

LAO PEOPLE'S DEMOCRATIC REPUBLIC

BASIC DESIGN STUDY REPORT
ON
REHABILITATION PROJECT
OF
SUBSTATIONS IN VIENTIANE AREA

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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BASIC DESIGN STUDY REPORT

ON

REHABILITATION PROJECT

OF

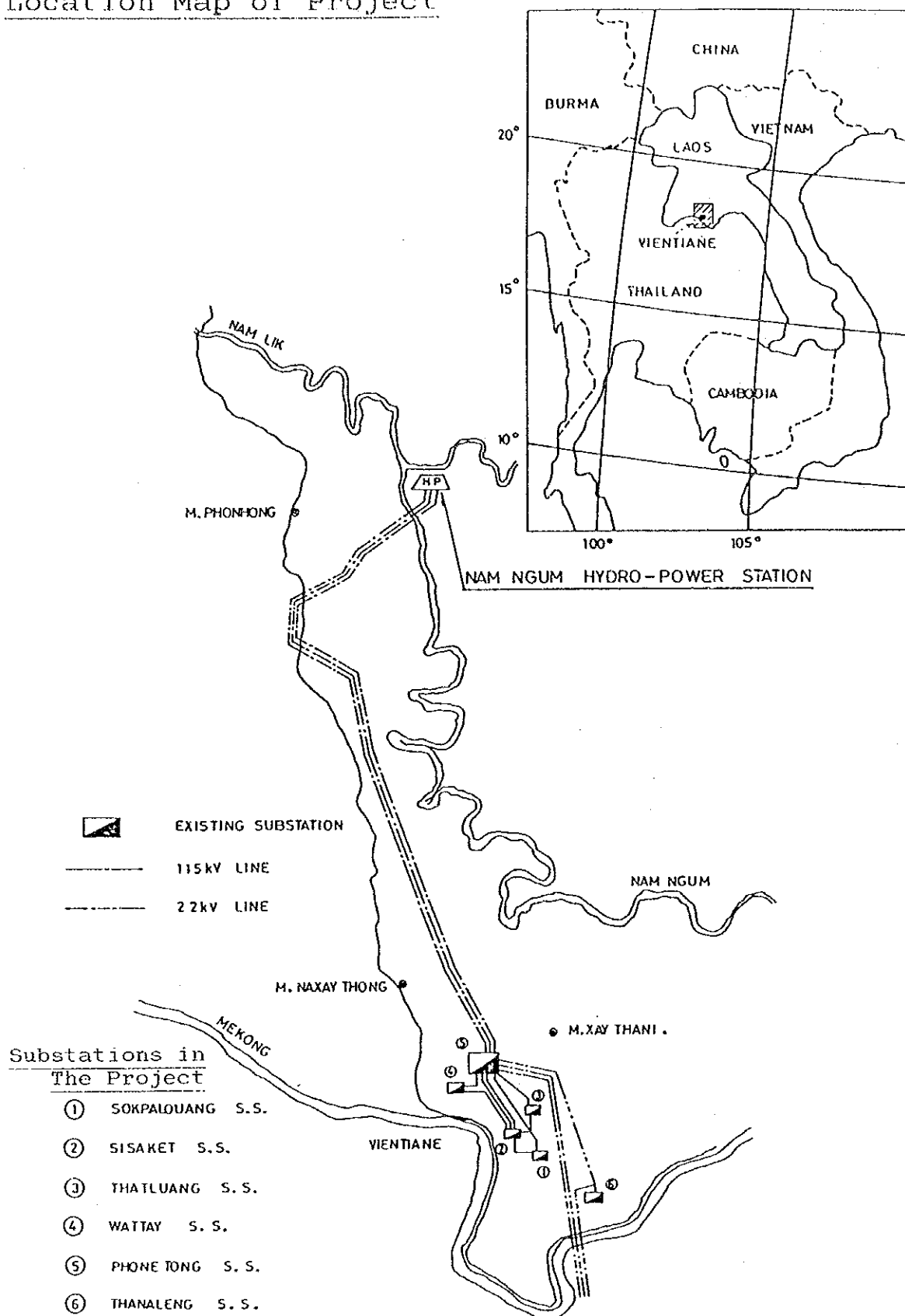
SUBSTATIONS IN VIENTIANE AREA

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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Location Map of Project



P R E F A C E

In response to the request of the Government of Lao People's Democratic Republic, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Substations in Vientiane District and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Lao People's Democratic Republic a study team headed by Mr. Hiroshi Manabe, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs from December 8 to December 27, 1985.

The team had discussions on the Project with the officials concerned of the Government of Lao People's Democratic Republic and conducted a field survey in the Vientiane area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Lao People's Democratic Republic for their close cooperation extended to the team.

March, 1986

A handwritten signature in black ink, appearing to read 'Keisuke Arita', written in a cursive style.

Keisuke Arita

President

Japan International Cooperation Agency

SUMMARY

The Government of Lao People's Democratic Republic (Lao PDR) aims, in the second Five-Year plan from 1986 to 1990, at obtaining the self-sufficiency of food and improvement in the balance of payment by the effective utilization of domestic resources.

In formulating the Plan, the Government lays importance on the consolidation of infrastructures and especially of hydroelectric power plants for the purpose of:-

- meeting increasing demand of electric power
- stabilizing income from export of electric power and improving imbalance of export and import of the country
- preserving of the forest resources by reducing firewood production

It is reported that Lao PDR has a very large potential for hydroelectric power of about 42,000 MW, but the power developed by December 1985 was only 153 MW which is equivalent to only 0.4 per cent of the potential. At present the total installed capacity of generating facilities in the country is 163 MW, out of which 93.8 per cent (153 MW) are from hydroelectric plants and 6.2 per cent (10 MW) are from diesel generating plants.

Most of electric power generated in the first Nam Ngum hydroelectric power station is delivered to the Vientiane area through the existing six (6) substations and to Thailand.

Those six (6) substations in the Vientiane area were built 7 to 16 years ago. The equipment and their ancillaries installed in the substations are extremely deteriorated and some of the equipment are left without repair due to shortage of maintenance materials and tools.

Under such conditions of substations, frequent shutdowns and sharp voltage drops have occurred in the Vientiane area. As a result, unstable supply of electric power to the consumers took place. Development of agriculture and industries in the country was also hindered.

Domestic electric-energy demand of the country is concentrated in the Vientiane area where the most projects of industrial and agricultural development are programmed.

The remaining energy besides the consumed in the Vientiane area is exported to Thailand through both Phone Tong and Thanaleng substations. The receipts from the exported electric power have account for 60 to 80 per cent of the total amount of national export and greatly contributed to the financial condition of the country.

Thus, such unstable operation of substations will result in not only slowing down of agricultural and industrial development but also decrease of export of electric power.

In order to improve such conditions, the Government of Lao PDR intended to rehabilitate the substations in the Vientiane area.

However, under such financial conditions of the country that the average annual deficit during the period from 1980 to 1984 amounted to US\$ 93 million and the deficits have been covered by external assistances, the Government could not afford to manage the rehabilitation.

Taking into account of the financial condition and the facts that most of the equipment installed in the first Nam Ngum power station and main substations in the Vientiane area were Japanese products, the Government of Lao PDR requested the Government of Japan to rehabilitate the substations under Japan's Grant Aid Program.

In response to the request, the Government of Japan decided to conduct a basic design study on the project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Lao PDR a study team from December 8 to December 27, 1985. The team conducted a field survey on those substations and discussed with officials of the authority concerned of Lao PDR, Electricite du Lao (EDL), for investigation of the actual conditions of equipment, confirmation of the details of the request and preparation of the basic design. Through the field survey, the team ascertained that the request of the Government of Lao PDR was reasonable.

In addition to the above-mentioned rehabilitation, it is found by the team that supply of maintenance materials and training of EDL's operators are also necessary for proper operation and maintenance of the substations in order to prevent the similar defects in future.

Major objectives of the project are (a) restoration of the proper functions of the existing substations, (b) implementation for preventive measures to faults on substations and to deterioration of equipment and (c) assurance of proper maintenance of equipment.

Basic design on the equipment except for the special equipment is prepared under the following criteria:-

- (1) Japanese Industrial Standards will be applied for manufacturing the equipment, since there are no specific standards in Lao PDR at present and all equipment under the project will be Japanese product.
- (2) Such equipment as those whose spare parts are difficult to obtain will be replaced with new equipment in consideration of easy maintenance in future.
- (3) The extremely complicated model of equipment will not be used for the reason of unfamiliar operation and maintenance.
- (4) Local products will be used as much as possible.

During the rehabilitation processes, shutdowns on the substations and lines will be required. However, no serious hindrances to the customers will be caused, because the shortage will be made up by other substations. The export of electric power will also not be affected during the works on 115 kV equipment, since 3 circuits of 115 kV transmission line can be alternatively shutdown.

Thus, the rehabilitation processes will be achieved without interruption of supply of electric power to the local customers and Thailand.

Taking account of the above conditions, the scope of the project is summarized as follows:-

- (1) Supply, installation, adjustment and test of substation equipment.
- (2) Supply, installation, adjustment and test of tele-supervisory and tele-communication equipment
- (3) Supply of materials and tools for maintenance use
- (4) Training for EDL's workers on operation and maintenance of substations

The total construction period is estimated to take 21 months from the conclusion of the Exchange of Notes by both Governments.

The Government of Lao PDR appointed EDL as the Executing Agency of the project and EDL organizes a new department for the smooth implementation of the project.

EDL is solely responsible for the whole field of electric power in Lao PDR including planning, construction, operation and maintenance of power stations, transmission lines, substations and distribution lines as well as electric power trade with Thailand since the founding of electric power business in the country. Operation and maintenance of the substations related with the project will be carried out by EDL after the rehabilitation project is completed.

EDL is the biggest public service cooperation in the country having about 1,500 employees as well as an in-house training school and a concrete pole manufacturing factory in its organization. EDL's receipts for exported electric power have contributed to the country's finance in great amount. Under such states, it is obvious that EDL will be able to manage the project satisfactorily as an executing agency.

It is noted that since all equipment, apparatus and materials are to be supplied and installed by Japanese consultant and contractor under Japan's Grant Aid Program, no financial burden will

be born by Lao PDR for the implementation of the project and no extra cost will be required for operation and maintenance of EDL after completion of the project, because the same operators and maintenance crew will continue their duties.

Upon completion of the project, the comprehensive functions of the substations will be fully restored and the maintenance works will be much improved. Completion of the project will result in the stable supply of qualified electric power made possible by prevention of faults on equipment and improved maintenance and will give the following effects to the country.

- (1) Contribution to public welfare by maintaining less voltage drop, less voltage fluctuation and less blackout.
- (2) Promotion of agricultural, forestry and manufacturing industries development by stable and rich power supply.
- (3) Continuation of stable energy export for acquisition of foreign currency.

Thus, innumerable benefits are expected to be created by the implementation of the project. The project, in this regard, has a great significance in being implemented under the Grant Aid Program of the Japanese Government.

