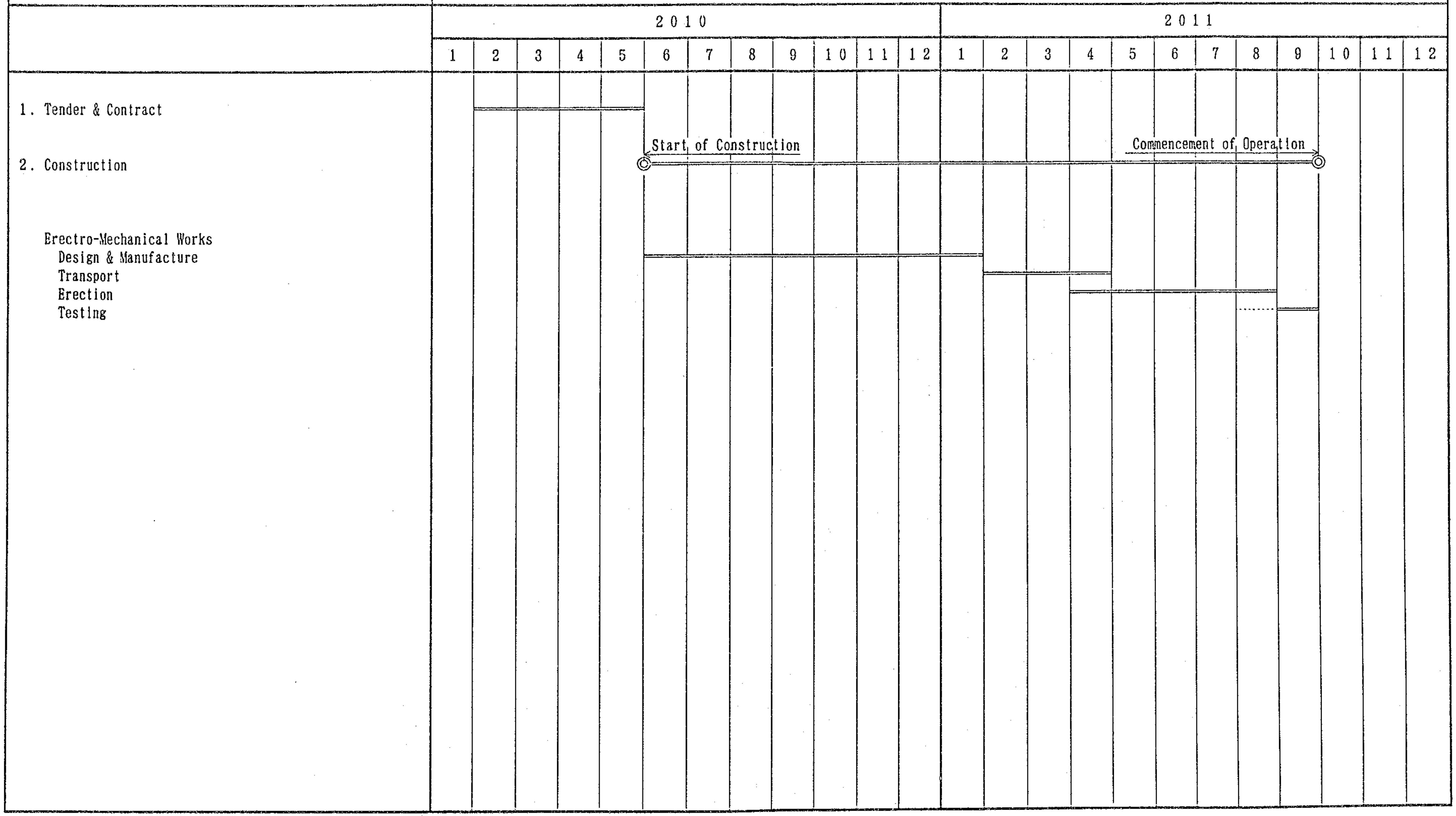
Fig. IV-2-2 Construction Schedule (Latter Stage) 2,000kW (1)

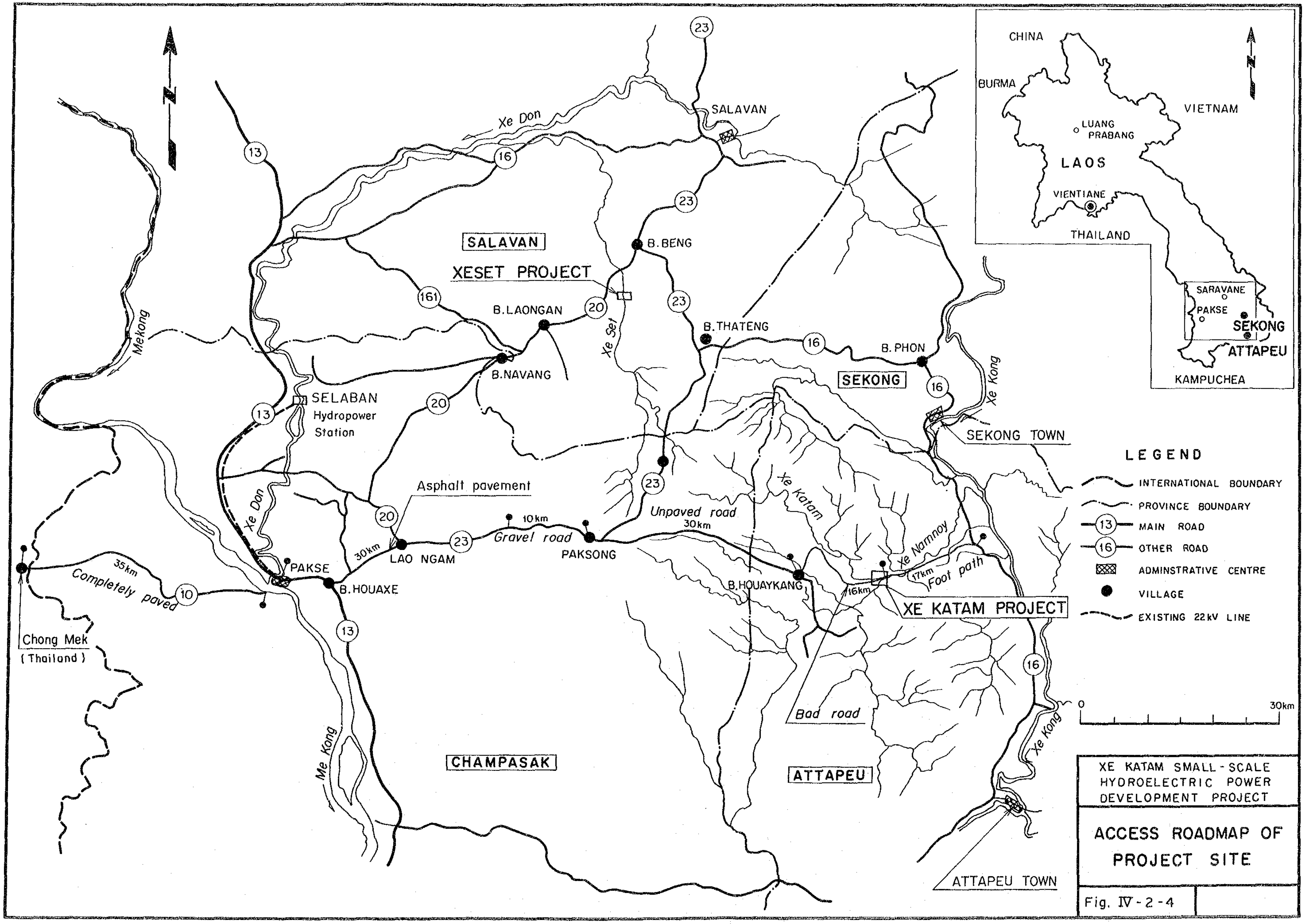


Nationality : Lao People's Democratic Republic

Name of Project : Xe Katam

Fig. IV-2-3 Construction Schedule (Latter Stage) 2,000kW (2)





XE KATAM SMALL-SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT

ACCESS ROADMAP OF PROJECT SITE

Fig. IV-2-4

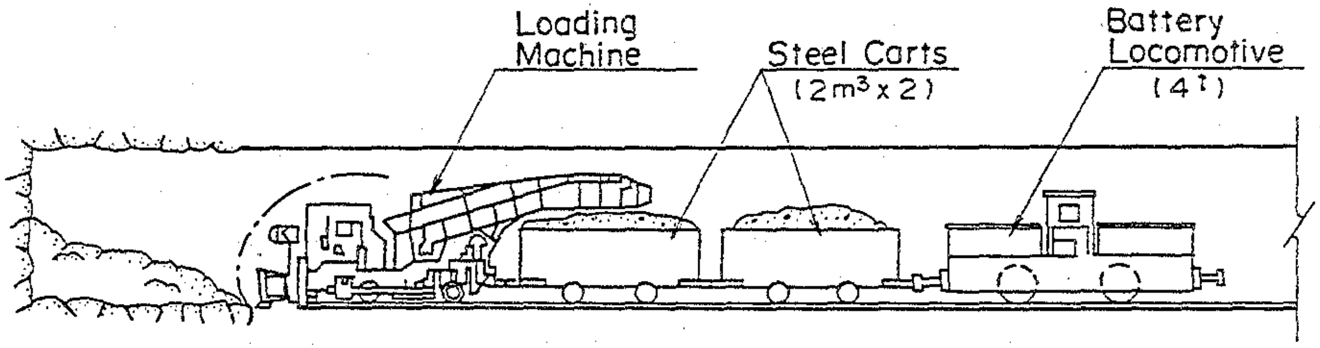


Fig. IV-2-5 Loading Machine of Tunnel Excavation

Table IV-2-1 Construction Machines List (1/2)

Item	Class	Number	Transport Weight (t)	
			Unit Weight	Total
Backhoe	0.6 m^3	2	18.8	37.6
Small Sized Backhoe	0.1 m^3	1	4.4	4.4
Bulldozer	21 ton	1	22.5	22.5
Bulldozer with Ripper	15 ton	2	16.7	33.4
Dump Truck	11 ton	3	9.3	27.9
Tractor Shovel	0.6 m^3	1	3.9	3.9
Truck Crane	15 ~ 16 ton	1	19.8	19.8
Truck Crane	4.8 ~ 4.9 ton	1	1.3	1.3
Leg Hammer	30 kg	4	0.03	0.1
Concrete Breaker	30 kg	1	0.03	-
Breaker	600 kg	1	0.6	0.6
Compressor	5 m^3/min	2	0.92	1.8
Boring Machine	5.5 kW	1	0.54	0.5
Truck Mixer	3 ~ 3.2 m^3	5	7.4	37.0
Loading Machine	0.15 m^3	1	1.9	1.9
Steel Cart	2.0 m^3	2	1.2	2.4
Battery Locomotive	4 ton	1	4.3	4.3
Concrete Placer	2.0 m^3	1	4.5	4.5
Motor Grader	3.1 m	1	9.7	9.7
Grout Mixer	400ℓ x 2	1	0.55	0.6
Grout Mixer	200ℓ x 2	1	0.23	0.2
Grout Pump	350 ~ 400 ℓ/min	1	1.3	1.3
Grout Pump	30 ~ 70 ℓ/min	1	0.19	0.2
Grout Flow & Pressure Meter	1,000 ℓ/min, 60 kg/cm^2	1	0.14	0.1

Table IV-2-1 Construction Machines List (2/2)

Item	Class	Number	Transport Weight (t)	
			Unit Weight	Total
Grout Flow & Pressure Meter	60 ℓ/min, 30 kg/m^2	1	0.13	0.1
Concrete Pump	40 ~ 45 m^3/h	2	4.7	9.4
Vibrator	28 mm	10	0.004	-
Tamper	60 ~ 100 kg	1	0.075	0.1
Drain Pump	φ50 mm, 10 m	7	0.02	0.1
Winch	2.8 ton	2	3.3	6.6
Propeller Fan	0.75 kW	2	0.03	0.1
Electric Welding Machine	200A	1	0.39	0.4
Diesel Generator	250 kVA	1	5.0	5.0
Diesel Generator	75 kVA	2	1.8	3.6
Aggregate Plant	20 t/h	1	136.0	136.0
Concrete Plant	18 m^3/h	1	26.0	26.0
Cement Silo	100 ton	1	17.0	17.0
Screw Conveyor	20 t/h, ℓ=7 m	1	-	-
Bucket Elevator	20 t/h, ℓ=20 m	1	-	-
Intake Pump	φ100 mm, 12 kW	2	0.2	0.4
Water Supply Pump	φ100 mm, 22 kW	2	0.5	1.0
Total (Transport Weight)				430 ton

Transport volume : $430^{ton} \times 2.5 = 1,075\ m^3$

Table IV-2-2 Summary of Cost Estimates

(Unit: 10^3 US$)

Item	First Stage			Latter Stage						Total		
				(1)			(2)					
	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t
1. Civil Construction	5,241	1,032	6,273	2,724	236	2,960	0	0	0	7,965	1,268	9,233
2. Electro - Mechanical Equipment	3,576	27	3,603	2,302	16	2,318	2,301	16	2,317	8,179	59	8,238
3. Transmission Line	1,666	850	2,516	-	-	-	-	-	-	1,666	850	2,516
4. Sub Total (1+2+3)	10,483	1,909	12,392	5,026	252	5,278	2,301	16	2,317	17,810	2,177	19,987
5. Detailed Design & Engineering (f.c = 4 x 15%, l.c = 4 x 10%)	1,572	191	1,763	754	25	779	345	2	347	2,571	218	2,889
6. Contingency (4 x 10%)	1,048	191	1,239	503	25	528	230	2	232	1,781	218	1,999
7. Sub Total (5+6)	2,620	382	3,002	1,257	50	1,307	575	4	579	4,452	436	4,888
8. Total (Project Cost) (4+7)	13,103	2,291	15,394	6,283	302	6,585	2,876	20	2,896	22,262	2,613	24,875
9. Interest during Construction*	107	176	283	434	25	459	154	1	155	695	202	897
10. Grand Total (Investment Cost) (8+9)	13,210	2,467	15,677	6,717	327	7,044	3,030	21	3,051	22,957	2,815	25,772

* The annual rates of interest are 0.75% in the first stage and 6.6% in the latter stage for foreign curriences, and 6.3% in the first stage and 7.0% in the latter stage for local currencies (Not consider a special fund allowance).