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CHAPTER 1 INTRODUCTION

All the electric energy demanded in the Vientiane (the capital of Lao PDR) area is supplied by the first Nam Ngum hydro-power station located at about 70 km to the north of Vientiane city.

The power station was completed in December, 1971 with 2 units of 15 MW and then additional 2 units of 40 MW were installed in 1978 and another unit of 40 MW in December, 1985 increasing its total installed capacity to 150 MW.

Since the power station started its operation, the electric power generated there had been transmitted to the Vientiane area by 3 circuits of 115 kV overhead transmission lines to meet the electric power demand of this area, and the surplus electric power after consumption in the area has been exported to Thailand by the extended 3 circuits of 115 kV transmission lines over Mekong river interconnecting with the transmission system of the Electricity Generating Authority of Thailand.

The annual receipts for the exported electric power account for about 80% of the whole export income of the country.

There are six (6) substations in the area, and they are supplying electric power from the first Nam Ngum power station to the customers in the area and further to Thailand.

The substations started their operations 7 to 16 years ago. Most of the equipment installed in the substations are extremely deteriorated and some faulty equipment are left at the site without repair because there are no spare parts. The conditions are causing serious interruptions for power supply to the customers in the area and possibility of failure to electric power export to Thailand.

From such situation, the Government of Lao PDR requested the Government of Japan to rehabilitate those substations under the grant aid program, since the financial state of the country is tight.

The request is made on rehabilitation of the existing substation equipment, replacement of faulty equipment, installation of additional equipment and also rehabilitation and replacement of tele-metering, tele-signalling and tele-communication equipment.

In response to the request, the Government of Japan sent a basic design study team headed by Mr. H. Manabe from December 8, 1985 to December 27, 1985 through Japan International Cooperation Agency (JICA). The team discussed with Electricite du Lao (EDL), the executing agency of the project in Lao PDR, carried out the investigation on the substations and collected data, records and information necessary for the basic design study.

Member list of the study team, schedule of the team, collected informations, minutes of discussions, etc. are compiled in the Appendixes.

Site survey and discussions achieved by the team were mainly as follows:-

- (1) Investigation on the condition of existing equipment
- (2) Classification of the equipment into repair, replacement or addition
- (3) Supply of materials, parts of equipment, tools and measuring equipment for maintenance use
- (4) Training of EDL personnel on operation and maintenance of substations

Based on the analysis of results of the site survey, study on appropriateness and scale of the project, estimate of the project cost, project schedule, maintenance of substations after completion of the project and evaluation and recommendation of the project were made and compiled in this basic design report.

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Economic Development Plan

Lao PDR was founded in 1975 and the Government has enforced the Three-Year Plan during the period from 1978 to 1980 and the first Five-Year Plan during the period from 1981 to 1985 for the economic and social development of the country aiming an average annual growth rate of economy at more than 6 per cent.

In the month of December, 1985, the last month of the Plan when JICA's survey for the project was conducted, the results of the Plan were not finalized, however according to the report "La Situation Economique et Sociale Strategie De Developpement et Besoins D'assistance (Vientiane 20.9.85)" issued in 1985 by United Nation Development Programme (UNDP) the results in prospect of the first Five-Year Plan were as below:-

- Growth rates of economy fluctuated enormously such as 1.9% in 1982, -3.5% in 1983 and 8.1% in 1984, which were influenced by amounts of agricultural production under variable weather conditions. The growth rates of GDP dropped in 1982 and 1983 when poor rice harvests were recorded as minus 5% and 8% respectively comparing with those of the previous years, while higher growth rate of GDP was recorded in 1984 owing to 15% increase of rice harvest.
- Productions of forestry and manufacturing industries in 1984 increased by 29% and 1.6% respectively comparing with those in the previous year.

During the period, deficits of trade and finance of the country were in transition at the similar rate every year and the amount of deficits trended toward increase.

In 1984, amounts of export and import of the country were recorded US\$36.2 million and 98.4 million respectively, resulting a large deficit of US\$ 62.2 million as seen in the following table.

International Import and Export (Million US\$)

Year	1979	1980	1981	1982	1983	1984
Import	19.4	13.5	19.4	39.8	52.3	36.2
Export	70.3	92.3	90.3	124.2	125.0	98.4
Balance	-50.9	-78.8	-70.8	-84.4	-72.7	-62.2

Source: Report on the Economic Social Situation Development, Strategy and Assistance Requirements, issued in 1983 by UNDP and informations from IMF

Operating income and expenditure of the country during the period from 1980 to 1984 amounted to an annual average deficit of US\$93 million which is equivalent to about 20% of GDP, and especially the deficit in the year of 1982 was US\$103million. Those deficits were caused by stagnation of export and increase of import of industrial products.

On the other hand, as the national financial status in 1982 is shown in the undermentioned table, revenue, expenditure and balance were US\$80.8million, US\$156.6million and -US\$75.8million, respectively.

Since those deficits have been made up by aids from foreign countries, the amount of public external debts increased and its accumulated balance reached US\$385million at the end of 1983 and its debt-service ratio turned to 15.6%. (Source: UNDP)

National Financial Status (Million US\$)

Year	1977	1978	1979	1980	1981	1982
Revenue	5.9	7.6	19.1	53.4	27.0	80.8
Expenditure	27.0	32.7	45.4	127.0	56.5	156.6
Balance	-21.0	-25.1	-26.3	-73.6	-29.5	-75.8

Source: Annual Statistics Report of Asian and Pacific Region :
UN

The Government of Lao PDR is preparing the second Five-Year Plan during the period from 1986 to 1990. According to the

above-mentioned report of UNDP, the Government is to give priority to the following terms in order to achieve the Plan by effective utilizations of domestic resources, especially stable self-sufficiency of foods and improvement of international trade which have not been completely achieved in the previous Five-Year Plan. (It is noted, however, that no investment program for the second Five-Year Plan has been published.)

- (1) Production increase of food through rehabilitation of the existing irrigation and drainage facilities, and development of agricultural project for self-sufficiency and promotion of export.
- (2) Protection and exploitation of forestry resources by development and introduction of new technology.
- (3) Promotion of small and medium scale industries for reducing import and increasing export by utilization of local resources
- (4) Construction of hydroelectric power stations for meeting the increasing local energy demand and for increasing income from energy export.
- (5) Improvement of the existing infrastructures such as transportation and communication system for the purpose of effective utilization of local resources.

For achieving the economic and social development of the country, the Government lays importance on improvement of various infrastructures. Especially development of electric power resources and rehabilitation on the existing electrical facilities are required as supply sources of energy in the country with the following reasons;

(1) Growth of Energy Demand

As seen in the following table prepared by EDL, both peak and energy demands in the country have been steadily growing and energy consumption of 129.1 GWh recorded in 1984 is expected to reach 274.7 GWh in 1995.

Domestic Demand Record and Forecast

Year	1975 (A)	1980 (A)	1983 (A)	1984 (A)	1985 (F)	1990 (F)	1995 (F)
Consumption (GWh)	70.8	85.2	124.1	129.1	147.1	204.8	274.7
Peak Demand (MW)	17.7	17.6	29.5	31.8	30.9	42.4	54.4

Note: (A) - Actual Record, (F) - Forecast

(2) Preservation of Forestry Resources

At present, firewood is the main source of energy in the country accounting for 93 percent of the energy consumption, while imported petroleum products provide about 5 per cent and electricity provides only 2 per cent of the energy. Besides, it is reported that forests covering 68 per cent of the national territory in the beginning of 1970 was reduced to 47 per cent of that in 1984, and the Government requested the local people to refrain from tree-cutting and shifting cultivation for reservation of the forestry resources. From this viewpoint, utilization of electric energy is needed as an alternative energy source since Lao PDR has no oil resources.

(3) Securing of Foreign Currency

About 80 per cent of electric power generated in Lao PDR is exported to Thailand through the international connecting lines. The electric power export among other exports shares the biggest part of acquisition of foreign currency in the country. Annual electric power export to Thailand has amounted to 700 GWh level and income from the export was stable since 1982 as tabled below.

Energy Export to Thailand (Source: EDL)

Year	1975	1980	1982	1984
Exported Energy (GWh)	155.81	766.41	749.76	709.71
Revenue from Export (Million US\$)	-	5.7	24.1	26.9
Share of Energy (%)	-	42.2	60.6	74.3

Note: "Share of energy" means a ratio of income from energy export against the total export income of the country.

According to the agreement for energy trade between both Governments, Thailand is to import all amount of exportable electric power of Lao PDR. Taking account of the increased demand in the north-east region of Thailand, the electric power export of Lao PDR is expected to increase if new electric power sources are to be developed.

Thus, the electric power sector is very important in the economy of the country, and therefore the Government lays importance on rehabilitation of the existing electric facilities, development of hydroelectric power projects and promotion of electrification.

2.2 Current Situation of Power Sector

Total installed capacity of the existing generating facilities in the country in 1985 is 163 MW consisting of 153 MW (93.8%) from hydroelectric plants and 10 MW (6.2%) from diesel generating plants as seen in the following table. It is reported that Lao PDR has a potential for hydroelectric power as large as 42,000 MW, but it has so far developed only 153 MW, 0.4 per cent of the potential.

There are three (3) hydroelectric power stations as of the end of 1985 in the country; the first Nam Ngum power station equipped with 150 MW for energy supply to Vientiane area and Thailand, Nam Dong power station with 1 MW and Selabam power station with 2 MW for energy supply to the related rural areas. The total electric power generated in 1984 was recorded at 891 GWh.

Existing Generating Facilities (Source: EDL)

	Power Station	Installed Capacity (MW)
(Hydro)	First Nam Ngum	150
	Nam Dong	1
	Selabam	2
	Subtotal	153
(Diesel)	Sokpalouang	8
	Luang Prabang	0.6
	Savannakhet	1
	Others	0.5
	Subtotal	10.1
Total		163.1

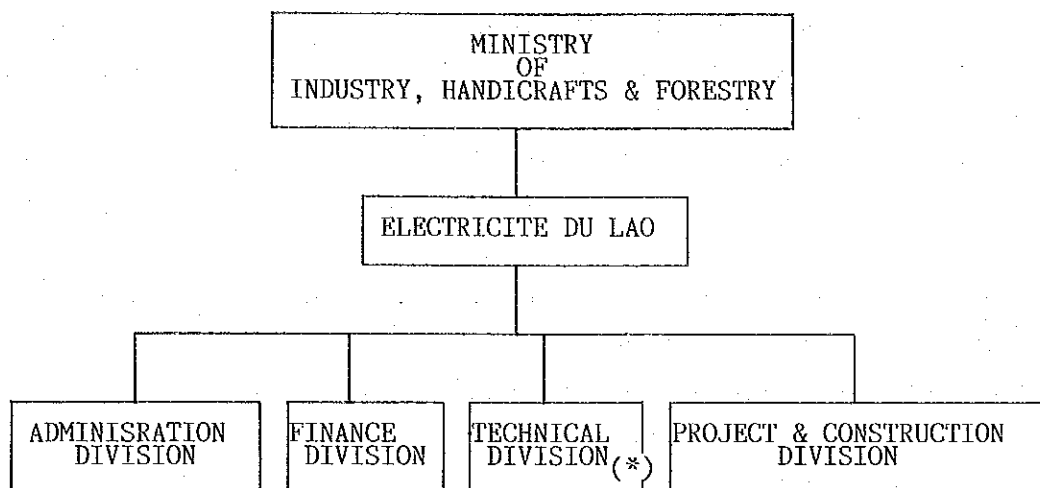
Total domestic consumption of electric energy in 1984 was 129.1 GWh; 114.47 GWh for general demand, 9.58 GWh for industrial demand and 5.05 GWh for agricultural demand. The total domestic consumption is only 14.5 per cent of energy produced in the country in 1984 and the remaining energy of 709.7 GWh (79.7%) was exported to Thailand. While, in the same year the country imports the electric power from Thailand into both Savannakhet and Khammouane prefectures in the southern part of the country to make up the shortage of electric power.