Table IV-2-3 Estimated Construction Cost (1/4)

(Civil Construction (1/2))

(Unit: 10^3 US$)

Item	First Stage			Latter Stage						Total		
				(1)			(2)					
	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t
1. Civil Works	1,647	836	2,483	447	138	585	0	0	0	2,094	974	3,068
Intake Dam	172	149	321	-	-	-	-	-	-	172	149	321
Intake	66	48	114	-	-	-	-	-	-	66	48	114
Sand Stilling basin	95	72	167	-	-	-	-	-	-	95	72	167
Culvert	53	40	93	-	-	-	-	-	-	53	40	93
Headrace tunnel	523	251	774	-	-	-	-	-	-	523	251	774
Sediment discharge tunnel	51	21	72	-	-	-	-	-	-	51	21	72
Penstock	89	86	175	73	64	137	-	-	-	162	150	312
Powerhouse	38	34	72	48	40	88	-	-	-	86	74	160
Tailrace	15	14	29	15	15	30	-	-	-	30	29	59
Switchyard	4	3	7	-	-	-	-	-	-	4	3	7
Disposal area (A, B)	19	18	37	-	-	-	-	-	-	19	18	37
New road	201	78	279	-	-	-	-	-	-	201	78	279
Powerhouse building	321	22	343	311	19	330	-	-	-	632	41	673

Table IV-2-3 Estimated Construction Cost (2/4)

(Civil Construction (2/2))

(Unit: 10^3 US$)

Item	First Stage			Latter Stage (1)			Latter Stage (2)			Total		
	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t
2. Provisional Facilities	1,334.5	89	1,423.5	749.5	19	768.5	0	0	0	2,084	108	2,192
Excavation facilities	34	14	48	7.5	2.5	10	-	-	-	41.5	16.5	58
Concrete facilities	1	0	1	0	0	0	-	-	-	1	0	1
Transport facilities	144	19.5	163.5	25.5	5	30.5	-	-	-	169.5	24.5	194
Electrical communication	60.5	17.5	78	8.5	0	8.5	-	-	-	69	17.5	86.5
Temporary building	89	31	120	27	6.5	33.5	-	-	-	116	37.5	153.5
Machine depreciation	195	0	195	136	0	136	-	-	-	331	0	331
Transportation of machines	566	7	573	396	5	401	-	-	-	962	12	974
Expenses common equipment	103	0	103	72	0	72	-	-	-	175	0	175
Safety provision cost	13	0	13	7	0	7	-	-	-	20	0	20
Others	129	0	129	70	0	70	-	-	-	199	0	199
3. Overhead Cost	1,313	12.5	1,325.5	804	12.5	816.5	0	0	0	2,117	25	2,142
4. Sub Total (1+2+3)	4,294.5	937.5	5,232	2,000.5	169.5	2,170	0	0	0	6,295	1,107	7,402
5. Equipment for Civil Works	279	32.5	311.5	-	-	-	-	-	-	279	32.5	311.5
6. Penstock	667	62	729	724	66	790	-	-	-	1,391	128	1,519
Total (Civil Construction) (4+5+6)	5,241	1,032	6,273	2,724	236	2,960	-	-	-	7,965	1,268	9,233

Table IV-2-3 Estimated Construction Cost (3/4)

(Electro-Mechanical Equipments)

(Unit: 10^3 US$)

Item	First Stage			Latter Stage (1)			Latter Stage (2)			Total		
	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t	f.c	l.c	s.t
Electro-Mechanical Equipments	3,576	27	3,603	2,302	16	2,318	2,301	16	2,317	817	59	8,238
Turbine & Generator	2,564	0	2,564	1,931	0	1,931	1,930	0	1,930	642	0	6,425
Substation Equipments	460	0	460	128	0	128	128	0	128	71	0	717
Control & Protection	176	0	176	57	0	57	57	0	57	28	0	289
Others	140	0	140	63	0	63	63	0	63	26	0	265
Inland Transportation	20	11	31	15	8	23	15	8	23	5	26	76
Erection	216	16	232	108	8	116	108	8	116	43	32	465

Table IV-2-3 Estimated Construction Cost (4/4)

(22 kV Transmission Line)

Unit: 10^3 US$

	F.C	L.C	Total
1. Equipment & Materials Line Conductors Insulators, etc.	1,319	0	1,319
Concrete Poles	0	284	284
Transformers for Distribution, etc.	200	0	200
Sub-Total	1,519	284	1,803
2. Transportation (Including Insurance)			
Marine Transportation	91	0	91
In-land Transportation	56	79	135
Sub-total	147	79	226
3. Installation and Erection	0	487	487
Total	1,666	850	2,516

Note: In-land Transportation Costs are divided in two portion

Bangkok - Pakse : F.C (foreign currency)

Pakse - Project site : L.C (local currency)

Table IV-2-4 Financial Program

Unit: 10^3US$

Year	Total	Foreign	Local	Remark
1993	709	630	79	
1994	8,169	6,606	1,563	
1995	6,799	5,974	825	
1996	-	-	-	
1997	-	-	-	
1998	-	-	-	
1999	322	312	10	
2000	3,143	2,944	199	
2001	3,579	3,461	118	
2002	-	-	-	
2003	-	-	-	
2004	-	-	-	
2005	-	-	-	
2006	-	-	-	
2007	-	-	-	
2008	-	-	-	
2009	143	142	1	
2010	644	639	5	
2011	2,264	2,249	15	
2012	-	-	-	
Total	25,772	22,957	2,815	

These amount are based on the price level as of 1991 year.

Table IV-2-5 Exchange Rate (Bank of Tokyo TTS Rate)

US$/Japan¥ Unit :¥/US$

Date	1990	1991				
	12	1	2	3	4	5
1			132.30	134.25	141.70	137.35
2					139.75	139.00
3	133.50				138.75	
4	135.00	134.40	132.30	135.65	138.50	
5	134.50		131.70	136.35	137.15	
6	134.85		130.30	137.30		
7	133.65	136.95	129.10			139.50
8		137.40	129.45	136.35	137.60	138.90
9		137.75			138.10	139.20
10	131.40	137.10				139.30
11	132.75	135.35		138.85		
12	133.10		128.70	138.90	136.80	
13	132.30		129.65	137.70		140.25
14	133.05	136.55	130.65	136.90		140.20
15			130.65	137.40	136.60	139.00
16		137.30			135.25	138.25
17	134.35	137.45			135.75	138.70
18	134.15	135.50	131.20	138.80	137.25	
19	134.15		131.30	139.40	138.90	
20	134.95		132.40	139.55		139.70
21	136.80	133.40	132.45			139.20
22		132.55	132.05	137.90	139.80	138.45
23		133.45			139.70	139.00
24		132.70			138.60	138.80
25	137.00	133.40	133.35	138.85	139.10	
26	137.45		133.80	140.15	138.80	
27	137.95		133.75	139.20		139.35
28	137.75	133.70	133.20	140.85		139.40
29		132.75		141.95		138.70
30		132.75			138.40	138.80
31	135.60	132.15				138.85
Sub Total	2,694.25	2,562.30	2,498.30	2,626.30	2,626.50	2,919.90
Total of days	20	19	19	19	19	21
Average Month	134.71	134.86	131.49	138.23	138.24	139.04
Average 6 Months	136.10					

Table IV-2-6 Price Indices of Xeset Project

	1988 Aug.	1989 Oct.	1990 Oct.	1990 Nov.	1990 Dec.	1991 Jan.	1991 Feb.	1991 Mar.
Plant Index	1.0000	1.0438	1.1037	1.1037	1.1037	1.1037	1.1037	1.1037
Labor Index	1.0000	1.1148	1.2128	1.2128	1.2128	1.2128	1.2128	1.2128
Explosive Index	1.0000	1.0598	1.1135	1.1135	1.1135	1.1135	1.1135	1.1135
Cement Index	1.0000	1.0244	1.5854	1.4939	1.4939	1.4939	1.4939	1.4939
Steel Index	1.0000	1.0841	1.0922	1.0743	1.0743	1.0743	1.0743	1.0743

Table IV-2-7 Labor Wages

Item	Labor Unit Prices (US$/day)	Labor Unit Prices (US$/month)
Foreman	5.9	177
Worker	3.3	99
Skilled Labour	5.9	177
Special Worker	5.9	177
Concrete Man	4.2	126
Bar Bender	4.2	126
Welder	4.7	141
Carpenter	4.2	126
Painter	4.2	126
Scaffolding Man	4.2	126
Plasterer	4.5	135
Masonry	4.5	135
Plumber	4.2	126
Electrician	4.7	141
Operator(Heavy Equipment)	6.2	186
Operator(Light Equipment)	5.1	153
Assistant Operator	4.5	135
Driver(Dump Truck)	4.5	135
Driver	4.2	126
Civil Engineer	9.2	276
Technical Assistance	4.7	141
Architect	9.2	276
Building Assistance	4.7	141
Office Worker	3.4	102
Typist	4.5	135
Handyman	2.6	78
Guardman	2.6	78

Table IV-2-8 Constitution of Civil Construction Costs

- Civil Construction Cost
  - Construction Costs
    - Direct Costs
      - Civil Works
    - Provisional Facility Costs
    - Overhead Costs
      - Technical Personnel Dispatching Cost
      - Expenses at Construction Site
      - Administrative Cost
  - Equipments for Civil Works (including transportation costs and installation costs)
  - Penstock (including transportation costs and installation costs)

Table IV-2-9 CONSTRUCTION UNIT COST

Unit:US$

Item	Unit	Rate	Remark
Excavation-common	m^3	6.0	Dam, Intake, Stilling Basin, Culvert
Excavation-common	m^3	5.0	Penstock, Power House, Outlet, S Yard
Excavation-common	m^3	2.0	Disposal Area
Excavation-rock	m^3	9.0	Dam, Intake, Stilling Basin, Culvert
Excavation-rock	m^3	30.0	Penstock
Excavation-rock	m^3	7.5	Power House
Excavation-Tunnel	m^3	100.0	Headrace Tunnel, Sediment Tunnel
Clearing	m^2	0.5	Disposal Area
Backfill	m^3	7.0	
Concrete(A)	m^3	116.0	Dam
Concrete(B)	m^3	125.0	Intake, Stilling Basin, Culvert, Tunnel
Concrete(C)	m^3	130.0	Penstock, Power House, Outlet, S Yard
Lining Concrete	m^3	220.0	Headrace Tunnel, Sediment Tunnel
Mortar Injection	m^3	150.0	Headrace Tunnel
Grouting	m	170.0	Headrace Tunnel
Reinforcing bar	t	800.0	
New Road(8m wide)	m	70.0	
New Road(4m wide)	m	42.0	
Powerhouse Building	m^2	880.0	

Table IV-2-10 WORK AMOUNT LIST (1/2)

Item	Unit	Work Amount First Stage	Work Amount Latter Stage
Dam			
Excavation-common	m^3	483	-
Excavation-rock	m^3	1,482	-
Backfill	m^3	2	-
Concrete(A)	m^3	2,087	-
Reinforcing bar	t	11	-
Intake			
Excavation-common	m^3	85	-
Excavation-rock	m^3	480	-
Backfill	m^3	80	-
Concrete(B)	m^3	543	-
Reinforcing bar	t	27	-
Sand Stilling Basin			
Excavation-common	m^3	110	-
Excavation-rock	m^3	844	-
Backfill	m^3	915	-
Concrete(B)	m^3	754	-
Reinforcing bar	t	38	-
Pressure Culvert			
Excavation-common	m^3	6	-
Excavation-rock	m^3	963	-
Backfill	m^3	179	-
Concrete(B)	m^3	411	-
Reinforcing bar	t	20	-
Headrace Tunnel			
Excavation-Tunnel	m^3	1,996	-
Lining Concrete	m^3	921	-
Reinforcing bar	t	32	-
Mortar Injection	m^3	85	-
Grouting	m	1,200	-
Sediment Discharge Tunnel			
Excavation-Tunnel	m^3	279	-
Excavation-rock	m^3	95	-
Lining Concrete	m^3	119	-
Concrete(B)	m^3	17	-
Reinforcing bar	t	4	-
Penstock			
Excavation-common	m^3	1,900	2,892
Excavation-rock	m^3	2,105	1,493
Backfill	m^3	1,150	1,170
Concrete(C)	m^3	470	333
Reinforcing bar	t	4.5	4.5