The Government plans the development of hydroelectric power plants at 10 locations to be equipped with a capacity of 600kW to 1,250MW, construction of 22 kV distribution lines over about 1,000 km and rehabilitation of the existing power stations and substations, however the implementation programs for most of the plans are not fixed yet.

2.3 Administrative Organization of Electric Power Sector

EDL, under the Ministry of Industry, Handicrafts and Forestry has managed all the electric power sector in Lao PDR including planning, construction, operation, maintenance and administration of power stations, transmission lines, substations and distribution lines as well as trade of electric power between the country and Thailand since the founding of electric power sector in the country. EDL is the biggest public enterprise in the country having in its

organization about 1,500 employees, its own training school and a factory of manufacturing concrete poles for distribution lines. The organization of EDL is shown below:



* Division in charge of the rehabilitation project

The financial situation of EDL is excellent as seen in the attached table-5. EDL pays the Government receipts for its domestic sales and exported electric power which contributes greatly to the national finance. In 1984 EDL pays the Government all of its net income of 690 million Kips, while its total income being 1,020 million Kips, total expenditure of 260 million Kips, total operation income 760 million Kips and total interest and provision 70 million Kips.

2.4 Trends in Foreign Assistances

As seen in the following table regarding foreign assistances to Lao PDR, the country was supported by total amount of US\$30.1 million in 1983. The amount equivalent to 57 per cent of the total support was from multiple countries and the assistance from IDA was the biggest amounting US\$4.6 million. In the year, the Government of Japan assisted the country by the fund of US\$2.37 million (accounting for 8% of total amount), out of which about 85 per cent was provided under Japan's Grant Aid Program.

Financial status of the country is tight and the considerable amount for development program of the country was assisted by foreign funds. At present, several projects are in progress under such funds; construction of a pharmaceutical technical center under Japan's Grant Aid Program, Vientiane rural electrification project under the World Bank's fund, road rehabilitation project, irrigation project, etc. As to the current electrical power sector, the Government of Japan rehabilitated the first Nam Ngum power station in 1984 and the World Bank is carrying forward the electrification of and expansion of distribution lines in the Vientiane area as above-mentioned. The project is carried out by EDL under the assistance of consultant using materials supplied by the fund from JDA. The first phase of the project was commenced in 1984 and is still in progress for construction of 22 kV distribution lines from Wattay substation toward the northern area along the national route. The second phase of the project is to extend the distribution lines and scheduled to promote electrification in the area around Thanaleng and to improve the distribution network in Vientiane city.

External Assistances

(Source: Handbook of South-east Asia 1984)(Million US\$)

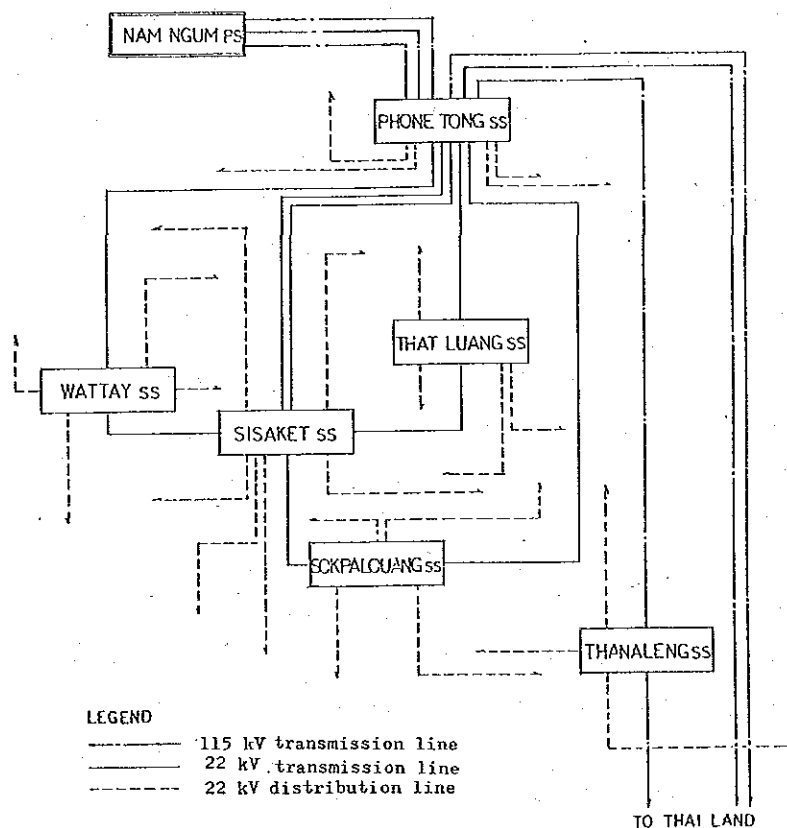
Year	1980	1981	1982	1983
Bilateral ODA	16.7	16.8	21.3	12.6
(from Japan)	(1.29)	(2.88)	(3.05)	(2.37)
Multiple	24.1	18.2	17.0	17.2
Total	39.9	35.0	38.1	30.1

2.5 Background of Request and Details of the Project

As shown in the following figure, the electric power generated in the first Nam Ngum power station is transmitted by 3 circuits of 115 kV transmission line to Phone Tong substation located in a suburb of Vientiane city. The energy is distributed from the substation to customers in Vientiane area through 6 substations (Sisaket, Thatluang, Sokpalouang, Wattay and Thanaleng as well as Phone Tong).

The remaining electric power after local consumption is exported to Thailand, which accounts for about 85 per cent of annual electric power reception by Phone Tong substation from the first Nam Ngum power station.

Those six (6) substations were built 7 to 16 years ago and have had many troubles due to deterioration of equipment, insufficient capacity of equipment and shortage of maintenance materials and tools. If no countermeasure is taken to those faulty equipment and materials of the substations, functions of the substations will further deteriorate and economy of Lao PDR will be seriously affected with the undermentioned reasons and therefore immediate rehabilitation on those substations is required.



(1) Affection to the stable agricultural production

Vientiane plain is producing rice utilizing rich water from Mekong river and its tributary Nam Ngum river and forming a center of agriculture in the country.

However, most of the agricultural production in the country depends on natural rainfall, and the amount of production is considerably, influenced by the local weather. Thus, weather dominates agricultural production in the country and the amount of its product sways the country's economic condition as stated in (2.1). Under such circumstances, the Government has promoted the development of irrigation and drainage facilities for stable production in agricultural sector. Some amount of electric power delivered from Wattay and Thanaleng substations is consumed by water pumps for irrigation, drainage and electrification of villages.

Interrupted or unsteady supply of electric power aggravates agricultural productivity and the national economy, and it also hampers the improvement of villagers' life.

Therefore, the reliable supply of electric power is indispensable to the stable agricultural production and development of primary products such as rice mill.

(2) Improvement of industry and life structures

Development of small and medium scale industries is one of the aims of the Government for reducing the imported industrial products, for which the stable supply of electric power is essential.

Vientiane city holds the largest population in the country as a capital and the electric power is basically necessary for the life of the local people. Accordingly, frequent failure or blackout of the energy supply from Sisaket, Sokpalouang and Thatluang substations to the center of town will affect the production activities and welfare of the people.

(3) Improvement on the balance of international trade

Receipts for the electric power export from Phone Tong and Thanaleng substations to Thailand is the biggest source of income in foreign currency to the country. Thus, the electric

power export makes a great contribution to improvement of financial status of the country.

However, due to deterioration or faults of 115 kV main equipment in the substations, the electric power export is in danger of interruption.

As mentioned above, unstable and unreliable electric power supply will cause a serious problem to the economic conditions not only in the Vientiane area but also in the whole country.

In order to restore such situations, the Government of Lao PDR requested the Government of Japan to rehabilitate the substations in the area under Japan's Grant Aid Program with the following reasons.

- Main electric facilities in the first Nam Ngum power station and main substations in the area were provided under Japanese assistances.
- Most of equipment in main stations in the area are Japanese products.
- Financial status of the country is tight to invest in the rehabilitation.

Details of the requests from the Government of Lao PDR are tabled in Chapter 4 and the summary is as follows:-

(1) Phone Tong substation

- (a) Purification of insulation oil and repair of on-load tap-changer, packings and gaskets and control circuits for 115/22kV main transformer.
- (b) Replacement of insulation oil and repair or replacement of 115 kV switchgears.
- (c) Replacement of insulation oil and repair or replacement of 22 kV switchgears.
- (d) Replacement of batteries
- (e) Replacement of parts for supervisory and control equipment and replacement of air-conditioners.

- (f) Additional installation of apparatus for improvement of voltage regulation and power factor of the system
- (g) Replacement of power and control cables
- (h) Replacement of air compressors and repair of air pipes
- (2) Sisaket substation
 - (a) Replacement of 12 units of 22 kV metal-enclosed switchgear cubicle
 - (b) Replacement of batteries
 - (c) Replacement of telemetering and telesignalling apparatus
- (3) Thanaleng substation
 - (a) Repair on 115 kV switchgears
 - (b) Replacement of 4 units of 22 kV metal-enclosed switchgear cubicle
 - (c) Replacement of batteries
- (4) Thatluang, Wattay and Sokpalouang substations
 - (a) Replacement of 15 units of 22 kV metal-enclosed switchgear cubicle
 - (b) Replacement of batteries
- (5) Repair of the existing power line carrier telephone system
- (6) Supply of vehicles for substation maintenance
- (7) Supply of mobile radio sets
- (8) Supply of spare materials, power cables and testing apparatus for maintenance use

The above requests are classified into (a) repair on and replacement of existing substation equipment in six (6) substations and (b) replacement of existing equipment for tele-metering tele-signalling and tele-communication.

CHAPTER 3 SITUATION OF POWER SECTOR IN VIENTIANE AREA

3.1 Current Situation of Power Sector

As shown in Figure, 4-1, electric power demand in this area is fully served by the first Nam Ngum hydroelectric power station through the existing six (6) substations, i.e. Phone Tong, Thanaleng, Sisaket, Thatluang, Wattay and Sokpalouang. The first Nam Ngum power station, the largest power station in the country was constructed with provision of 2 units of 15 MW in December 1971 under the funds from 9 countries including Japan and fund management of the World Bank and then additionally installed with 2 units of 40 MW under the funds from ADB and 10 other countries and with 1 unit of 40 MW under the fund from IDA, OPEC and self-fund of the Government in December 1984, making total installed capacity to be 150 MW.