Table IV-2-10 WORK AMOUNT LIST (2/2)

Item	Unit	Work Amount First Stage	Work Amount Latter Stage
Power House			
Excavation-common	m^3	386	1,899
Excavation-rock	m^3	-	-
Backfill	m^3	412	363
Concrete(C)	m^3	370	419
Reinforcing bar	t	9	9
Tailrace			
Excavation-common	m^3	268	169
Concrete(C)	m^3	167	177
Reinforcing bar	t	1.5	1.0
Switch Yard			
Excavation-common	m^3	156	-
Backfill	m^3	112	-
Concrete(C)	m^3	28	-
Reinforcing bar	t	1	-
Disposal Area(A, B)			
Clearing	m^2	8,590	-
Excavation-common	m^3	77	-
Concrete(C)	m^3	199	-
Reinforcing bar	t	-	-
New Roads			
New Construction-8m	m	1,680	-
New Construction-4m	m	3,850	-
Powerhouse Building	m^2	390	375

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3. Economic Evaluation

Chapter IV 3. Economic Evaluation

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3. Economic Evaluation

3.1 Method of and Assumptions for Economic Evaluation

3.1.1 Method of Economic Evaluation

The Xe Katam Small-Scale Hydroelectric Power Development Project (hereinafter called the "PROJECT") envisages construction of a hydro power plant and associated facilities including transmission lines with a final installed capacity of 6,000 kW as an isolated power system for supplying electricity to Sekong, Attapeu, etc. For achieving this goal, investments are to be made for construction/ installation/erection of civil structures, electro/mechanical equipment and transmission lines with an installed capacity of 2,000 kW in 1993 and subsequent two years. It is assumed that investments will also be made for facilities of 2,000 kW each which are expected to be constructed in 2001 and 2011 respectively in correspondence with the growing demand in Sekong, Attapeu, etc.

Based on the above-mentioned requirement, the economic evaluation has been performed by converting the Benefit and Cost stated below to present values thereof at the beginning of the first year (1993) when the investments for the implementation of the PROJECT commence to be made with the aim of finding values of Benefit-Cost and Benefit/Cost Ratio. At the same time, the economic evaluation has also been made by calculating an economic equalizing discount rate (EEDR) which makes a present value of Benefit and that of Cost equalized.

Cost :

(1) Total Investment Cost for the PROJECT

(2) Operation and Maintenance Cost after completion of equipment/facilities

Benefit:

(1) It is assumed that diesel power plants having the same scale as that of the PROJECT on a comparable level are to be installed at the load centres of Sekong, Attapeu, etc. Total Investment Cost for these alternative diesel power plants are taken into consideration.

(2) Operation and Maintenance Cost after completion of such diesel power plant facilities.

(3) Fuel cost to be accrued in correspondence with the quantity of required energy demand at a bus point of 22 kV transmission line.

3.1.2 Assumptions for Economic Evaluation

Calculations for the economic evaluation were worked out according to the following conditions:

(1) Price level and escalation

All prices are as of 1991. No escalation rate is taken in calculations according to general principles of economic evaluation.

(2) Conversion rates

US$ 1 = Kip 700
US$ 1 = Yen 136

(3) Service life

The facilities contained in the PROJECT are mainly composed of civil structures, electro/mechanical equipment and transmission facilities. No clear-cut stipulations are made in the Lao Accounting Code in connection with individual service lives of the said equipment and facilities. Therefore, the following standards were set up by reference to stipulations in Japan and other overseas countries.

(a)	Civil Structures	58 years
(b)	Electro/Mechanical Equipment	23 years
(c)	Transmission Facilities	27 years

The average weighted service life was calculated, using the percentage of the respective facilities and equipment from (a) to (c) accounted for in the total amount of investments for the 6,000 kW facilities. The calculation has resulted in 40 years which is equivalent to the composite service life of the PROJECT. On the other hand, the service life of the diesel power plant has been determined to be 20 years according to Lao practice.

(4) Discount rate

As for the discount rate, 10% is to be used as a result of consultation with the Lao side.

(5) Conditions for calculations for economic evaluation

The conditions for calculations inclusive of (1) through (4) above are shown in Tables IV-3-1 and IV-3-2. The values of the respective items except for those for fuel were not made available by the Lao side during the JICA Team's visit to Laos in July 1991. Therefore, appropriate values are cited by reference to those of similar items in other developing countries.

Table IV-3-1 Assumptions for Calculations for Economic Evaluation

	Description	PROJECT	Diesel
(1)	Rated Output (kW)	6,000	6,496 (=6,000x1.08)
(2)	kW Adjustment Factor	1	1.083 1/
(3)	Station Service Rate (%)	0.5	3.0
(4)	Transmission Line Loss Rate (%)	3.4	0
(5)	Scheduled outage Rate (%)	2.0	8.0
(6)	Forced Outage Rate (%)	0.5	3.0
(7)	Construction Cost of D/G per kW (Thousand $)		1.0
(8)	Composite Service Life (Yr)	40	20
(9)	Kind of Fuel		Diesel Oil
(10)	Thermal Efficiency (%)		34.0
(11)	Calorific Value (kcal/kg)		10,200
(12)	Specific Gravity (kg/litre)		0.85
(13)	Fuel Consumption (litre/kWh)		0.292
(14)	Fuel Unit Price (Kip/litre)		300
(15)	Fuel Unit Price ($/litre) 300 Kip/700 Kip		0.429
(16)	Fuel Cost per kWh ($/kWh)		0.125
(17)	Composite OM Cost Ratio to Total Construction Cost (%)	1.5 2/	4.5

1/ kW Adjustment

$$\frac{\text{PROJECT} \quad \overset{(3)}{(1-0.005)} \times \overset{(4)}{(1-0.034)} \times \overset{(5)}{(1-0.02)} \times \overset{(6)}{(1-0.005)}}{\text{Diesel} \quad (1-0.03) \times (1-0) \times (1-0.08) \times (1-0.03)}$$

= 1.082724758

Therefore, the Rated Output of D/G is equivalent to 6,496 kW (= 6,000 kW x 1.083).

2/ Composite Ratio of PROJECT OM Cost to Total Construction Cost

(a)	Civil Works	11,491	0.5%	58 ($10^3$$)
(b)	Hydro Power Plant	10,253	2.5%	256
(c)	Transmission Line	3,131	1.5%	47
	Total	24,875		361

361×10^3 \$ / 24.875×10^3 \$ = 0.01452 ≒ 1.5%

Table IV-3-2 Salable & Generating Energy

Saleable Energy (MWh)	Generat. Energy at D/G Plant (MWh)	Generat. Energy at Hydro Plant (MWh)
7650	7688	7960
8552	8595	8899
9129	9175	9500
9739	9788	10134
10382	10434	10803
11062	11118	11511
11782	11841	12260
12540	12603	13049
13337	13404	13879
14175	14247	14751
15055	15130	15666
15973	16053	16621
16934	17019	17621
17940	18030	18668
18994	19089	19764
20099	20200	20915
21260	21367	22123
22475	22588	23387
23746	23865	24710
25076	25202	26093
26464	26597	27538
27909	28049	29042
29358	29505	30549
30459	30612	31695
31473	31631	32751
32475	32638	33793
33459	33627	34817
34443	34616	35841
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
35357	35535	36792
976226	981131	1015844

3.2 Cost

3.2.1 Total Investment for the PROJECT

The total amount of investments for the PROJECT with a final installed capacity of 6,000 kW amounts to 24,875 x 10^3\$ as shown hereunder:

Investment for PROJECT implementation

(10^3 \$)

	FC Portion	LC Portion	Total
2,000 kW (a) (1st stage)	13,103	2,291	15,392
2,000 kW (b) (2nd stage)	6,283	302	6,585
2,000 kW (c) (3rd stage)	2,876	20	2,896
Final Installed Capacity 6,000kW	22,262	2,613	24,875

3.2.2 Operation and Maintenance Cost

The ratio of the operation and maintenance cost of the PROJECT to its total investment (construction cost) is estimated to be 1.5% on a yearly basis. Therefore, 223 x 10^3\$ after commissioning of the first completed 2,000 kW facilities of the hydro power plant, 319 x 10^3\$ upon completion of the second completed 2,000 kW hydro facilities and 361 x 10^3\$ for the third completed 2,000 kW hydro facilities to reach 6,000 kW are estimated to be accrued annually.

3.3 Benefit (Alternative Diesel Power Plant)

3.3.1 Investments for Alternative Diesel Power Plant

The installed capacity of the diesel power plant equivalent to 6,000 kW of the PROJECT is 6,496 kW. The total amount of investment for the alternative diesel power plant is to be 6,496 x 10^3\$ which is obtainable by multiplying

6,496 kW by $1,000, construction cost per kW. At each stage, 2,166 x 10^3 is to be invested during the entire service life of the PROJECT. However, the diesel power plants installed at the second and third stages will still have extra service lives at the last year of depreciation of the PROJECT. Accordingly, the residual cost was calculated by the following equation and subtracted so as to make an adjustment of investment costs between both schemes.

$$- (6/20 + 16/20) \times (1,516 + 650) = -2,382$$

3.3.2 Operation and Maintenance Cost

The ratio of the annual Operation and Maintenance Cost of the diesel power plant to its total investments amounts to 4.5%. After commissioning of the first 2,000 kW of the PROJECT (corresponding installed capacity of the diesel power plant: 2,165kW), 97 x $10^3$$ is to be needed as the Operation and Maintenance Cost annually. Likewise, 195 x $10^3$$ and 292 x $10^3$$ will be needed respectively after completion of 4,000 kW and 6,000 kW facilities of the PROJECT.

3.3.3 Fuel Cost

(1) Unit price of fuel

JICA Team visited the Pakse Branch and Head Office of the State Fuel Company in July 1991 in order to know the particulars and prices of diesel oil actually being used at existing diesel power plants in Sekong and Attapeu. It was found that the diesel oil being used at these power plants is of a standard quality, as shown in (11), (12) and (13) of Table IV-3-1. The unit price of diesel oil was approximately 270 Kip per litre. However, it was informed that around ten (10) percent of the diesel oil price was subsided by the Government. The amount of government subsidy was excluded according to general principles of economic evaluation. Consequently, 300 Kip per litre is to be used as the unit price of the Fuel Cost.

Accordingly, the unit price of fuel per kWh can be calculated to be \$0.125 as shown below:

	Thermal Efficiency		Specific Gravity		
860 Kcal/	0.34	/10,200 Kcal/	0.85	=	0.292 litre/kWh
0.292 litre x \$0.429/litre		=	\$0.125/kWh		

(2) Quantity of energy to be generated at diesel power plant

It is needed for the diesel power plant to generate the quantity of energy which will meet the quantity of "Saleable Energy" as shown in Table IV-3-2. Therefore, the fuel cost of the diesel power plant was calculated as given hereunder, assuming that the station service rate is to be 3%.

$$Saleable\ Energy \times \frac{1}{(1-0.03)} \times \$0.125/kWh = Fuel\ Cost\ (10^3\$)$$

3.4 Economic Evaluation

The streams of Benefit and Cost are shown is Table IV-3-3. B-C and B/C Ratio are as given hereunder:

Discount rate = 10%

B-C	:	1,365 x 10^3\$
B/C	:	1.08
EDR	:	10.80%

As can be seen from the B-C and B/C Ratio given above, the implementation of the PROJECT is more economical than the alternative diesel power plant scheme which will provide the same level of services. These figures indicate that the superiority can be maintained until a social discount rate which reflects the opportunity cost of capital in Laos reaches 10.80%.

Table IV-3-3 Economic Evaluation

SDR= 10.0%

Xekatam(as Cost) IR= 1 | Diesel(as Benefit) FIR= 1 | (Thousand dollars)

Serial No.	Year afte Commissio	Xekatam Invest.	Xekatam OM Cost	Xekatam Sub-Total	Sale. Energy (MWh)	Diesel Invest.	Diesel OM Cost	Fuel Cost	Diesel Sub-Total	B-C	PV Factor	NPV Cost	NPV Benefit	NPV B-C
1		705		705					0	-705	0.909	641	0	-641
2		8088		8088		1516			1516	-6572	0.826	6684	1253	-5432
3		6601		6601		650			650	-5951	0.751	4959	488	-4471
4	1		223	223	7650		97	986	1084	860	0.683	152	740	588
5	2		223	223	8552		97	1102	1200	977	0.621	139	745	606
6	3		223	223	9129		97	1177	1274	1051	0.564	126	719	593
7	4	312	223	535	9739		97	1255	1353	817	0.513	275	694	420
8	5	3023	223	3246	10382	1516	97	1338	2951	-295	0.467	1514	1377	-138
9	6	3250	223	3473	11062	650	97	1426	2173	-1300	0.424	1473	922	-551
10	7		319	319	11782		195	1519	1714	1395	0.386	123	661	538
11	8		319	319	12540		195	1616	1811	1493	0.350	112	635	523
12	9		319	319	13337		195	1719	1914	1595	0.319	102	610	508
13	10		319	319	14175		195	1827	2022	1703	0.290	92	586	493
14	11		319	319	15055		195	1941	2135	1817	0.263	84	562	478
15	12		319	319	15973		195	2059	2254	1935	0.239	76	540	463
16	13		319	319	16934		195	2183	2378	2059	0.218	69	517	448
17	14	138	319	457	17940		195	2312	2507	2051	0.198	90	496	406
18	15	615	319	933	18994	1516	195	2448	4159	3226	0.180	168	748	580
19	16	2144	319	2462	20099	650	195	2591	3435	973	0.164	403	562	159
20	17		361	361	21260		292	2740	3033	2672	0.149	54	451	397
21	18		361	361	22475		292	2897	3189	2829	0.135	49	431	382
22	19		361	361	23746	1516	292	3061	4869	4508	0.123	44	598	554
23	20		361	361	25076	650	292	3232	4174	3813	0.112	40	466	426
24	21		361	361	26464		292	3411	3703	3343	0.102	37	376	339
25	22		361	361	27909		292	3597	3890	3529	0.092	33	359	326
26	23		361	361	29358		292	3784	4077	3716	0.084	30	342	312
27	24		361	361	30459		292	3926	4219	3858	0.076	28	322	294
28	25		361	361	31473	1516	292	4057	5865	5504	0.069	25	407	382
29	26		361	361	32475	650	292	4186	5128	4767	0.063	23	323	301
30	27		361	361	33459		292	4313	4605	4244	0.057	21	264	243
31	28		361	361	34443		292	4440	4732	4371	0.052	19	247	228
32	29		361	361	35357		292	4558	4850	4489	0.047	17	230	213
33	30		361	361	35357		292	4558	4850	4489	0.043	16	209	193
34	31		361	361	35357		292	4558	4850	4489	0.039	14	190	176
35	32		361	361	35357		292	4558	4850	4489	0.036	13	173	160
36	33		361	361	35357		292	4558	4850	4489	0.032	12	157	145
37	34		361	361	35357		292	4558	4850	4489	0.029	11	143	132
38	35		361	361	35357	1516	292	4558	6366	6005	0.027	10	170	161
39	36		361	361	35357	650	292	4558	5499	5139	0.024	9	134	125
40	37		361	361	35357		292	4558	4850	4489	0.022	8	107	99
41	38		361	361	35357		292	4558	4850	4489	0.020	7	97	90
42	39		361	361	35357		292	4558	4850	4489	0.018	7	89	82
43	40		361	361	35357	-2382	292	4558	2468	2107	0.017	6	41	35
Total		24875	13185	38060	976226	10611	9550	125835	145996	107936		17813	19178	1365

B-C	1365
B/C	1.077
EDR	10.797%

3.5 Sensitivity Analysis

The following is the results of sensitivity analysis regarding variations in the construction cost of the PROJECT and those in the fuel cost of the alternative diesel power plant.

(1) Variations in Construction Cost of the PROJECT

(discount rate : 10%)

Construction Cost	Up 3%	Up 5%	Up 7%	Up 9%
B-C (10^3\$)	831	474	118	-238
B/C	1.045	1.025	1.006	0.988

(2) Variations in Fuel Cost of Alternative Diesel Power Plant

(discount rate : 10%)

Fuel Cost	Up 3%	Up 5%	Up 7%	Up 9%
B-C (10^3\$)	1,797	2,085	2,373	2,661
B/C	1.101	1.117	1.133	1.149

4. Financial Analysis

Chapter IV 4. Financial Analysis

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4. Financial Analysis

4.1 Methods and Basic Conditions for Financial Analysis

4.1.1 Methods of Financial Analysis

The financial analysis was made according to the following two (2) methods.

(1) Financial Analysis Viewed from Total Amount of Investments

A discount rate which makes the present value of operating revenue to be raised following the commissioning of the plant and associated facilities upon completion of the PROJECT equalized with that of the total cost (investments and operation and maintenance costs) is to be found. This discount rate obtainable is to be compared with a social discount rate which duly reflects the opportunity cost of capital in Laos. In this kind of comparisons, no consideration is given to annual interest rates to obtain borrowed funds, repayment period, payment and repayment conditions, etc.

(2) Financial Analysis Viewed from Standpoint of Project Equity

As far as an enterprise or agency for the implementation of the PROJECT is concerned, somewhat managerial guidelines and/or targets will be needed in obtaining funds, maintaining the completed plant, associated facilities and the like. For this purpose, the projected amortization schedule, profit and loss statement and cash-flow sheet were prepared so that debt service ratios to serve as a managerial criterion can be computed.

In performing the study from the two standpoints; considerations were given to the very fact that the Lao Government anticipates the most favoured fund accommodation for construction of 2,000 kW at the earlier stage, and they do not compile any investment budgets in their national development plan. Accordingly, the study was made on two cases; a case in which the amount of investments for the 2,000 kW facilities of the PROJECT at the earlier (first) stage is counted and the other case in which the most favoured fund accommodation is made for the said facilities.

4.1.2 Basic Conditions for Financial Analysis

(1) Conditions for Financial Analysis in View of Investments

a) Construction Cost

	(10^3 US$)
2,000 kW (1st stage)	15,394
2,000 kW (2nd stage)	6,585
2,000 kW (3rd stage)	2,896
Final Installed Capacity 6,000 kW	24,875

b) Operation and Maintenance Cost

As explained in the "Economic Evaluation" in 3, the annual operation and maintenance cost was calculated on assumption that it is to be equivalent to 1.5% (0.01452) of the total construction cost. Accordingly, 15,394 x 10^3\$ x 0.01452 = 223 x 10^3\$ is needed annually until the commissioning of the second 2,000 kW plant. Upon realization of 4,000 kW plant, the annual operation and maintenance cost will amount to 21,979 x 10^3\$ x 0.01452 = 319 x 10^3\$. Then, 24,875 x 10^3\$ x 0.01452 = 361 x 10^3\$ will be finally needed on a year-wise basis for operation and maintenance of the 6,000 kW plant.

c) Energy Sales Revenue

i) Sale Rate

The following figures of the energy sales revenue and the quantity of sold energy for domestic use were made available by EDL to the JICA Team on the occasion of the said Team's visit to EDL headquarters in July 1991.

	Revenue (10^3\$)	Energy Sold (GWh)	Average Sale Rate per kWh (Kip)
1986	3,530,100	805	4.38 (\$0.040)
1987	2,021,490	529	3.82 (\$0.040)
1988	5,565,100	508	10.95 (%0.029)
1989	10,966,170	639	17.16 (\$0.024)
1990	15,287,570	789	19.40 (\$0.028)

EDL's records of the average sale rate/kWh shown above range from \$0.02 to \$0.03. Nevertheless, such sale rates include some amounts of government subsidy. EDL is contemplating reviewing this subsidy system and willing to set up a reasonable level of electricity charges in the future. It is the JICA Team's understanding that EDL was trying to take up 42 Kip (\$0.06)/kWh as a sale rate for the domestic use. If compared with the sale rate of 191 Kip (\$0.27)/kWh provisionally calculated in the SPE-II report, it is considered that the sale rate of 42 Kip/kWh is still extremely cheap. Therefore, the said average sale rate of 42 Kip/kWh recommended by EDL has been taken up in the Financial Analysis.

ii) Estimated Quantity of Sold Energy

The figures of saleable energy given in Table IV-3-2 give a quantity of energy available at the bus-point of 22 kV transmission line. In view of the existing distribution lines in Sekong, Attapeu, etc. a distribution loss rate from the said bus point is estimated at 1% thereby calculating the quantity of energy sold at ultimate consumers in the above localities.

(2) Conditions for Financial Analysis from the Standpoint of an Enterprise

a) Conditions for Raising Funds for 2,000 kW: (1st stage):

i) Foreign Currency Portion

Annual Interest Rate	:	0.75%
Grace Period	:	10 years (counted from L/A date)
Repayment Period	:	20 years
Repayment Mode	:	Equal Amount of Principal Annual Repayment

ii) Local Currency Portion

Annual Interest Rate	:	6.3%
Grace Period	:	10 years (counted from Sanction date)
Repayment Period	:	20 years
Repayment Mode	:	Equal Amount of Principal Annual Repayment

b) Conditions for Raising Funds

Latter Period (2nd and 3rd stages) 4,000 kW (2,000 kW + 2,000 kW)

The following conditions were laid down since it seems that the Lao side expects multilateral financial assistance for the construction of 4,000 kW plant in the latter period except for the funds for the construction of the 2,000 kW facilities in the 1st stage.

i) Foreign Currency Portion

Annual Interest Rate	:	6.6%
Grace Period	:	7 years (counted from L/A date)
Repayment Period	:	20 years
Repayment Mode	:	Equal Amount of Principal Annual Repayment

ii) Local Currency Portion

Annual Interest Rate	:	7%
Grace Period	:	7 years (counted from Sanction date)
Repayment Period	:	20 years
Repayment Mode	:	Equal Amount of Principal Annual Repayment

c) Customs Duties, etc.

No customs duties, levies and taxes are not included in the construction cost.

d) Depreciation

The depreciation amount was calculated by the straight line method with a salvage value of zero.

e) Operation and Maintenance Cost

The annual operation and maintenance cost was calculated as 1.5% of the total construction cost. (Refer to 4.1.2 (1)-b for details)

f) Energy Sales Revenue

Refer to 4.1.2 (1)-c).

g) Escalation

The costs were calculated as of 1991 and no escalation is considered.

4.1.3 Financial Analysis

(1) Financial Equalizing Discount Rate

a) Case in which the amount of investments for the 1st 2,000 kW is counted.

The equalizing discount rate can be calculated at 2.68%, far below a social discount rate of 10% which is a criterion for project evaluation in Laos, as shown in Table IV-4-1.

b) Case in which the amount of investments for the 1st 2,000 kW is not counted (regarded as null).

The calculations were made on assumption that the amount of the investments for the construction of 2,000 kW facilities at the first stage is not counted. However, an operation and maintenance cost is to be accrued regardless of any nature of funds raising. Therefore, the amount of such operation and maintenance cost was summed up. As a result, FEDR resulted in 14.28% for exceeding the social discount rate of 10%.

Table IV-4-1 Financial Evaluation of Benefit & Cost
(In case of counting the amount of investments for 1st 2000kW)

Sale Rate 42 Kip
0.060 $
SDR= 10.0% IR=

Serial No.	Year afte Commissio	Invest.	Xekatam(as Cost) 1.00 OM Cost	Sub-Total	Sale. Elect.(as Benefit) Energy (MWh)	Sale Revenue	B-C	(Thousand dollars) PV Factor	NPV Cost	NPV Benefit	NPV B-C
1		705		705			-705	0.909	641	0	-641
2		8088		8088			-8088	0.826	6684	0	-6684
3		6601		6601			-6601	0.751	4959	0	-4959
4	1		223	223	7650	454	231	0.683	152	310	158
5	2		223	223	8552	508	285	0.621	139	315	177
6	3		223	223	9129	542	319	0.564	126	306	180
7	4	312	223	535	9739	578	43	0.513	275	297	22
8	5	3023	223	3246	10382	617	-2630	0.467	1514	288	-1227
9	6	3250	223	3473	11062	657	-2816	0.424	1473	279	-1194
10	7		319	319	11782	700	381	0.386	123	270	147
11	8		319	319	12540	745	426	0.350	112	261	149
12	9		319	319	13337	792	473	0.319	102	252	151
13	10		319	319	14175	842	523	0.290	92	244	152
14	11		319	319	15055	894	576	0.263	84	235	152
15	12		319	319	15973	949	630	0.239	76	227	151
16	13		319	319	16934	1006	687	0.218	69	219	150
17	14	138	319	457	17940	1066	609	0.198	90	211	120
18	15	615	319	934	18994	1128	194	0.180	168	203	35
19	16	2144	319	2463	20099	1194	-1269	0.164	403	195	-207
20	17		361	361	21260	1263	902	0.149	54	188	134
21	18		361	361	22475	1335	974	0.135	49	180	132
22	19		361	361	23746	1411	1050	0.123	44	173	129
23	20		361	361	25076	1489	1129	0.112	40	166	126
24	21		361	361	26464	1572	1211	0.102	37	160	123
25	22		361	361	27909	1658	1297	0.092	33	153	120
26	23		361	361	29358	1744	1383	0.084	30	146	116
27	24		361	361	30459	1809	1449	0.076	28	138	110
28	25		361	361	31473	1870	1509	0.069	25	130	105
29	26		361	361	32475	1929	1568	0.063	23	122	99
30	27		361	361	33459	1987	1627	0.057	21	114	93
31	28		361	361	34443	2046	1685	0.052	19	107	88
32	29		361	361	35357	2100	1739	0.047	17	99	82
33	30		361	361	35357	2100	1739	0.043	16	90	75
34	31		361	361	35357	2100	1739	0.039	14	82	68
35	32		361	361	35357	2100	1739	0.036	13	75	62
36	33		361	361	35357	2100	1739	0.032	12	68	56
37	34		361	361	35357	2100	1739	0.029	11	62	51
38	35		361	361	35357	2100	1739	0.027	10	56	47
39	36		361	361	35357	2100	1739	0.024	9	51	42
40	37		361	361	35357	2100	1739	0.022	8	46	38
41	38		361	361	35357	2100	1739	0.020	7	42	35
42	39		361	361	35357	2100	1739	0.018	7	38	32
43	40		361	361	35357	2100	1739	0.017	6	35	29
Total		24876	13185	38061	976226	57988	19927		17813	6635	-11178