The electric power generated by the first, Nam Ngum power station is transmitted to Phone Tong primary substation by three circuits of 115 kV transmission lines. The transmission lines of three circuits are further extended to Thailand and connected with the power supply system of EGAT at Nongkhai and Udon.

Part of electric power transmitted from Nam Ngum No.1 power station is distributed to the customers in Vientiane city and its suburb, directly from Phone Tong substation and/or through the secondary substations in this area (Sisaket, Thatluang, Sokpalouang and Wattay) after the line voltage of 115 kV is stepped down to 22 kV, and the remaining electric power is further transmitted to Thanaleng substation and Thailand through 115 kV lines.

At Thanaleng substation, electric power is distributed to its surrounding customers by 22 kV distribution lines. In addition to the Nam Ngum power station, diesel power plants (4 x 2,000 kW) exist as stand-by plants at the Sokpalouang.

The power supply system in this area is formed by 22 kV lines which are interconnected each other in the town area in order to minimize the area with no electric supply under abnormal conditions.

Electric energy consumption in the Vientiane area was recorded at 129 GWh in 1984, consisting of 7 per cent for industrial demand, 4 per cent for irrigation purpose and the remaining 89 per cent for the home, commercial and public demand. Electric power and its demands are increased with rates of 15 per cent and 10.9 per cent per annum since 1980, respectively.

According to the power demand forecast of EDL, annual increase rates of electric power and its demand are estimated at 4 to 7 per cent and 5 to 9 per cent, respectively.

3.2 Current Situation of Each Substation

The actual operating records on 22 kV circuits for the past 20 months from January 1984 to August 1985 are summarized as follows:

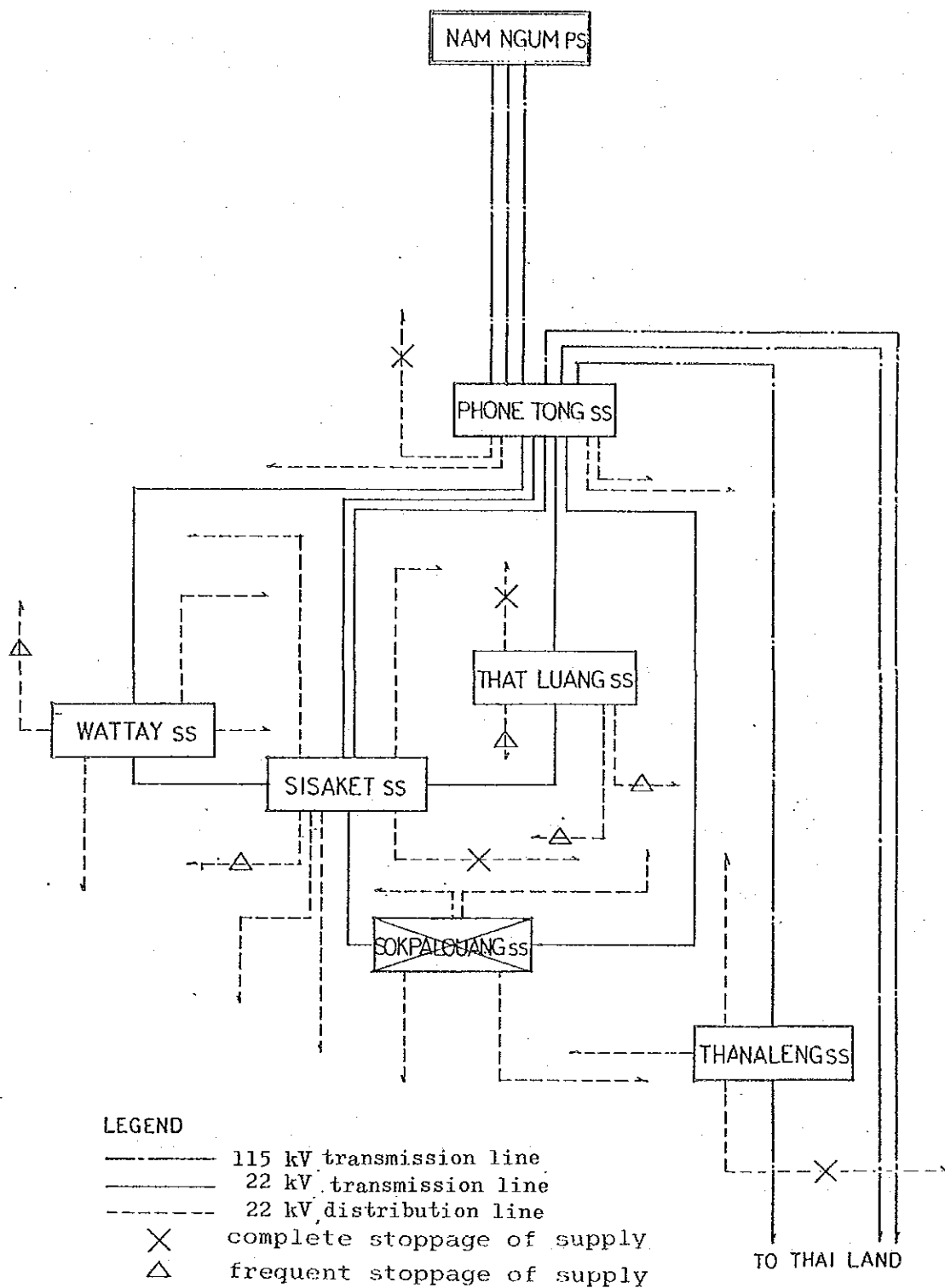
Substation	T/L (CCT)	D/L (CCT)	Total Operation (CCT.M)	Operated (CCT.M)	Not Operated (CCT.M)	Ratio of Outage (%)
Phone Tong	5	-	100	64	36	36(16)
Phone Tong	-	4	80	66	19	24
Sisaket	-	6	120	111	9	8
Thanaleng	-	3	60	50	10	17
Thatlueng	-	4	80	37	43	54
Wattay	-	4	80	57	23	29
Sokpalouang	-	5	100	-	100	100
Total	5	26	620	385	240	39

(Remark) a) T/L: 22 kV lines from Phone Tong substation to other substations

b) D/L: 22 kV distribution lines

c) CCT.M = (Circuits) x (Months)

d) The details are shown in Table 8.



The periods of the interrupted lines from each substation are as follows:

(1) Supply from Phone Tong substation to each substation

- Line to the Sokpalouang S/S : 20 months
(due to faults of Sokpalouang S/S)
- Line No. 1 to Sisaket S/S : 9 months
- Line No. 2 to Sisaket S/S : 4 months
- Line to Thatluang S/S : 3 months

(2) Distribution lines from Phone Tong substation

- Line to Tha Ngon area (max. 2,000 kW) : 19 months
(due to the faults of distribution line)

(3) Distribution lines from Sisaket substation

- Line No. 2 (max. 50 kW) : 4 months
- Line No. 3 (max. 200 kW) : 5 months, since May 1985

(4) Distribution lines from Thatluang substation

- Line No. 1 (max. 1,800 kW) : 6 months
- Line No. 2 (max. 1,400 kW) : 6 months
- Line No. 3 (max. 2,000 kW) : 11 months
- Line No. 4 : Since Jan. 1984

The above periods include a duration of forced outage of substations itself for 6 months.

(5) Distribution lines from Wattay substation

- Whole substation (max. 5,000 kW) : 4 months
- Line No. 4 (max. 40 kW) : 12 months in 1984

(6) Distribution lines from Thanaleng substation

- Line No. 3 (max. 4,000 kW) : Since Nov. 1984

(7) Sokpalouang substation

- Whole substation : Since May 1983

Those forced outage of one substation and four distribution line feeders for a long time does not cause a hindrance in power supply at present, because the existing distribution system is constructed as a loop system, but causes an increase of power loss of the system and voltage drop.

3.3 Current Situation of Operation and Maintenance

Operation and maintenance of each substation are carried on by EDL under three (3) shifts consisting of 2 to 5 operators per shift. Repair on the substation equipment when faults occur is managed by the maintenance group of 25 workers, however the repairing is not satisfactorily performed due to the shortage of materials, tools and measuring equipment for maintenance use.

3.4 General Situation of Project Site

The general situations of six (6) substations in Vientiane area are as follows:

(1) Phone Tong substation

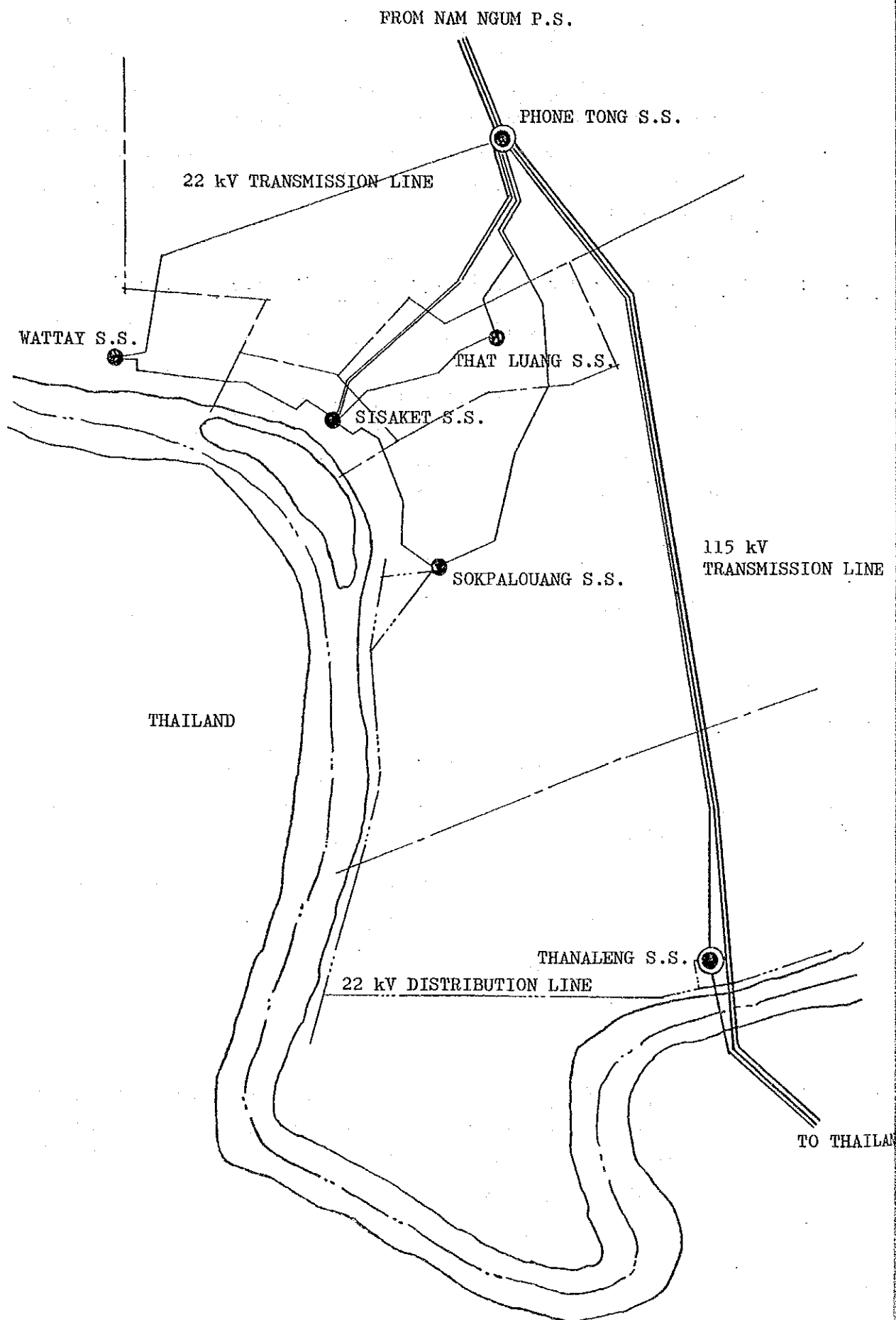
The Phone Tong substation is located on the hill to be 5 km away to the north of the center of Vientiane city, and surrounded with public facilities, such as hospital, a radio station, etc.