B-C	-11178
B/C	0.372
FEDR	2.682%

Table IV-4-2 Financial Evaluation of Benefit & Cost
(In case of regarding the amount of investments as null for 1st 2000kW)

Sale Rate 42 Kip
0.060 $
SDR= 10.0%

Serial No.	Year afte Commissio	Xekatam(as Cost) Invest.	OM Cost	Sub-Total	Sale. Elect.(as Benefit) Energy (MWh)	Sale Revenue	B-C	(Thousand dollars) PV Factor	NPV Cost	NPV Benefit	NPV B-C
1				0			0	0.909	0	0	0
2				0			0	0.825	0	0	0
3				0			0	0.751	0	0	0
4	1		223	223	7650	454	231	0.683	152	310	158
5	2		223	223	8552	508	285	0.621	139	315	177
6	3		223	223	9129	542	319	0.564	126	306	180
7	4	312	223	535	9739	578	43	0.513	275	297	22
8	5	3023	223	3246	10382	617	-2630	0.467	1514	288	-1227
9	6	3250	223	3473	11062	657	-2816	0.424	1473	279	-1194
10	7		319	319	11782	700	381	0.386	123	270	147
11	8		319	319	12540	745	426	0.350	112	261	149
12	9		319	319	13337	792	473	0.319	102	252	151
13	10		319	319	14175	842	523	0.290	92	244	152
14	11		319	319	15055	894	576	0.263	84	235	152
15	12		319	319	15973	949	630	0.239	76	227	151
16	13		319	319	16934	1006	687	0.218	69	219	150
17	14	138	319	457	17940	1066	609	0.198	90	211	120
18	15	615	319	934	18994	1128	194	0.180	168	203	35
19	16	2144	319	2463	20099	1194	-1269	0.164	403	195	-207
20	17		361	361	21260	1263	902	0.149	54	188	134
21	18		361	361	22475	1335	974	0.135	49	180	132
22	19		361	361	23746	1411	1050	0.123	44	173	129
23	20		361	361	25076	1489	1129	0.112	40	166	126
24	21		361	361	26464	1572	1211	0.102	37	160	123
25	22		361	361	27909	1658	1297	0.092	33	153	120
26	23		361	361	29358	1744	1383	0.084	30	146	116
27	24		361	361	30459	1809	1449	0.076	28	138	110
28	25		361	361	31473	1870	1509	0.069	25	130	105
29	26		361	361	32475	1929	1568	0.063	23	122	99
30	27		361	361	33459	1987	1627	0.057	21	114	93
31	28		361	361	34443	2046	1685	0.052	19	107	88
32	29		361	361	35357	2100	1739	0.047	17	99	82
33	30		361	361	35357	2100	1739	0.043	16	90	75
34	31		361	361	35357	2100	1739	0.039	14	82	68
35	32		361	361	35357	2100	1739	0.036	13	75	62
36	33		361	361	35357	2100	1739	0.032	12	68	56
37	34		361	361	35357	2100	1739	0.029	11	62	51
38	35		361	361	35357	2100	1739	0.027	10	56	47
39	36		361	361	35357	2100	1739	0.024	9	51	42
40	37		361	361	35357	2100	1739	0.022	8	46	38
41	38		361	361	35357	2100	1739	0.020	7	42	35
42	39		361	361	35357	2100	1739	0.018	7	38	32
43	40		361	361	35357	2100	1739	0.017	6	35	29
		9482	13185	22667	976226	57988	35321		5528	6635	1107

B-C	1107
B/C	1.200
FEDR	14.280%

(2) Variations in FEDR by Sensitivity Analysis

The sensitivity analysis of the PROJECT was made on the following cases.

a) Case in which the amount of investments for the 1st 2,000 kW is counted.

- Variations in Construction Cost

Construction Cost	Up 5%	Up 7%	Up 10%
FEDR (%)	2.368	2.225	2.071

- Variations in Sale Rate

Sale Rate (Kip/kWh)	80	100	130
FEDR (%)	7.157	8.953	11.329

b) Case in which the amount of investments for the 1st 2,000 kW is not counted (regarded as null).

- Variations in Construction Cost

Construction Cost	Up 10%	Up 20%	Up 30%
FEDR (%)	11.80	10.00	8.589

- Variations in Sale Rate

Sale Rate (Kip/kWh)	30	35	40
FEDR (%)	7.416	10.00	12.925

(3) Debt Service Ratios

The debt service ratios were calculated on the following cases.

- Case in which the amount of investments for the 1st 2,000 kW is counted

- Case in which the amount of investments for the 1st 2,000 kW is not counted (regarded as null).

a) Projected Overall Amortization Schedule

  i) Table IV-4-3 shows the projected overall amortization schedule for the case in which the amount of investments for the 1st 2,000 kW is counted.

  ii) Table IV-4-7 shows the projected overall amortization schedule for the case in which the amount of investments for the 1st 2,000 kW is not counted (regarded as null).

b) Profit and Loss Statement and Cash-Flow Sheet

  i) Table IV-4-5 through Table IV-4-6 give the Profit and Loss Statement and Cash-Flow Sheet for the case in which the amount of investments for the 1st 2,000 kW is counted.

  ii) Table IV-4-8 through Table IV-4-9 give the Profit and Loss Statement and Cash-Flow Sheet for the case in the amount of investments for the 1st 2,000 kW is not counted (regarded as null).

c) Debt Service Ratio

  i) Case in which the amount of investments for the 1st 2,000 kW is counted.

  The debt service ratios for the above case are laid out in Table IV-4-10. The average debt service ratio during the respective 10 years counted from the commissioning of the plant is as given hereunder:

10th year from the commissioning:	0.53
20th year from the commissioning:	0.51
30th year from the commissioning:	0.75

40th year from the commissioning: 1.16

ii) Case in which the amount of investments is not counted (regarded as null).

The debt service ratios for this case are laid out in Table IV-4-11. The average debt service ratio during the respective 10 years counted from the commissioning of the plant is as given hereunder:

10th year from the commissioning: 1.73
20th year from the commissioning: 0.74
30th year from the commissioning: 0.97
40th year from the commissioning: 1.49

Table IV-4-3 Overall Amortization Schedule for 6000kW
(In case of counting the amount of investments for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	Year after Co-mmision.	Loan FC	Loan LC	Loan Total	Repayment FC	Repayment LC	Repayment Total	Interest Amount IDC FC	Interest Amount IDC LC	Interest Amount IDC Total	Working Interest FC	Working Interest LC	Total
1		628	77	705				2	2	5			
2		6577	1511	8088				29	52	82			
3		5898	703	6601				76	122	198			
4	1										98	144	243
5	2										98	144	243
6	3										98	144	243
7	4	302	10	312				10	0	10	98	144	243
8	5	2831	192	3023				113	7	121	98	144	243
9	6	3150	100	3250				311	18	328	98	144	243
10	7										513	165	678
11	8				655	115	770				510	162	672
12	9				655	115	770				506	155	660
13	10				655	115	770				501	147	648
14	11				969	130	1099				485	140	625
15	12				969	130	1099				460	131	591
16	13				969	130	1099				434	123	557
17	14	137	1	138	969	130	1099	5	0	5	408	115	523
18	15	610	5	615	969	130	1099	29	0	29	383	107	489
19	16	2129	15	2144	969	130	1099	120	1	120	357	98	455
20	17				969	130	1099				521	91	613
21	18				969	130	1099				496	83	579
22	19				969	130	1099				470	75	545
23	20				969	130	1099				444	67	511
24	21				1113	131	1244				414	58	472
25	22				1113	131	1244				379	50	429
26	23				1113	131	1244				344	42	385
27	24				1113	131	1244				309	33	342
28	25				1113	131	1244				273	25	298
29	26				1113	131	1244				238	17	255
30	27				1113	131	1244				203	8	211
31	28				458	16	474				170	4	174
32	29				458	16	474				140	2	143
33	30				458	16	474				110	1	111
34	31				144	1	145				90	1	91
35	32				144	1	145				81	1	81
36	33				144	1	145				71	1	72
37	34				144	1	145				62	0	62
38	35				144	1	145				52	0	53
39	36				144	1	145				43	0	43
40	37				144	1	145				33	0	33
41	38				144	1	145				24	0	24
42	39				144	1	145				14	0	14
43	40				144	1	145				5	0	5
Total		22262	2613	24875	22262	2613	24875	695	204	899	10134	2769	12903

Table-IV-4-4 Amortization Schedule

FC Portion for 2000kW (a)

(Thousand dollars)

Annual Interest Rate: 0.75%

No. of Year	Disburse-ment	Repay-mentt	Outstand. Begin.	Balance End	Average of Loan	Interest IDC	Work.Int.
1	628		0	628	314	2	
2	6577		628	7205	3917	29	
3	5898		7205	13103	10154	76	
Total	13103		7833	20936	14385	108	
4			13103	13103	13103		98
5			13103	13103	13103		98
6			13103	13103	13103		98
7			13103	13103	13103		98
8			13103	13103	13103		98
9			13103	13103	13103		98
10			13103	13103	13103		98
11		655	13103	12448	12775		96
12		655	12448	11793	12120		91
13		655	11793	11138	11465		86
14		655	11138	10482	10810		81
15		655	10482	9827	10155		76
16		655	9827	9172	9500		71
17		655	9172	8517	8845		66
18		655	8517	7862	8189		61
19		655	7862	7207	7534		57
20		655	7207	6551	6879		52
21		655	6551	5896	6224		47
22		655	5896	5241	5569		42
23		655	5241	4586	4914		37
24		655	4586	3931	4258		32
25		655	3931	3276	3603		27
26		655	3276	2621	2948		22
27		655	2621	1965	2293		17
28		655	1965	1310	1638		12
29		655	1310	655	983		7
30		655	655	-0	328		2
Total		13103					1671

LC Portion for 2000kW (a)

(Thousand dollars)

Annual Interest Rate: 6.30%

No. of Year	Disburse-ment	Repay-mentt	Outstand. Begin.	Balance End	Average of Loan	Interest IDC	Work.Int.
1	77		0	77	39	2	
2	1511		77	1588	833	52	
3	703		1588	2291	1940	122	
Total	2291					177	
4			2291	2291	2291		144
5			2291	2291	2291		144
6			2291	2291	2291		144
7			2291	2291	2291		144
8			2291	2291	2291		144
9			2291	2291	2291		144
10			2291	2291	2291		144
11		115	2291	2176	2234		141
12		115	2176	2062	2119		134
13		115	2062	1947	2005		126
14		115	1947	1833	1890		119
15		115	1833	1718	1776		112
16		115	1718	1604	1661		105
17		115	1604	1489	1546		97
18		115	1489	1375	1432		90
19		115	1375	1260	1317		83
20		115	1260	1145	1203		76
21		115	1145	1031	1088		69
22		115	1031	916	974		61
23		115	916	802	859		54
24		115	802	687	745		47
25		115	687	573	630		40
26		115	573	458	515		32
27		115	458	344	401		25
28		115	344	229	286		18
29		115	229	115	172		11
30		115	115	-0	57		4
Total		2291					2454

FC Portion for 2000kW (b)

(Thousand dollars)

Annual Interest Rate: 6.60%

No. of Year	Disburse-ment	Repay-mentt	Outstand. Begin.	Balance End	Average of Loan	Interest IDC	Work.Int.
7	302		0	302	151	10	
8	2831		302	3133	1718	113	
9	3150		3133	6283	4708	311	
Total	6283					434	
10			6283	6283	6283		415
11			6283	6283	6283		415
12			6283	6283	6283		415
13			6283	6283	6283		415
14		314	6283	5969	6126		404
15		314	5969	5655	5812		384
16		314	5655	5341	5498		363
17		314	5341	5026	5183		342
18		314	5026	4712	4869		321
19		314	4712	4398	4555		301
20		314	4398	4084	4241		280
21		314	4084	3770	3927		259
22		314	3770	3456	3613		238
23		314	3456	3142	3299		218
24		314	3142	2827	2984		197
25		314	2827	2513	2670		176
26		314	2513	2199	2356		156
27		314	2199	1885	2042		135
28		314	1885	1571	1728		114
29		314	1571	1257	1414		93
30		314	1257	942	1100		73
31		314	942	628	785		52
32		314	628	314	471		31
33		314	314	0	157		10
Total		6283					5805

LC Portion for 2000kW (b)

(Thousand dollars)

Annual Interest Rate: 7.00%

No. of Year	Disburse-ment	Repay-mentt	Outstand. Begin.	Balance End	Average of Loan	Interest IDC	Work.Int.
7	10		0	10	5	0	
8	192		10	202	106	7	
9	100		202	302	252	18	
Total	302					25	
10			302	302	302		21
11			302	302	302		21
12			302	302	302		21
13			302	302	302		21
14		15	302	287	294		21
15		15	287	272	279		20
16		15	272	257	264		18
17		15	257	242	249		17
18		15	242	226	234		16
19		15	226	211	219		15
20		15	211	196	204		14
21		15	196	181	189		13
22		15	181	166	174		12
23		15	166	151	159		11
24		15	151	136	143		10
25		15	136	121	128		9
26		15	121	106	113		8
27		15	106	91	98		7
28		15	91	75	83		6
29		15	75	60	68		5
30		15	60	45	53		4
31		15	45	30	38		3
32		15	30	15	23		2
33		15	15	-0	8		1
Total		302					296

FC Portion for 2000kW (c)

(Thousand dollars)

Annual Interest Rate: 6.60%

No. of Year	Disburse-ment	Repay-mentt	Outstand. Begin.	Balance End	Average of Loan	Interest IDC	Work.Int.
17	137		0	137	69	5	
18	610		137	747	442	29	
19	2129		747	2876	1812	120	
Total	2876					153	
20			2876	2876	2876		190
21			2876	2876	2876		190
22			2876	2876	2876		190
23			2876	2876	2876		190
24		144	2876	2732	2804		185
25		144	2732	2588	2660		176
26		144	2588	2445	2517		166
27		144	2445	2301	2373		157
28		144	2301	2157	2229		147
29		144	2157	2013	2085		138
30		144	2013	1869	1941		128
31		144	1869	1726	1797		119
32		144	1726	1582	1654		109
33		144	1582	1438	1510		100
34		144	1438	1294	1366		90
35		144	1294	1150	1222		81
36		144	1150	1007	1078		71
37		144	1007	863	935		62
38		144	863	719	791		52
39		144	719	575	647		43
40		144	575	431	503		33
41		144	431	288	359		24
42		144	288	144	216		14
43		144	144	-0	72		5
Total		2876					2657

LC Portion for 2000kW (c)

(Thousand dollars)

Annual Interest Rate: 7.00%

No. of Year	Disburse-ment	Repay-mentt	Outstand. Begin.	Balance End	Average of Loan	Interest IDC	Work.Int.
17	1		0	1	1	0	
18	5		1	6	3	0	
19	15		6	20	13	1	
Total	20					1	
20			20	20	20		1
21			20	20	20		1
22			20	20	20		1
23			20	20	20		1
24		1	20	19	20		1
25		1	19	18	19		1
26		1	18	17	18		1
27		1	17	16	17		1
28		1	16	15	16		1
29		1	15	14	15		1
30		1	14	13	14		1
31		1	13	12	13		1
32		1	12	11	12		1
33		1	11	10	11		1
34		1	10	9	10		1
35		1	9	8	9		1
36		1	8	7	8		1
37		1	7	6	7		0
38		1	6	5	6		0
39		1	5	4	5		0
40		1	4	3	4		0
41		1	3	2	3		0
42		1	2	1	2		0
43		1	1	0	1		0
Total		20					20

Table IV-4-5 Profit and Loss Statement for 6000kW
(In case of counting the amount of investments for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	Deprecia-tion Year	Operating Revenue	Operating Deprecia-tion	Expense OM	Expense Total	Profit	Financial IDC	Financial Working Interest	Expense Total	Net Pro-fit
1							5		5	-5
2							82		82	-82
3							198		198	-198
4	1	454	392	223	615	-161		243	243	-403
5	2	508	392	223	615	-107		243	243	-350
6	3	542	392	223	615	-73		243	243	-316
7	4	578	392	223	615	-37	10	243	253	-290
8	5	617	392	223	615	1	121	243	363	-362
9	6	657	392	223	615	42	328	243	571	-529
10	7	700	599	319	918	-218		678	678	-896
11	8	745	599	319	918	-173		672	672	-845
12	9	792	599	319	918	-126		660	660	-786
13	10	842	599	319	918	-76		648	648	-724
14	11	894	599	319	918	-24		625	625	-649
15	12	940	599	319	918	31		591	591	-560
16	13	1006	599	319	918	88		557	557	-469
17	14	1066	599	319	918	148	5	523	528	-380
18	15	1128	599	319	918	210	29	489	519	-308
19	16	1194	599	319	918	276	120	455	576	-300
20	17	1263	726	361	1087	176		613	613	-437
21	18	1335	726	361	1087	248		579	579	-331
22	19	1411	726	361	1087	323		545	545	-221
23	20	1489	726	361	1087	402		511	511	-109
24	21	1572	726	361	1087	485		472	472	13
25	22	1658	726	361	1087	571		429	429	142
26	23	1744	726	361	1087	657		385	385	271
27	24	1809	726	361	1087	722		342	342	380
28	25	1870	726	361	1087	782		298	298	484
29	26	1929	726	361	1087	842		255	255	587
30	27	1987	726	361	1087	900		211	211	689
31	28	2046	726	361	1087	959		174	174	785
32	29	2100	726	361	1087	1013		143	143	871
33	30	2100	726	361	1087	1013		111	111	902
34	31	2100	726	361	1087	1013		91	91	922
35	32	2100	726	361	1087	1013		81	81	932
36	33	2100	726	361	1087	1013		72	72	941
37	34	2100	726	361	1087	1013		62	62	951
38	35	2100	726	361	1087	1013		53	53	961
39	36	2100	726	361	1087	1013		43	43	970
40	37	2100	726	361	1087	1013		33	33	980
41	38	2100	726	361	1087	1013		24	24	989
42	39	2100	726	361	1087	1013		14	14	999
43	40	2100	726	361	1087	1013		5	5	1008
Total		57988	25774	13185	38959	19029	899	12903	13802	5227

Table IV-4-6 Cash Flow Sheet for 6000kW
(In case of counting the amount of investments for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	Deprecia-tion Year	CASH INFLOW Invest-ment	Net Profit	Deprecia-tion	Total	CASH OUTFLOW Const. Cost	Repayment of Princ.	Total	Balance Yearly	Accumula.
1		705	-5		700	705		705	-5	-5
2		8088	-82		8006	8088		8088	-82	-87
3		6601	-198		6403	6601		6601	-198	-285
4	1		-403	392	-11			0	-11	-296
5	2		-350	392	42			0	42	-254
6	3		-316	392	76			0	76	-178
7	4	312	-290	392	414	312		312	102	-75
8	5	3023	-362	392	3053	3023		3023	30	-45
9	6	3250	-529	392	3113	3250		3250	-137	-183
10	7		-896	599	-297			0	-297	-480
11	8		-845	599	-246		770	770	-1016	-1496
12	9		-786	599	-187		770	770	-956	-2452
13	10		-724	599	-125		770	770	-895	-3347
14	11		-649	599	-50		1099	1099	-1149	-4495
15	12		-560	599	39		1099	1099	-1060	-5555
16	13		-469	599	130		1099	1099	-969	-6524
17	14	138	-380	599	357	138	1099	1237	-880	-7404
18	15	615	-308	599	905	615	1099	1713	-808	-8213
19	16	2144	-300	599	2443	2144	1099	3242	-800	-9012
20	17		-437	726	289		1099	1099	-810	-9822
21	18		-331	726	395		1099	1099	-704	-10525
22	19		-221	726	505		1099	1099	-594	-11120
23	20		-109	726	618		1099	1099	-481	-11601
24	21		13	726	739		1244	1244	-505	-12106
25	22		142	726	868		1244	1244	-376	-12481
26	23		271	726	998		1244	1244	-246	-12727
27	24		380	726	1107		1244	1244	-137	-12864
28	25		484	726	1210		1244	1244	-33	-12898
29	26		587	726	1313		1244	1244	70	-12828
30	27		689	726	1415		1244	1244	172	-12656
31	28		785	726	1511		474	474	1037	-11619
32	29		871	726	1597		474	474	1123	-10497
33	30		902	726	1628		474	474	1154	-9342
34	31		922	726	1649		145	145	1504	-7839
35	32		932	726	1658		145	145	1513	-6325
36	33		941	726	1668		145	145	1523	-4802
37	34		951	726	1677		145	145	1533	-3270
38	35		961	726	1687		145	145	1542	-1728
39	36		970	726	1696		145	145	1552	-176
40	37		980	726	1706		145	145	1561	1385
41	38		989	726	1716		145	145	1571	2956
42	39		999	726	1725		145	145	1580	4536
43	40		1008	726	1735		145	145	1590	6126
Total		24875	5227	25774	55876	24875	24875	49750	6126	

Table IV-4-7 Overall Amortization Schedule for 6000kW
(In case of counting the amount of investments for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	Year after Commision.	Loan FC	Loan LC	Loan Total	Repayment FC	Repayment LC	Repayment Total	Interest Amount IDC FC	Interest Amount IDC LC	Interest Amount IDC Total	Working Interest FC	Working Interest LC	Total
1													
2													
3													
4	1												
5	2												
6	3												
7	4	302	10	312				10	0	10			
8	5	2831	192	3023				113	7	121			
9	6	3150	100	3250				311	18	328			
10	7										415	21	436
11	8				655						415	21	436
12	9				655						415	21	436
13	10				655						415	21	436
14	11				969	15	984				404	21	425
15	12				969	15	984				384	20	403
16	13				969	15	984				363	18	381
17	14	137	1	138	969	15	984	5	0	5	342	17	360
18	15	610	5	615	969	15	984	29	0	29	321	16	338
19	16	2129	15	2144	969	15	984	120	1	120	301	15	316
20	17				969	15	984				470	16	485
21	18				969	15	984				449	15	464
22	19				969	15	984				428	14	442
23	20				969	159	1128				408	12	420
24	21				1113	16	1129				382	11	393
25	22				1113	16	1129				352	10	362
26	23				1113	16	1129				322	9	331
27	24				1113	16	1129				291	8	299
28	25				1113	16	1129				261	7	268
29	26				1113	16	1129				231	6	237
30	27				1113	16	1129				201	5	205
31	28				458	16	474				170	4	174
32	29				458	16	474				140	2	143
33	30				458	16	474				110	1	111
34	31				144	1	145				90	1	91
35	32				144	1	145				81	1	81
36	33				144	1	145				71	1	72
37	34				144	1	145				62	0	62
38	35				144	1	145				52	0	53
39	36				144	1	145				43	0	43
40	37				144	1	145				33	0	33
41	38				144	1	145				24	0	24
42	39				144	1	145				14	0	14
43	40				144	1	145				5	0	5
Total		9159	322	9481	22262	466	20762	587	27	614	8463	316	8778

Table IV-4-8 Profit and Loss Statement for 6000kW
(In case of regarding the amount of investments as null for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	Deprecia-tion Year	Operating Revenue	Operating Expense: Deprecia-tion	Operating Expense: OM	Operating Expense: Total	Profit	Financial Expense: IDC	Financial Expense: Working Interest	Financial Expense: Total	Net Pro-fit
1										
2										
3										
4	1	454		223	223	231				231
5	2	508		223	223	285				285
6	3	542		223	223	319				319
7	4	578		223	223	355	10		10	345
8	5	617		223	223	393	121		121	273
9	6	657		223	223	434	328		328	105
10	7	700	207	319	526	174		436	436	-262
11	8	745	207	319	526	219		436	436	-217
12	9	792	207	319	526	266		436	436	-170
13	10	842	207	319	526	316		436	436	-120
14	11	894	207	319	526	368		425	425	-57
15	12	949	207	319	526	423		403	403	20
16	13	1006	207	319	526	480		381	381	99
17	14	1066	207	319	526	540	5	360	364	176
18	15	1128	207	319	526	602	29	338	367	235
19	16	1194	207	319	526	668	120	316	436	232
20	17	1263	334	361	695	568		485	485	82
21	18	1335	334	361	695	640		464	464	176
22	19	1411	334	361	695	715		442	442	274
23	20	1489	334	361	695	794		420	420	374
24	21	1572	334	361	695	877		393	393	483
25	22	1658	334	361	695	963		362	362	601
26	23	1744	334	361	695	1049		331	331	718
27	24	1809	334	361	695	1114		299	299	815
28	25	1870	334	361	695	1174		268	268	906
29	26	1929	334	361	695	1234		237	237	997
30	27	1987	334	361	695	1292		205	205	1087
31	28	2046	334	361	695	1351		174	174	1177
32	29	2100	334	361	695	1405		143	143	1263
33	30	2100	334	361	695	1405		111	111	1294
34	31	2100	334	361	695	1405		91	91	1314
35	32	2100	334	361	695	1405		81	81	1324
36	33	2100	334	361	695	1405		72	72	1333
37	34	2100	334	361	695	1405		62	62	1343
38	35	2100	334	361	695	1405		53	53	1353
39	36	2100	334	361	695	1405		43	43	1362
40	37	2100	334	361	695	1405		33	33	1372
41	38	2100	334	361	695	1405		24	24	1381
42	39	2100	334	361	695	1405		14	14	1391
43	40	2100	334	361	695	1405		5	5	1400
Total		57988	10095	13185	23280	34708	614	8778	9392	25316