The access road to the substation is available and paved with asphalt except about 100 m of its vicinity.

Bearing capacity of soil in the substation is estimated at about 40 t/m².

(2) Thanaleng substation

The transformer of the substation was installed on the reclaimed land in the rice field without special foundation treatment such as piling. A concrete pole factory of EDL is also existing in this area.



A study on the substation building and soil investigation will be however, done during the detailed design stage, because removal of a partition wall is included in the project.

The substation is located about 100 m away from the national route No.13.

(3) Sisaket substation

The Sisaket substation is located in the premises of EDL's head office in the center of Vientiane city and provides mainly electric energy to the surrounding government offices, hospitals, shops, etc. Transportation of goods to the substation will be done without any hindrance, because of comparatively small traffic volume.

The substation is elevated about one meter from the original ground level in order to avoid any damages from the flood of the Mekong river.

The main rehabilitation work for this substation is to replace the existing 22 kV metal-enclosed cubicles, load dispatching and telecommunication facilities.

(4) Thatluang substation

The substation is located on a hill on outskirts of the town. There are no difficulties in construction works.

(5) Sokpalouang substation

In this site, there are a EDL's training center, stand-by diesel power plants and warehouse together with a substation. Only replacement work of telecommunication facilities is planned under this project.

(6) Wattay substation

The Wattay substation is located in the town area in the western part of Vientiane city. A distribution line to the north for rural electrification which is under construction is extending from this substation.

During detailed design stage, a soil investigation will be done for the construction of outdoor type, 22 kV metal-enclosed cubicles in detail.

CHAPTER 4 DETAILS OF PROJECT

4.1 Objectives of the Project

As stated in Chapter 3, the existing six (6) substations in service in Vientiane area are not fulfilling their proper functions due to deterioration of their equipment and ancillaries, leaving of fault equipment and insufficient capacity of some equipment. Unless countermeasures are taken to the equipment, serious hindrances due to enlarging deterioration of the equipment will occur to the present energy supply to customers, the increasing electric power demand, development of manufacturing and agricultural industries and the energy export and finally complete replacement of all equipment and ancillaries of the substations will be required.

Main objective of this rehabilitation project is, therefore, the immediate restoration of functions of those six (6) substations.

4.2 Examination on the Request

Electric power demands in the Vientiane area are served by the first Nam Ngum power station through those six substations.

In general, a primary substations with high or extra high voltage are normally located in the suburbs of demanding town in consideration of influence to circumstances, such as social safety, noise, pollution, regional development plan, etc. Similary, Phone Tong and Thanaleng substations being the primary substations in the area are located in the suburb of Vientiane city and the secondary substations for energy distribution to the customers are located in the demanding area.

A dispatching center synthetically supervising, controlling and managing the system is normally to be located at a substation or a headquarter where a center of the regional operation is situated. It is reasonable from the above view point that the main tele-metering and tele-signalling equipment for the Vientiane system is set at Sisaket substation on the premises of EDL's headquarter. The existing equipment provides indication of on-off conditions of

main switches and for indication of flowing currents of each substation except Thanaleng substation.

This rehabilitation project for the substations is to repair and to replace of faulty or deteriorated equipment with new equipment, to install additional equipment and to supply of materials for the purpose of maintenance of substations' function and prevention of faults. Although there are several problems with rehabilitation of equipment as mentioned in Chapter 3, they are examined in details in the basic design.

Summary of plan for the project is as below:-

(1) Repair and replacement of substation equipment

From the viewpoints of restoration, maintenance and prevention of faults of the existing substation equipment, other equipment and ancillaries than those requested by Lao PDR were also visually observed during the field survey by the basic design team, which resulted that the request from Lao PDR is reasonable, but it is found that there are other equipment necessary to be restored than those in the request.

As to the rehabilitation to Sokpalouang substation which was involved in the request, EDL withdrew the request for rehabilitation of the substation, since necessary substation equipment and batteries for its restoration had been delivered to the site from the manufacturer of the existing equipment (confirmed by the team at site). Therefore, rehabilitation on the substation equipment is to be executed for the existing five (5) substations; Phone Tong, Sisaket, Thanaleng, Thatluang and Wattay. (except Sokpalouang substation)

Prior to or during the rehabilitation works, detailed inspection or adjustment on the existing equipment will be carried out including cleaning the equipment utilizing period of shutdown, and in case that equipment or parts necessary for repair are found, repair on them will be made immediately.

(2) Replacement of tele-metering, tele-signalling and tele-communication equipment

The existing equipment installed in Sisaket substation is left without repair as it was broken-down, due to no supply of spare parts and no drawings and manuals for repair. The equipment is necessary for synthetic operation of supervision of substations and collection of power data of substations in the system, accordingly rehabilitation to the equipment is required. While, power line carrier telephone equipment of Japanese products on 115 kV system and European products on 22 kV system are provided for operation and maintenance of the substations, the equipment, especially those on several 22 kV circuits are now unused due to shortage of spare parts for its repair. Those equipment are necessary to be rehabilitated.

(3) Training for operation and maintenance

For proper operation and maintenance of the substations after completion of the rehabilitation project, training to EDL's operators and maintenance crew will be conducted by Japanese engineers throughout the period of the site rehabilitation works. Detailed program for the training is stated in Chapter 5.

(4) Supply of maintenance materials and tools

Under the situation that few spare parts and spare materials have been imported, necessary repair have not been carried out, which has accelerated deterioration of the equipment and disturbed the proper operation of the system. If spare materials, tools and testing apparatus will run short after completion of the project, the similar state of substations will recur in several years. Accordingly, spare materials, tools and testing apparatus will be supplied under the project.

Maintenance and repair works are not quickly performed because there are no exclusive vehicles for the substation sector. Vehicles are by all means required for maintenance and repair

of scattered substations. Providing vehicles with radios and a base station at Sisaket substation as a maintenance center are supplied, the maintenance work will be mobilized, which will rapidly separate the faulty section from the system, minimize the extent of fault, shorten time of blackout and finally conduct to quick repair. Accordingly, supply of vehicles as well as radio system will be involved in the project.

Results of the examination on the request and the plan of rehabilitation works under this basic design are summarized in the next page, and the rehabilitation of the existing substation equipment, tele-supervisory facilities and communication equipment are needed in order to restore the function of substations.

In order to confirm whether the capacities of the first Nam Ngum power station and substations in the area are able to meet increasing demand in the area, the demand forecast is made up to 1995 in the Appendix-2. The forecast estimates the electric power demand in 1995 to be 265.8 GWh and capacities of the existing power station and substations are sufficient to meet the demand. Accordingly, increase in the capacity of the existing substations is not taken into account in the rehabilitation project. It is also noted that no influence from the distribution line project is extended to the system under the rehabilitation project.

Request by Lao PDR and Plan in Basic Design

Request	Plan	Reasons
Rehabilitation of equipment of the existing 6 substations	<p>a) Supply of equipment, parts, tools apparatus and materials for inspection and replacement, and</p> <p>b) Installation including inspection, cleaning, adjustment and site test for existing 5 substations</p>	<p>a) To restore the original function of substation equipment,</p> <p>b) To supply stable electric energy to the customers and</p> <p>c) To keep continuous export of electric energy.</p> <p>One substation is deleted from the plan, because equipment and materials have been supplied for its rehabilitation by the European manufacturer.</p>
Rehabilitation of existing tele-supervisory and communications equipment	Supply and erection of tele-supervisory and communication equipment for replacement of the existing faulty equipment	a) To be needed for managing and controlling the power supply system
Supply of equipment and materials for operation and maintenance including vehicles	<p>Supply of:</p> <p>a) Vehicles and motor cycles</p> <p>b) Maintenance tools and apparatus and</p> <p>c) Spare parts</p>	a) To operate and maintain the substation equipment in the acceptable level after completion of the rehabilitation work.
-	On-job-training for operation and maintenance of the substations	- Same with the above -

PHONE TONG SUBSTATION: REQUEST, EXAMINATION & PLAN

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>(1) Main transformers</p> <ul style="list-style-type: none"> • Purifying of insulation oil and measurement of acid value and withstand voltage • Characteristic test • Removal of rust and painting • Replacement of gasket • Repair of oil leakage • Replacement of operational mechanism of electrically-driven for on-load tap changer • Repair and/or replacement of fixed and moving contacts of on-load tap changer 	<p>• Generally, periodical inspection shall be done at least once in 3 years. Foreign materials on insulators, distinct noise of movable parts, oil leakage, etc. were observed when site visit. Therefore, inspection and repair will be made for all transformers, and parts on which abnormality is found and may result in degeneration of performance.</p>	<p>• For the stable power supply to Vientiane district and for meeting the increased demand in this district, the following inspection and repair are planned for all transformers (22 MVA x 2, 30 MVA x 1):</p> <ol style="list-style-type: none"> 1. Inspection of transformer according to Appendix-5 Inspection Items 2. Cleaning and painting of transformers • For No. 1 transformer only <ol style="list-style-type: none"> 1. Insulation oiling to bushings 2. Replacement of parts of motor operated mechanism 3. Replacement of gaskets where oil leakage appears 4. Replacement of control relays for cooling for motor
<p>(2) 115 kV switchgears</p> <ol style="list-style-type: none"> i) Air blast circuit breakers <ul style="list-style-type: none"> • Check of dashpot and replacement of parts deteriorated • Replacement of packings • Check and repair of operating mechanism ii) Disconnecting switches <ul style="list-style-type: none"> • Check of porcelain insulators 	<p>• Periodical inspection shall be done at least once in 3 years. Foreign materials on insulator were observed and disorder on main contacts was found. Inspection and repair will be made for all switchgears, and parts on which abnormality are found and may result in degeneration of performance.</p>	<p>• For exporting energy to Thailand, the function of 115 kV switchgear is highly important. The following inspection and repair are planned for the rehabilitation of the substation and up-grading of power system reliability:</p> <ol style="list-style-type: none"> 1. Inspection of air blast circuit breakers 2. Inspection of disconnecting switches 3. Inspection of current transformers