Table IV-4-9 Cash Flow Sheet for 6000kW
(In case of regarding the amount of investments as null for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	Deprecia-tion Year	Invest-ment	CASH INFLOW Net Profit	CASH INFLOW Deprecia-tion	CASH INFLOW Total	CASH OUTFLOW Const. Cost	CASH OUTFLOW Repayment of Princ.	CASH OUTFLOW Total	Balance Yearly	Balance Accumula.
1								705	-5	-5
2								8088	-82	-87
3								6601	-198	-285
4	1		231		231			0	21	-264
5	2		285		285			0	78	-185
6	3		319		319			0	115	-70
7	4	312	345		657	312		312	144	73
8	5	3023	273		3296	3023		3023	74	147
9	6	3250	105		3355	3250		3250	-90	57
10	7		-262	207	-55			0	-247	-190
11	8		-217	207	-10			770	-963	-1153
12	9		-170	207	38			770	-900	-2053
13	10		-120	207	87			770	-834	-2887
14	11		-57	207	151		984	1099	-1085	-3972
15	12		20	207	227		984	1099	-992	-4964
16	13		99	207	306		984	1099	-897	-5861
17	14	138	176	207	521	138	984	1237	-804	-6665
18	15	615	235	207	1057	615	984	1713	-728	-7393
19	16	2144	232	207	2582	2144	984	3242	-714	-8107
20	17		82	334	417		984	1099	-719	-8827
21	18		176	334	511		984	1099	-608	-9435
22	19		274	334	608		984	1099	-493	-9928
23	20		374	334	709		1128	1099	-375	-10303
24	21		483	334	818		1129	1244	-393	-10695
25	22		601	334	935		1129	1244	-257	-10953
26	23		718	334	1052		1129	1244	-121	-11074
27	24		815	334	1149		1129	1244	-8	-11082
28	25		906	334	1241		1129	1244	100	-10982
29	26		997	334	1332		1129	1244	207	-10774
30	27		1087	334	1421		1129	1244	314	-10461
31	28		1177	334	1511		474	474	1183	-9277
32	29		1263	334	1597		474	474	1273	-8005
33	30		1294	334	1628		474	474	1304	-6700
34	31		1314	334	1649		145	145	1654	-5047
35	32		1324	334	1658		145	145	1663	-3383
36	33		1333	334	1668		145	145	1673	-1710
37	34		1343	334	1677		145	145	1683	-28
38	35		1353	334	1687		145	145	1692	1664
39	36		1362	334	1696		145	145	1702	3366
40	37		1372	334	1706		145	145	1711	5077
41	38		1381	334	1716		145	145	1721	6798
42	39		1391	334	1725		145	145	1730	8528
43	40		1400	334	1735		145	145	1740	10268
Total		9481	25316	10095	44892	9481	20762	49750	10268	

Table IV-4-10 Debt Service Ratio for 6000kW
(In case of counting the amount of investments for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	No. of Deprecia-tion Year	INTERNAL FUND GENERATED Operating Profit	Deprecia-tion	Total	Cumulat. (A)	REPAYMENT OF DEBT Interest	Principal	Total	Cumulat. (B)	Debt Service Ratio (A)/(B)
1		0		0	0	5		5	5	0.00
2		0		0	0	82		82	87	0.00
3		0		0	0	198		198	285	0.00
4	1	-161	392	231	231	243		243	528	0.44
5	2	-107	392	285	516	243		243	770	0.67
6	3	-73	392	319	835	243		243	1013	0.82
7	4	-37	392	355	1190	253		253	1266	0.94
8	5	1	392	393	1584	363		363	1629	0.97
9	6	42	392	434	2017	571		571	2200	0.92
10	7	-218	599	381	2399	678		678	2878	0.83
11	8	-173	599	426	2825	672	770	1442	4321	0.65
12	9	-126	599	473	3298	660	770	1430	5750	0.57
13	10	-76	599	523	3821	648	770	1418	7168	0.53
14	11	-24	599	576	4397	625	1099	1724	8892	0.49
15	12	31	599	630	5027	591	1099	1690	10582	0.48
16	13	88	599	687	5714	557	1099	1656	12239	0.47
17	14	148	599	747	6461	528	1099	1627	13865	0.47
18	15	210	599	809	7271	519	1099	1618	15483	0.47
19	16	276	599	875	8146	576	1099	1675	17158	0.47
20	17	176	726	902	9048	613	1099	1712	18870	0.48
21	18	248	726	974	10022	579	1099	1678	20547	0.49
22	19	323	726	1050	11072	545	1099	1644	22191	0.50
23	20	402	726	1129	12200	511	1099	1610	23801	0.51
24	21	485	726	1211	13412	472	1244	1716	25517	0.53
25	22	571	726	1297	14709	429	1244	1673	27190	0.54
26	23	657	726	1383	16092	385	1244	1629	28819	0.56
27	24	722	726	1449	17540	342	1244	1586	30405	0.58
28	25	782	726	1509	19049	298	1244	1542	31947	0.60
29	26	842	726	1568	20617	255	1244	1499	33445	0.62
30	27	900	726	1627	22244	211	1244	1455	34900	0.64
31	28	959	726	1685	23929	174	474	648	35549	0.67
32	29	1013	726	1739	25669	143	474	617	36165	0.71
33	30	1013	726	1739	27408	111	474	585	36751	0.75
34	31	1013	726	1739	29148	91	145	236	36986	0.79
35	32	1013	726	1739	30887	81	145	226	37212	0.83
36	33	1013	726	1739	32626	72	145	217	37429	0.87
37	34	1013	726	1739	34366	62	145	207	37636	0.91
38	35	1013	726	1739	36105	53	145	197	37833	0.95
39	36	1013	726	1739	37845	43	145	188	38021	1.00
40	37	1013	726	1739	39584	33	145	178	38199	1.04
41	38	1013	726	1739	41324	24	145	169	38368	1.08
42	39	1013	726	1739	43063	14	145	159	38527	1.12
43	40	1013	726	1739	44803	5	145	150	38677	1.16
	Total	19029	25774	44803		13802	24875	38677		

Table IV-4-11 Debt Service Ratio for 6000kW
(In case of regarding the amount of investments as null for 1st 2000kW)

(Thousand dollars)

Serial No. of Year	No. of Deprecia-tion Year	INTERNAL FUND GENERATED Operating Profit	Deprecia-tion	Total	Cumulat. (A)	REPAYMENT OF DEBT Interest	Principal	Total	Cumulat. (B)	Debt Service Ratio (A)/(B)
1										
2										
3										
4	1	231		231	231			0	0	
5	2	285		285	516			0	0	
6	3	319		319	835			0	0	
7	4	355		355	1190	10		10	10	115.37
8	5	393		393	1584	121		121	131	12.08
9	6	434		434	2017	328		328	459	4.39
10	7	174	207	381	2399	436		436	895	2.68
11	8	219	207	426	2825	436		436	1331	2.12
12	9	266	207	473	3298	436		436	1767	1.87
13	10	316	207	523	3821	436		436	2203	1.73
14	11	368	207	576	4397	425	984	1409	3612	1.22
15	12	423	207	630	5027	403	984	1388	5000	1.01
16	13	480	207	687	5714	381	984	1366	6365	0.90
17	14	540	207	747	6461	364	984	1349	7714	0.84
18	15	602	207	809	7271	367	984	1352	9065	0.80
19	16	668	207	875	8146	436	984	1421	10486	0.78
20	17	568	334	902	9048	485	984	1470	11956	0.76
21	18	640	334	974	10022	464	984	1448	13404	0.75
22	19	715	334	1050	11072	442	984	1426	14830	0.75
23	20	794	334	1129	12201	420	1128	1548	16378	0.74
24	21	877	334	1211	13412	393	1129	1523	17901	0.75
25	22	963	334	1297	14709	362	1129	1491	19392	0.76
26	23	1049	334	1383	16092	331	1129	1460	20852	0.77
27	24	1114	334	1449	17540	299	1129	1429	22281	0.79
28	25	1174	334	1509	19049	268	1129	1397	23678	0.80
29	26	1234	334	1568	20617	237	1129	1366	25044	0.82
30	27	1292	334	1627	22244	205	1129	1335	26379	0.84
31	28	1351	334	1685	23929	174	474	648	27027	0.89
32	29	1405	334	1739	25669	143	474	617	27643	0.93
33	30	1405	334	1739	27408	111	474	585	28229	0.97
34	31	1405	334	1739	29148	91	145	236	28464	1.02
35	32	1405	334	1739	30887	81	145	226	28690	1.08
36	33	1405	334	1739	32627	72	145	217	28907	1.13
37	34	1405	334	1739	34366	62	145	207	29114	1.18
38	35	1405	334	1739	36106	53	145	197	29311	1.23
39	36	1405	334	1739	37845	43	145	188	29499	1.28
40	37	1405	334	1739	39585	33	145	178	29677	1.33
41	38	1405	334	1739	41324	24	145	169	29846	1.38
42	39	1405	334	1739	43064	14	145	159	30005	1.44
43	40	1405	334	1739	44803	5	145	150	30155	1.49
	Total	34708	10095	44803		9392	20762	30155		

(4) Generating Cost

A generating cost equaling to and comparable with a "manufacturing cost" of goods will be an important factor for electricity utilities in determining their sale rate(s). In this sense, average generating costs/kWh of the hydro power plant and associated equipment and facilities over the service life of 40 years have been calculated as follows for the two (2) cases:

a) Case in which the amount of investments for the 1st 2,000 kW is counted.

<u>Total Quantity of Generated Energy over 40 Years</u>	:	1,015,844 MWh
• Depreciation Amount	:	$25,773 \times 10^3$\$ (= Construction Cost; $24,875 \times 10^3$\$ + IDC; 898×10^3\$)
• Working Interest	:	$12,903 \times 10^3$\$
• Operation and Maintenance Cost	:	$13,185 \times 10^3$\$
Total		$51,861 \times 10^3$\$

$51,861 \times 10^3$\$/($1,015,844 \times 10^3$kWh) = \$0.0511/kWh (= Kip 35.74)

b) Case in which the amount of investments is not counted (regarded as null).

<u>Total Quantity of Generated Energy over 40 Years</u>	:	1,015,844 MWh
• Depreciation Amount	:	$10,094 \times 10^3$\$ (= Construction Cost; $9,481 \times 10^3$\$ + IDC; 613×10^3\$)
• Working Interest	:	$8,778 \times 10^3$\$
• Operation and Maintenance Cost	:	$13,185 \times 10^3$\$
Total		$32,057 \times 10^3$\$

$32,057 \times 10^3$\$/($1,015,844 \times 10^3$kWh) = \$0.0316/kWh (= Kip 22.09)

4.2 Conclusions of Financial Analysis

It can hardly be said that this PROJECT is financially sound in terms of the equalizing discount rate. It will be indispensable to rely upon the specially arranged most favoured fund accommodation for construction of the first 2,000 kW plant in order that FEDR of the PROJECT can exceed the social discount rate of 10% which the Lao side has as its criterion in project evaluation.

When viewed from the standpoint of power utilities, it is essential that an ample amount of revenue be obtained through the materialization of the PROJECT. Under the sale rate of 42 Kip taken up in this Study, profitability obtainable from sales of energy is quite severe. A great increase in the sale rate will be necessary for improving this profitability. If such hike should be avoided, it will be necessary to obtain specially arranged most favoured funds for the construction of the 2,000 kW plant at the first stage and borrow funds at the lowest rate as much as possible for the construction of 2,000 kW plant each in the second and third stages.

5. Environment

Chapter IV 5. Environment

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5. Environment

5.1 General

5.1.1 General Description of Project Area

Champassak Province is one of the larger provinces in the southern Laos and the area of this province lying east of the Mekong River is bounded on the north by Xe Don River and on the east and southeast by the Xe Kong River. East of Pakse there is spread out the vast Bolaven plateau.

The Bolaven plateau is a conical shaped lava tableland, the elevation of which reaches EL. 1,000 m, the highest peak being as high as 1,716 m. The area of the plateau higher than EL. 500 m is estimated to be approximately 4,500 km^2. The watersheds of the rivers and streams running through the Bolaven plateau are mostly covered by good-quality, natural, tropical deciduous and semi-deciduous seasonal trees. Savanna areas with scrub trees are seen at top areas of the tableland. The Bolaven plateau is the source of numerous tributaries and torrents which feed the Xe Don River and the Xe Kong River which are major tributaries of the Mekong River, and is favored with abundant water resources and hydroelectric potentials.

The rainy season in this area is, in general, from May to October and the dry season from November to April. The average annual rainfall from 1984 to 1990 is approximately 2,500 mm at Nikhon 34 station (EL 1,150 m) close to the Xe Katam River basin. The maximum record of monthly mean temperature was 21.3°C in July and the minimum 15.8°C in January.

5.1.2 Basic Concept of Central Lao Government Regarding Environment

The Lao Central Government, in view of the importance of environmental issues, has deepened its interest in protection and preservation of forest resources, wildlife and water resources.

At present, the Central Government is preparing the inventory of forests from a view point of conservation of the environment and also undertaking the

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program or activity to preserve wildlife, as well as preparation of environmental regulations or codes. While the provincial offices, in line with the basic concept of the Central Government, are providing administrative guidance to villagers to limit the slash-and-burn farming to the minimum extent and to maintain natural resources in good condition as much as possible by methods such as forestation programs and settled agriculture.

5.1.3 Xe Katam Small-scale Hydroelectric Power Development Project and Environmental Setting

The Xe Katam Small-scale Hydroelectric Project is planned near the confluence of the Xe Namnoy River which is a tributary of the Xe Kong River and the Xe Katam River.

The diversion site proposed on the Xe Katam River is located 1,000 m upstream of the abovementioned confluence. Immediately downstream of this site there are two waterfalls, the one is small with about 20 m in its cascade and another is large of about 100 m in its head. The powerstation is planned on the Xe Namnoy River at a point approximately 400 m upstream of the confluence. The diversion site and the power station will be connected by a headrace tunnel of approximately 320 m.

The discharge after power generation will be immediately returned to the Xe Namnoy River. The river section affected by diverting water for power generation will be only the approximately 1,000 m from the diversion site on the Xe Katam River to the junction point. Water use for irrigation, drinking water, fishing, etc. is not found at present in this section. Further, the projected sites for the diversion, headrace tunnel, powerstation, transmission line, etc. and their vicinities - project area- are covered by natural tropical forests, and there are no villages nor cultivated fields. Accordingly, there will be no occurrence of troubles concerning moving of residents, loss of property and compensation.

Thus, since the scales of the structures comprising the Project are small and the impact on the river system is limited, the negative impact on the natural environment such as wildlife, forest resources, water resources, etc. due to the Project implementation will be extremely limited. There seems to be no prominent loss to cultivated fields and properties directly affected by the Project implementation.

It is imagined however that at the stage of construction of the Project, various negative impacts will occur during a limited period and in a limited area accompanying execution of construction works.

At the stages of construction works and operation of the power station, frequent exchanges between villagers will start to occur such as trading of various commodities including construction materials which did not exist prior to the Project in this area.

Such socio-economic activities will have considerable impact on the conventional concept of value among residents, and as a result, this may bring about changes in the daily pattern of living of the residents.

5.2 Natural Environmental Setting of Project Area

5.2.1 Forests and Vegetation in the Xe Katam River Basin

The left-bank watershed of the Xe Katam River, compared with the right-bank basin, generally comprises steep slopes, and these slopes continue up to the highest ridge from where the Xe Katam River rises.

At the right-bank watershed extending to the west and southwest of the Xe Katam River, except for the steep riparian areas along the Xe Katam, there are spreads of hills and plains with gentle relief at elevations of 800 to 1,000 m.

The mountainous basin, other than the plains used for agriculture and livestock raising, is covered by natural tropical deciduous seasonal forests or semi-deciduous seasonal forests with a dense or closed canopy of trees.

The forests consist of various species of trees, tall ones from 20 to 30 m high, middle and short 10 m and under.

The principal tree species are as listed in Table IV-5-1. Included along these are trees with commercial values corresponding to Grades 1, 2, and 3 in the lumber standard of Lao. The groves of tall bamboo are seen here and there in the Xe Namnoy and Xe Katam basins. So far as in the Xe Katam River basin where the reconnaissances were made in December 1990 and July 1991, trees fortunately have not been cut down in that area up to the present and verdant natural forests have been preserved untouched. However, it is reported by the aerial observation that farmlands reclaimed by slash-and-burn are distributed here and there in the watershed of Xe Katam River.

The central and local governments have undertaken campaign with strict control to villagers not to make slash-and-burn farming in verdant forest areas. As a result, acreage of farmland opened by means of slash-and-burn in Paksong District has decreased to approximately 300 ha in 1990/1991 which is a half of 700 ha in 1989/1990.

5.2.2 Wildlife in the Xe Katam and Xe Namnoy River Basins

It has been indicated by the survey of the Mekong Committee conducted in 1970 that 1,121 species of wildlife animals inhabit in the whole lower basin of Mekong River, and that there was possibility of precious species such as Kouprey and Douc Lungur live in this area. The Mekong Committee expressed strong interest in preservation of these wildlife animals.

There is a simple air-strip near Ban Houaykong. As the noise of airplanes is reduced in recent years, it seems that the environmental conditions for wildlife animals is returning better.

It is reported that mammals such as elephants, tigers, wild pigs, deer, monkey and hares, reptiles such as cobras, and various kinds of fowl inhabit in the Xe Katam and Xe Namnoy river basins at present.

Shooting and catching are not allowed by the ministry of agriculture for the animals which have become reduced in number and have been endangered recently. The wildlife animals among them deemed to inhabit in the said basins are as listed below. Of the wildlife animals, endangered elephant has been strictly protected from shooting in this region.

Pygmy Loris,	Asia Elephant,	Francois Langur,
Gaur,	Black Gibbon,	Banteng,
Tigar,	Leopard,	etc.

5.2.3 Fish and Shellfish in the Xe Katam and Xe Namnoy Rivers

According to the results of reconnaissances, fish and shellfish inhabiting in the Xe Katam and Xe Namnoy Rivers in the project area and the vicinity are few, both in variety and number. The names of fishes found in the two rivers are given in Table IV-5-2.

There are a small waterfall and a large waterfall, head of which is as high as about 20 m and 100 m respectively located approximately 700 m upstream from the confluence of the Xe Katam and Xe Namnoy Rivers. It may be said that these waterfalls act as a great obstacle to movement of fish between the two river systems.

The main sources of protein of the people in villages of the neighboring area are domestic fowl and small- to medium-sized animals. It is unlikely that fish is considered to be an important protein resource for villagers.

5.2.4 Water Resource of the Xe Katam River and Aquatic Impact

The catchment area at the diversion site is 290 km^2, and the annual average runoff is approximately 290 MCM (average runoff 9.2 m^3/sec). The gradient of the Xe Katam River in this vicinity is from 1/50 to 1/60 and the width of river bed at normal water level is estimated to be about 30 m. Gravels and boulders of basalt and/or shale are deposited over the river bed from upstream to downstream stretches.

According to the field investigations carried out in December of 1990 and July of 1991, the river water seems to be clear and odorless with no suspended sediment and the temperature was about 20°C. Table IV-5-3 indicates the results of quality analysis of the water collected in the Xe Namnoy and Xe Katam Rivers.

Water for power generation diverted from the Xe Katam River will be released into the Xe Namnoy River approximately 400 m upstream of the junction of the two rivers. The distance between the proposed diversion site and the confluence of the two rivers is approximately 1,000 m, and there may generally, be only a slight effect on the flow condition at this stretch due to intake the water for power generation.

However, in the driest season, water at the small fall and the adjacent large fall, which are respectively located immediate downstream of the intake structure, would be almost lost so that the present beauty of the falls might be diminished. Since there is no access to the said falls in the remote area, it is not regarded to be sightseeing spot up to the present.

Water use for irrigation, drinking, etc., does not presently exist, while the water diverted for power generation will immediately be returned. It is considered there will be no prominent negative impact on water resource.

5.3 Socio-economic Environmental Setting of Project Area

5.3.1 Village, Ethnic Group and Population

An area of gentle relief between elevations of 700 and 900 m is spread out to the west of the project area, and in this area are scattered 22 villages. The collection of these 22 villages makes up an administrative unit called a khet, and this unit belongs to Administrative District No. 5, Paksong District, Champassak Province.

The total number of households in this khet is 1,075, with the population being 5,052 (as of December 1990). Of this population, the labor force between ages of 16 and 50 numbers about 1,700.

It is reported that 10 ethnic groups are living in this khet. Two of them which are major may be said to be the Lavine and Nga Heun. Information concerning the villages of this khet is given in Table IV-5-4.

5.3.2 Land Use and Agriculture

Almost all of the people living in this khet are engaged in agriculture for their livelihood. Cultivated land is mostly used for growing coffee and rice. These farmlands were originally reclaimed from the forest by means of slash-and-burn.

Almost all farmlands developed in this way are used for upland rice planting during the first one (1) year, after which they are converted to coffee fields. This method is different from conventional "shifting agriculture", by which burned lands reduce their productivity and are thereafter abandoned and thus forests are opened up one after another. Therefore, it may be said that the method adopted here will be along the lines of settled agriculture aimed at by the Central Government.

Since it takes about five years for coffee trees to grow to the productive ones, it is likely that some of villagers practice slash-and-burn farming for rice plating in order to get their food during the said period. While, the central and local governments, for the purpose of preserving good forests and keeping the environment impact minimum, have repeatedly undertaken their campaign to the villagers to open un-used swamp or depressed areas into paddy fields and/or low grade forests into rice fields as much as possible which give less impact on the environment.

Coffee fields amounted to 500.8 ha in area as of 1990, of which 265 ha were productive fields, the remainder still consisting of young non-productive shrubs. The production of coffee beans in 1989 was 220 tons, and sold in markets such as at Pakse for 350 to 380 kp. per kilogram, which is the only cash earning source for the villagers.

Next to coffee, the area is regarded to be rice producing zone in the Bolaven plateau and more than 30% of villagers are engaged in the rice (paddy and upland) production. Rice (upland rice and paddy) is grown for the purpose of home consumption and the cultivated area was about 442 ha including 388 ha reclaimed by slash-and-burn method as of 1990 . It is said more than 80% of the area is planned to be converted to coffee fields.

The average yield of rice in the area is 0.8 to 1.0 ton/ha. It is said in the area that average 1.5 ton/ha of paddy can be expected in case the settled agricultural practice be executed. Farmers also raise chicken, pigs, cattle, and horses on a small scale.

Promotion of cattle husbandry seems important in this area in order to improve nutrient conditions and to enhance living standard of the villagers.

5.3.3 Endemic Diseases and Medical Facilities

The main endemic disease in this region is malaria. Population afflicted was reported to be not more than 3% in 1986, 1987 and 1988 and the malaria was outbroken and spread in the entire country in May, June and July of 1991. The affliction of malaria in this region was also greatly increased in the simultaneous period since that in 1989. Because this region is at elevations from 700 to 900 m and the temperature is relatively low, the rate of affliction is low compared with other regions of Laos. The ratio of the population suffering from malaria has been declining year by year due to increases in preventive injections. However, the outbreak of malaria with high rate has been still seen periodically.

It is said that the diseases caused by parasites are not such serious problems compared with other regions of Laos. Recently malignant diarrhea and various diseases caused by insufficient nutrition have been outbroken in the children of the villages.

First aid stations have been provided at 13 places in this khet, but there is an extreme shortage of medical staff. A medical facility playing a central role in this region is located at Ban Houaykong, where three medical staff are stationed to be engaged in medical services.

5.3.4 Education

There are eleven 3-year and five 5-year elementary schools, and two middle schools in this khet. It was learned in interviews at a school at Ban Latsasin and Ban Houaykong that the percentage of school attendance of children of the villages is 70 ~ 80%, which means that the rate of school attendance is fairly high in this region.

5.3.5 Social Infrastructure and Trading Situation in the Region

Paksong, located at the center of the Bolaven Plateau, and Pakse, one of the largest cities of Laos next to the capital city of Vientiane, are connected by National Highway No. 23.

There is an arterial road still unpaved leading further east from Paksong to Ban Houaykong, the center of Administrative District No. 5. The distance between Paksong and Ban Houaykong requires 3 to 4 hours by automobile even in the dry season. There are sections of road in this stretch which are poorly maintained in the vicinity of Paksong, and traffic-particularly in the rainy season - is extremely difficult.

There are also routes to Paksong and Ban Houaykong going via Laongam located to the north of the Bolaven Plateau, but trafficable access roads from Sekong and Attapeu do not exist at present. A road network passable for small- and medium-sized trucks has been prepared within the khet.

This khet does not yet provide an electric power supply system, let alone telecommunications facilities such as microwave.
Only several households provide privately-owned gasoline generators operated for a mere 2 to 2.5 hours in the nighttime. Energy for cooking depends on firewood and dry twigs collected from nearby woodlands.

Scheduled buses ran between Pakse and Ban Houaykong every other day providing an extremely useful means of transportation, communication and trade at the reconnaissance time in December of 1990. Mainly agricultural products were transported out to Pakse and elsewhere using these buses, while from Pakse and