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<ul style="list-style-type: none"> . Repair of main contactors . Repair of operating mechanism . Check of control circuits iii) Current transformers and potential transformers <ul style="list-style-type: none"> . Check of porcelain . Check of control wiring iv) Lightning arresters <ul style="list-style-type: none"> . Check of porcelain insulators . Insulation resistance measurement . Repair of accessories 		<ul style="list-style-type: none"> 4. Inspection of potential transformers 5. Inspection of lightning arresters 6. Cleaning and painting of 115 kV switch-gears <ul style="list-style-type: none"> . Replacement of conductor for disconnecting switch (one phase) . Replacement of control box for disconnecting switch (all) . Replacement of terminal box for current transformer (3 set) . Replacement of a cover for indicating lamp of circuit breaker (1 set) . Installation of protective cover for air piping for circuit breakers (2 sets)
<p>(3) 22 kV switchgear</p> <ul style="list-style-type: none"> i) Circuit breakers <ul style="list-style-type: none"> . Replacement of circuit breakers (2 sets) . Replacement of insulation oil (all) . Check of main contactors and replacement and repair of parts . Replacement of packing and gaskets . Operation tests and characteristic tests . Repair of control circuits . Removal of rust and painting 	<ul style="list-style-type: none"> . Circuit breakers Oil leakage is observed on almost all circuit breakers. According to the sample check of a circuit breaker tank upon dismantling, damage on main contacts and deterioration of insulation oil were found. For coping with a lead increase in future and easy maintenance, replacement by vacuum type circuit breakers is judged to be necessary. 	<ul style="list-style-type: none"> . For the stable power supply to Vientiane district, for meeting the demand increase in the district, and for shortening of time of outage for inspection, repair of switchgears are planned as follows:- <ol style="list-style-type: none"> 1. Replacement of oil circuit breakers to vacuum circuit breakers. 2. Inspection of disconnecting switches 3. Inspection of current transformer 4. Inspection of potential transformers 5. Inspection of lightning arresters 6. Inspection of station service transformers

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>ii) Disconnecting switches</p> <ul style="list-style-type: none"> Check of porcelain insulators Repair of main contactors Repair of operating mechanism Check of control circuits <p>iii) Current transformers and potential transformers</p> <p>iv) Lightning arresters</p> <ul style="list-style-type: none"> Check of porcelain insulators Insulation resistance measurement Repair of accessories <p>v) Static condensers</p> <ul style="list-style-type: none"> Additional installation <p>(4) Control switchboard and auxiliary equipment</p> <ul style="list-style-type: none"> Replacement of control devices and protective relays 	<ul style="list-style-type: none"> Disconnecting switches and lightning arresters inspection and repair will be required for all switchgear, on which abnormality are found and may result in degradation of performance. Although this is not required by EDL, a potential transformer will be additionally installed on the secondary bus of No. 3 main transformer for its protection and metering, for which so far the potential transformer for No. 2 main transformer bus has commonly been used. For preventing damage due to lightning surge, lightning arresters will be additionally installed. Power factor at Phone Tong Substation is sometimes worsening to 65%. Power demands from both agricultural and industrial sectors will cause further worsening of power factor, resulting increase of voltage fluctuation and power losses. To keep the power factor around 90% and to decrease voltage fluctuation and power losses, static condenser units will be additionally installed. Periodical inspection shall be done once in 3 years. Including resetting of protective relays, check, calibration and adjustment of meters and relays will be required. 	<ul style="list-style-type: none"> 7. Inspection of static condensers 8. Cleaning and painting of 22 kV switch-gears (Items 2 to 8 be referred to Appendix-5) Replacement of disconnecting switch (1 set) Replacement of control box for disconnecting switch (28 sets) Replacement of gaskets for terminal box for current transformer (1 set) Additional installation of a 400-200-100/5 A current transformer Additional installation of lightning arresters (9 sets) Additional installation of potential transformer on the secondary bus of No. 3 main transformer For stable power supply, the following are planned: <ol style="list-style-type: none"> Additional installation of 4 banks of 5,000 KVA static condenser Installation of control panel for the condenser bank in the control room Replacement of current transformers, because increased capacity
		<ul style="list-style-type: none"> Check, calibration and adjustment of meters and relays are planned. Following are the meters and relays will be tested:

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>Replacement of DC power source equipment</p>	<p>Inspection and repair of devices which were found to be out of order, will also be required.</p> <p>On existing DC 104 V and DC 48 V batteries, rust at connecting terminals and damage on containers are observed. There are several cells mixed with different unit capacity. Since battery is an important equipment to operate the substation equipment, it is planned to replace the existing batteries with new ones so as to prevent such trouble as control source missing.</p>	<ol style="list-style-type: none"> 1. Protective relays for buses/and transformers 2. Protective relays for distribution lines 3. Indication meters and recording meters <p>Check of control switchboard (according to Appendix-5)</p> <p>Replacement of name plates for change-over switches and indication lamps</p> <p>Replacement of storage battery, of 104 V, 210 Ah (52 cells) for switchgear control and that of DC 48 V, 60 Ah (24 cells) for telecommunication equipment source.</p> <p>The existing 48 V power source is distributing power directly to each individual equipment.</p> <p>This system will be improved providing a distribution panel to prevent extension of a fault over the entire system. Under the project one set of DC 48 V distribution panel will be installed.</p> <p>Painting of floor for the battery room will also be carried out.</p>
<p>(5) Ancillary equipment</p> <p>i) Replacement of air compressor and repair of air piping</p>	<p>The existing installations comprise two air compressors (AC 1 set and DC 1 set) in the first stage, and two air compressors (AC x 2 sets) and three sets of air tanks in the second stage. Of which, two air compressors have already been out of service and the remaining equipment is not enough for supply</p>	<ol style="list-style-type: none"> Replacement of two AC air compressors Check and repair of existing equipment in service are planned according to Appendix-5. The following equipment will be checked and repaired: <ol style="list-style-type: none"> 1. Air compressor (AC)

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>ii) Replacement of power and control cables</p>	<p>air to the switchgears; air blast circuit breakers and disconnecting switches. The air compressors are also very important facilities for operation of substation; so replacement of existing broken air compressors and check and repair of equipment in service will be necessary.</p> <p>. All cables which are connected to the equipment to be replaced are also replaced with new ones, and measures to prevent small animals entering into cable ducts are required.</p>	<p>2. Air compressor (DC)</p> <p>3. Control panel for air compressors</p> <p>4. Air piping including valves</p> <p>. Replacement of control cables (5,000 m long)</p> <p>. Sealing of cable entrance holes to keep equipment from small animals entering into duct and to prevent short-circuit faults and corrosion of cable.</p> <p>All outdoor switchgears will be provided with devices to prevent small animals getting inside.</p>
<p>(6) Drainage pumps</p>	<p>. The existing drainage pumps and control panel have been broken and there is a temporary engine-operated drainage pump in insufficient capacity.</p>	<p>. To prevent cable troubles due to inundation of cable ducts, it is necessary to rehabilitate the drainage pumps.</p> <p>Installation of new drainage pumps and the control panel is planned.</p>
<p>(7) Air conditioners for the control room</p>	<p>. Degeneration of air conditioner was observed.</p>	<p>. Replacement of existing air conditioners with new ones.</p>

THANALENG SUBSTATION: REQUEST, EXAMINATION & PLAN

REQUEST FROM LAC PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
(1) Main transformers	<p>Although not included in the request from EDL, inspection and repair will be made for the transformers, as the conditions are all the same as Phone Tong Substation.</p>	<p>To maintain stable power supply and to meet to the demand increase, the following are planned:</p> <ol style="list-style-type: none"> 1. Inspection of transformers 2. Cleaning and painting of transformers
<p>(2) 115 kV switchgears</p> <p>i) Air blast circuit breakers</p> <ul style="list-style-type: none"> Check of dashpot and replacement of parts deteriorated Replacement of packing and gaskets Check and repair of operating mechanism 	<p>Although the request from EDL for switchgears was limited to rehabilitation for air blast circuit breakers, inspection and repair for other 115 kV switchgears are required.</p> <p>Inspection and repair will be made for all switchgears and parts on which abnormality are found and may result in degeneration of performance.</p>	<p>Similarly to Phone Tong Substation the following inspection and repair are planned for the rehabilitation of the substation and up-grading of power system reliability:</p> <ol style="list-style-type: none"> 1. Inspection of air blast circuit breakers 2. Inspection of disconnecting switches 3. Inspection of current transformers 4. Inspection of potential transformers 5. Inspection of lightning arresters 6. Cleaning and painting of 115 kV switchgears <p>Replacement of a cover for indicating lamp of a circuit breaker (1 set)</p>
<p>(3) 22 kV switchgears</p> <ul style="list-style-type: none"> Replacement of 22 kV indoor metal enclosed type switchgear cubicles 	<p>As the existing 22 kV switchgears were designed too compact, there are many traces of arc observed between the energized portions and enclosure. Because of difficulties to obtain spare parts, the switchgears are put into service by removing the damaged parts. For secured operation and maintenance, replacement of 22 kV switchgears as required is planned.</p>	<p>Since the existing switchgear is small, the room is not large enough to accommodate the new switchgear. Therefore, the room for 22 kV switchgears will be expanded by removing the wall to the adjacent store room. The existing control switchboards will be used as they are. The outline of plan is as follows:</p>

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
		<ol style="list-style-type: none"> 1. Replacement of 22 kV indoor use metal enclosed switchgear cubicles 2. Remodelling of building (removal of walls) 3. Modification of cable ducts
<p>(4) DC power source equipment</p> <ul style="list-style-type: none"> . Replacement of DC 104 V, 90 Ah battery (52 cells) . Replacement of DC 48 V, 60 Ah battery (24 cells) 	<ul style="list-style-type: none"> . Replacement of batteries has already been completed when the team visited the site, therefore, the request for replacement of batteries are excepted from the rehabilitation project. 	

THATUANG SUBSTATION: REQUEST, EXAMINATION & PLAN

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>(1) 22 kV switchgears</p> <ul style="list-style-type: none"> Replacement of 22 kV indoor metal enclosed switchgear cubicles 	<p>As the existing 22 kV switchgears were designed too compact, there were many traces of arc observed inside. And also leakage of oil from circuit breakers and insulation varnish from current transformers were observed. Because of difficulties to obtain spare parts, the switchgears are put into service by removing the damaged parts. For secured operation and maintenance, replacement of 22 kV switchgears as requested is required.</p>	<ul style="list-style-type: none"> Since the existing switchgear is small, the space is not enough for the new switchgears. Therefore the switchgear to newly be installed will be designed for outdoor. The outline of works is as follows: <ol style="list-style-type: none"> 1. Replacement of 22 kV indoor use metal enclosed switchgear with outdoor one. 2. Newly installation of control and protective relays. 3. Construction of foundation and duct (outdoor) 4. Remodelling of ducts in the building.
<p>(2) DC power source equipment</p> <ul style="list-style-type: none"> Replacement of DC 104 V, 90 Ah battery (52 cells) Replacement of DC 48 V, 60 Ah battery (24 cells) 	<p>On existing DC 104 V and DC 48 V batteries, rust at connecting terminals and damage on containers were observed. There are several cells mixed with different unit capacity. Since battery is an important equipment to operate the substation equipment, it is required to replace the existing batteries with new ones so as to prevent such trouble as control source missing.</p>	<ul style="list-style-type: none"> Replacement of DC 104 V, 90 Ah battery (52 cells) and the battery charger for switchgear control Replacement of DC 48 V, 60 Ah battery (24 cells) and the battery for telecommunication equipment.

SISAKET SUBSTATION: REQUEST, EXAMINATION & PLAN

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>(1) 22 kV switchgears</p> <p>. Replacement of 22 kV indoor metal enclosed switchgear cubicles</p>	<p>. As the existing 22 kV switchgears were designed too compact, there were many traces of arc observed inside. Leakage of oil from circuit breakers, and insulation varnish from current transformers were observed. For secured operation and maintenance, replacement of 22 kV switchgears as requested is required.</p>	<p>. The Sisaket substation is located at the center of the city supplying energy to the government offices, hospitals, etc; Therefore it is difficult to plan a long time shutdown for repair. It is planned first to locate the 22 kV temporary outdoor switchgear cubicles for Thatluang and Vatty substations and change over the load to the temporary switchgear and carry out removal of the existing switchgear, cubicles, remodelling of building, installation of new cubicles and then change over the load to the newly installed switchgear cubicles.</p> <p>The outline of work is as follows:</p> <ol style="list-style-type: none"> 1. Replacement of 22 kV indoor metal enclosed switchgear cubicles 2. Modification of indoor ducts
<p>(2) DC power source equipment</p> <p>. Replacement of DC 104 V, 90 Ah, battery (52 cells)</p> <p>. Replacement of DC 48 V, 60 Ah battery (24 cells)</p>	<p>. On existing DC 104 V and DC 48 V batteries, rust on connecting terminals and damage on containers were observed. There are several cells mixed with different unit capacity.</p> <p>Since battery is an important equipment to operate the substation equipment, it is required to replace the existing batteries with new ones so as to prevent such trouble as control source missing.</p>	<p>. Replacement of DC 104 V, 90 Ah battery (52 cells) and the battery charger for switchgear control.</p> <p>. Replacement of DC 48 V, 60 Ah battery (24 cells) and the battery charger for telecommunication equipment.</p>

WATTAY SUBSTATION: REQUEST, EXAMINATION & PLAN

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>(1) 22 kV switchgears</p> <ul style="list-style-type: none"> Replacement of 22 kV indoor metal enclosed switchgear cubicles 	<p>With the same reason as in the case of Thatluang Substation, the replacement as requested is required.</p>	<p>With the same reason as in the case of Thatluang, the existing switchgear cubicle is small and the space for the new cubicles is not large enough. Therefore the switchgear cubicles to be newly installed will be designed for outdoor use. The outline of work is as follows:</p> <ol style="list-style-type: none"> Replacement of 22 kV indoor use metal enclosed switchgear cubicles with outdoor ones Installation of control and protective relay panel
<p>(2) DC power source equipment</p> <ul style="list-style-type: none"> Replacement of DC 104 V, 90 Ah, battery (52 cells) Replacement of DC 48 V, 60 Ah battery (24 cells) 	<p>With the same reason as in the case of Thatluang Substation, the replacement as requested is needed.</p>	<ul style="list-style-type: none"> Replacement of DC 104 V, 90 Ah battery (52 cells) and the battery charger for switchgear control. Replacement of DC 48 V, 60 Ah battery (24 cells) and the battery charger for telecommunication equipment.

TELEMETERING, TELESIGNALLING & TELECOMMUNICATION
REQUEST, EXAMINATION & PLAN

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
<p>Replacement of despatching supervision and telemetering system panels</p>	<p>There is a fault existing system to supervise the status of distribution system in Vientiane, however no spare parts are available and it is not in service now.</p> <p>There is neither drawing nor instruction manual for the system equipment. Therefore the system equipment are necessary to be replaced totally and also rehabilitation of data transmission system will be replaced.</p>	<p>At the dispatching center in Sisaket Substation, the master unit and system supervisory panel will be replaced.</p> <p>At each substation, a remote terminal unit and an interface panel will be installed and information will be transmitted to the master unit over existing power line carrier (PLC) telephone system.</p> <p>Number of remote stations in Vientiane district is 6.</p> <p>Rehabilitation of PLC telephone system will also be made to rearrange the information transmission.</p>

SUPPLY OF MAINTENANCE MATERIALS & TOOLS
REQUEST, EXAMINATION & PLAN

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
(1) Supply of spare parts and test apparatus	<p>At present, since spare parts and tools for substation equipment are not imported, repair of station equipment is not available. As a result, degeneration of equipment performance is accelerated and troubles on system operation are reported.</p> <p>Almost all tools and meters supplied at the time of initial operation have been missing. Therefore, it is necessary to newly supply spare parts and testing equipment.</p>	<p>Necessary spare parts for substation equipment for two years operation will be supplied.</p> <p>Following tools and meters for inspection and maintenance of substation will be supplied.</p> <ol style="list-style-type: none"> 1. Insulation oil tester 2. Motor-operated tools and machine tools 3. Safety devices such as grounding device 4. Relay and meter testing devices
(2) Supply of vehicles and mobile radio equipment	<p>Number of vehicles for maintenance of 6 sub-stations is not sufficient for transporting tools, materials and crews and for carrying out maintenance works under de-energized conditions.</p> <p>By providing a mobile radio equipment, time for de-energizing line will be shortened and thereby up-grading of reliability will be realized and also change-over of distribution lines and restoration of power shutdown will be efficiently made, and as a result, safety for maintenance crew at site will be secured. Therefore the requirements are reasonable.</p>	<p>Following vehicles will be supplied:</p> <ol style="list-style-type: none"> 1. 1,800 - 2,000 cc pick-up type automobiles mounted with mobile radio communication equipment 2. 125 cc motorcycles 3. Radio station equipment (The operating range is the Vientiane substation division)

REQUEST FROM LAO PDR	EXAMINATION OF REQUEST	REHABILITATION PLAN
(3) Supply of 22 kV power cables	<p>There is neither power nor control cable materials for maintenance and repair of substation. Some of the existing cables are damaged and are to be replaced.</p>	<p>Following cables are to be replaced:</p> <ol style="list-style-type: none"> 1. Phone Tong Substation Control cables 2. Thanaleng Substation 22 kV power cables and control cables 3. Thatluang Substation 22 kV power cables and control cables 4. Sisaket Substation 22 kV power cables and control cables 5. Watty Substation 22 kV power cables and control cables

CHAPTER 5 BASIC DESIGN ON REHABILITATION PROJECT

Following the examination into the request and the plan of the project in the preceding chapter, the basic design was prepared for the rehabilitation project for each substation, including:

- repair and replacement plan of substation equipment
- replacement plan of tele-metering, tele-signalling and tele-communication equipment
- supply plan of materials, parts, tools and vehicles for maintenance use
- training program for operation and maintenance of substations.

In preparing the basic design, following design criteria are applied to the project.

- (1) Since there are no particular standards in Lao PDR at present and all materials, parts and equipment supplied under the project will be Japanese products, Japanese current standards such as JIS, JEC, JEM, etc. are mainly adopted for design and manufacturing of materials equipment, etc. except for special equipment.
- (2) Equipment whose spare parts are difficult to obtain will be replaced with new equipment in consideration of prevention of similar troubles in future operation.
- (3) The extremely complicated model of equipment will not be used to avoid operation and maintenance unfamiliar to EDL.
- (4) Local products will be used as much as possible.

Basic designs on the rehabilitation of substation equipment, tele-supervisory and tele-communication equipment and equipment and materials for the maintenance use are summarized in the following tables.

It is noted that there may possibly be amendments in the items and quantities in the tables for ancillary equipment related with the power line carrier facilities, in case the existing ancillary

equipment installed on the live lines are confirmed to be suitable for the replaced system during the detailed survey.

5.1 Phone Tong Substation

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Q'ty
(1) Inspection & Repair (Reference made to Appendix-7)				
a) 115/22kV Transformers				
(i) No.1 Unit	<ul style="list-style-type: none">- inspection, cleaning, adjustment & painting- purifying and deairing of insulation oil in main tank- supplement of insulation oil to bushing- decomposition & inspection of cooling fan	<ul style="list-style-type: none">- outdoor-type, 3-phases, 22 MVA with an on-load tap-changer	unit	1
(ii) No.2 Unit	<ul style="list-style-type: none">- inspection, cleaning, adjustment & painting- purifying and deairing of insulation oil in main tank- decomposition & inspection of cooling fan	<ul style="list-style-type: none">- outdoor-type, 3-phases, 22 MVA with an on-load tap-changer	set	80
(iii) No.3 Unit	<ul style="list-style-type: none">- inspection, cleaning, adjustment & painting- purifying and deairing of insulation oil in main tank- decomposition & inspection of cooling fan	<ul style="list-style-type: none">- outdoor-type, 3-phases, 30 MVA with an on-load tap-changer	unit	1
b) 115 kV Switchgears				
(i) Air Circuit Breaker	<ul style="list-style-type: none">- inspection, cleaning, adjustment & painting	<ul style="list-style-type: none">- outdoor-type, 800 A, 1,500 MVA	set	9
(ii) Disconnecting Switch	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- outdoor-type, 800 A	set	26
(iii) Potential Transformer	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- outdoor-type, 1-phase, 110 kV/110V	set	8
(iv) Current Transformer	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- outdoor-type, 500/5A	set	9
(v) Lightning Arrester	<ul style="list-style-type: none">- ditto -		set	2
c) 22 kV Switchgear				
(i) Oil Circuit Breaker	<ul style="list-style-type: none">- inspection, cleaning, adjustment & painting	<ul style="list-style-type: none">- outdoor-type, 24 kV, 1,200 A, 1,000 MVA	set	1
(ii) Disconnecting Switch	<ul style="list-style-type: none">- inspection, cleaning, adjustment & painting	<ul style="list-style-type: none">- outdoor-type, 24 kV	set	28
(iii) Potential Transformer	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- ditto -	set	2
(iv) Current Transformer	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- ditto -	set	13
(v) Lightning Arrester	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- ditto -	set	2
(vi) Station Service Trans.	<ul style="list-style-type: none">- ditto -	<ul style="list-style-type: none">- outdoor-type, 3-phases, 5,000 kVA with reactor (L: 6%) & discharge coil	unit	1
(vii) Static Condenser	<ul style="list-style-type: none">- ditto -		bank	1

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
d) Control Panel & Ancillaries				
(i) Distribution Panel	- inspection	- indoor-use self-standing type (with front & rear panel)	panel	15
(ii) Protection Relay	- inspection, calibration & operation	- 30 relays for bus & trans., 50 relays for lines	piece	80
(iii) Indicating Meter	- ditto -		piece	120
e) Other Facilities				
(i) Air Compressor	- inspection, cleaning, adjustment & painting	- indoor-type AC & DC	unit	2
(ii) Control Panel for the above	- ditto -	- indoor-use self-standing type	panel	1
(iii) Air Pipes	- inspection for air-leakage		m	200
(Miscellaneous Materials for Inspection & Repair)			Lot	1
(2) Replacement & Modification				
a) 115/22kV Transformers				
(i) No.1 Unit	- replacement of insulation oil in cam chamber - replacement of motor-driven operation mechanism - replacement of gaskets - replacement of relay No.57 for fan		l	80
(ii) No.2 Unit	- replacement of insulation oil in cam chamber - replacement of relay No.57 for fan		unit	1
(iii) No.3 Unit	- replacement of insulation oil in cam chamber		unit	1
b) 115 kV Switchgears			set	1
(i) Air Blasting Breaker	- replacement of cover for indicating lamp - additional installation of protective cover for air-pipes at the equipment		l	80
(ii) Disconnecting Switch	- replacement of dropper from transmission line - replacement of operation box	- ACSR 240 sq.mm	set	80
(iii) Potential Transformer	- replacement of terminal box		phase box	1
			box	26
			box	3

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
c) 22 kV Switchgears				
(i) Oil Circuit Breaker	- replacement of breaker	- 24 kV, 630 A, 20 kA, Vacuum Circuit Breaker	unit	14
(ii) Disconnecting Switch	- replacement of switch - replacement of operation box	- 24 kV, 600 A	unit box	1 28
(iii) Potential Transformer	- installation of additional set to 2ry bus of No.2 transformer	- 22 kV/110V, 3-phase	set	1
(iv) Current Transformer	- installation of additional set - replacement of 2 sets on static condenser circuit - replacement of gasket	- 400-200-100/5A - 600-300/5A	set set	1 2
(v) Lightning Arrester	- additional installation on outgoing feeders		set	1
(vi) Station Service Trans.	- replacement of power cable on 2ry circuit - replacement of cable termination	- 600V, CV. 250 sq.mm 3 cores - for outdoor and indoor type	m each	200 2
(vii) Static Condenser	- additional installation of 20,000 kVA - modification on bus for the circuit	- condenser: 5,000 kVA/bank - vacuum circuit breaker - vacuum switch - disconnecting switch - discharging coil - series reactor (L-6%) - bus modification	bank set set set set set curcuit	4 1 3 1 4 4 1
d) Control Panel & Ancillary				
(i) Distribution Panel	- supply of name plate for change-over switch - indication lamp		piece piece	20 20
(ii) DC Source Apparatus	- replacement of batteries - - ditto - - floor painting of battery room - supply of DC panel for 48V circuit	- 52 cells of DC 104V & 210AH - 24 cells of DC 48V & 60AH - indoor-type for 5 circuits	set set sq.m panel	1 1 50 1

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
e) Other Facilities				
(i) Air Compressor	- replacement with new compressor	- AC driven compressor	set	2
(ii) Drainage Pump	- supply of pump		set	1
	- replacement of control panel		panel	1
(iii) Air Conditioner	- replacement	- air-cooling & floor type for 100 sq.m/unit	unit	3
f) Concrete Foundation		- for 22 kV circuit breakers	cub.m	20
		- for 22 kV potential transformer for No.3 unit	cub.m	5
		- for static condenser	cub.m	120
		- for drainage pump	cub.m	5
g) Shift of Condenser		- 5,000 kVA with ancillaries	bank	1

5.2 Thanaleng Substation

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
(1) <u>Inspection & Repair</u> a) 115/22kV Transformer b) 115 kV Switchgear (i) Air Circuit Breaker (ii) Disconnecting Switch (iii) Potential Transformer (iv) Current Transformer (v) Lightning Arrester (Miscellaneous Materials for Inspection & Repair)	<ul style="list-style-type: none"> - inspection, cleaning, adjustment & painting - purifying and deairing of insulation oil in main tank - decomposition & inspection of cooling fan - inspection, cleaning, adjustment & painting - ditto - - ditto - - ditto - - ditto - 	<ul style="list-style-type: none"> - outdoor-type, 3-phases, 10 MVA with an on-load tap-changer - outdoor-type, 800A, 1,500 MVA - outdoor-type, 800A - outdoor-type, 1-phase, 110kV/110V - outdoor-type - outdoor-type 	unit	1
			set	8,000
			set	4
			set	1
(2) <u>Replacement & Modification</u> a) 115/22kV Transformer b) 115 kV Switchgears (i) Air Circuit Breaker c) 22 kV Switchgears (i) Indoor Metal-enclosed Switchgear Cubicles	<ul style="list-style-type: none"> - replacement of insulation oil in cam chamber - replacement of cover for indicating lamp - replacement of cubicles 	<ul style="list-style-type: none"> - indoor type metal-enclosed switchgear cubicle (existing) 1 cub. for 2ry of main transformer 3 cub. for distribution lines 1 cub. for station trans. 1 cub. for potential & auxiliary transformer 	set	80
			set	1
			cubicle	5
			Lot	1

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
d) Civil Works				
(i) Wall of Building	- removal of wall between switchgear room and store room	- concrete mixture of 1:2:4	sq.m	42
(ii) Cable Duct	- modification on existing cable duct	- ditto-	cub.m	7

5.3 Thatluang Substation

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
<u>Replacement & Modification</u> a) 22 kV Switchgears (i) Indoor Metal-enclosed Switchgear Cubicles	- replacement of cubicles	- indoor-type metal-enclosed switchgear cubicle (existing) - indoor-type metal-enclosed switchgear cubicle (new) 2 cub. for transmission line 4 cub. for distribution line 1 cub. for station trans. 1 cub. for potential trans. 2 cub. for spare	cubicle	7
b) Control Panel & Ancillary (i) Control and Relay Panel (ii) DC Source Apparatus c) Civil Works (i) Foundation for Cubicles (ii) Cable Ducts	- additional installation - replacement of battery & battery charger - ditto - concrete foundation for new outdoor-type cubicles - modification on existing cable ducts	- indoor-type self-standing panel for the above - 52 cells of DC 104 V, 90 AH - 24 cells of DC 48 V, 60 AH - concrete mixture of 1:2:4 - ditto -	panel set set	4 1 1
			cub.m	27
			cub.m	15

5.4 Sisaket Substation

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
<u>Replacement & Modification</u> a) 22 kV Switchgears (i) Indoor Metal-enclosed Switchgear Cubicles	- replacement of cubicles	- indoor type metal-enclosed switchgear cubicles (existing) 5 cub. for transmission line 6 cub. for distribution line 1 cub. for station trans. 1 cub. for potential trans. 1 cub. for spare	cubicle	12
		- 52 cells of DC 104 V, 90 AH - 24 cells of DC 48 V, 60 AH	set	1
b) Control Panel & Ancillary				
(i) DC Source Apparatus	- replacement of battery & battery charger		set	1
c) Other Facilities	- ditto -			
(i) Clock System	- replacement of existing disorder system		set	1
d) Civil Works				
(i) Cable Duct	- modification on existing cable ducts		cub.m	5
e) Temporary Works				
(i) Before Modification	- temporary installation of 16 cubicles at Sisaket substation and temporary connection of 11 circuits of distribution lines.		cubicle	16
(ii) After Modification	- removal of the above cubicles and connection.		connection	16
			cubicle	16
			connection	16

5.5 Wattay Substation

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
(1) Replacement & Modification a) 22 kV Switchgears (i) Indoor Metal-enclosed Switchgear Cubicles	- replacement of cubicles	- indoor-type metal-enclosed switchgear cubicle (existing)	cubicle	7
		2 cub. for transmission line 4 cub. for distribution line 1 cub. for station trans. 1 cub. for potential trans. 2 cub. for spare		
b) Control Panel & Ancillary (i) Control and Relay Panel (ii) DC Source Apparatus c) Civil Works (i) Foundation for Cubicles (ii) Cable Ducts	- additional installation - replacement of battery & battery charger - - concrete foundation for new outdoor-type cubicles - modification on existing cable ducts	- indoor-type self-standing panel for the above - 52 cells of DC 104 V, 90 AH - 24 cells of DC 48 V, 60 AH - concrete mixture of 1:2:4 - - ditto -	panel	4
			set	1
			set	1
			cub.m	27
			cub.m	15

5.6 Materials for Maintenance Use

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
(1) <u>Spare Materials</u>	- supply of spare materials and parts for 2 years	- minor spare parts to be frequently replaced of various equipment	Lot	1
(2) <u>Tools and Testing Equipment</u>	- supply of necessary tools and testing or measuring equipment	- various tools, testers, measuring equipment for common use of substations	Lot	1
(3) <u>Vehicles for Maintenance</u>	- supply of vehicles for maintenance	- 1,800 to 2,000 c.c, pick-up type 4 WD vehicle mounted with mobile radio (25 W, 145 MHz)	car	4
a) Vehicles	- supply of motor cycles	- 125 c.c capacity	unit	10
b) Motor cycles	- supply of radio set with antenna	- for use of mobile radio communication of Sisaket	station	1
c) Radio Base-station				
(4) <u>Replacement of 22kV Power Cables and Control Cables</u>	- for connection to distribution lines at poles	- 22 kv steel tape armoring CV cables, 200sq.mm x 3cores	m	500
a) 22 kv Power Cable	- for connection to transmission and distribution lines	- ditto -	m	1,000
(i) Thanaleng Substation	- ditto -	- ditto -	m	2,000
(ii) Thatluang Substation	- ditto -	- ditto -	m	1,000
(iii) Sisaket Substation				
(iv) Wattay Substation				
b) 22 kv Cable Terminal Materials	- works of termination of 22kv power cables	- for outdoor use termination of the above 22kv cable	set	3
(i) Thanaleng Substation	- ditto -	- ditto -	set	6
(ii) Thatluang Substation	- ditto -	- ditto -	set	12
(iii) Sisaket Substation	- ditto -	- ditto -	set	6
(iv) Wattay Substation	- ditto -	- ditto -	set	7
(v) Thanaleng Substation	- ditto -	- ditto -	set	8
(vi) Thatluang Substation	- ditto -	- ditto -	set	12
(vii) Sisaket Substation	- ditto -	- ditto -	set	8
(viii) Wattay Substation	- ditto -	- ditto -	set	8

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
c) Control Cable				
(i) Phone Tong Substation	- works of control cables	- 600 V, CVV, 3.5 sq.mm x 2 cores	m	1,500
		- 600 V, CVV, 3.5 sq.mm x 6 cores	m	2,200
(ii) Thanaleng Substation	- ditto -	- 600 V, CVV, 8.0 sq.mm x 4 cores	m	1,300
		- 600 V, CVV, 3.5 sq.mm x 2 cores	m	100
(iii) Thatluang Substation	- ditto -	- 600 V, CVV, 3.5 sq.mm x 6 cores	m	200
		- 600 V, CVV, 8.0 sq.mm x 4 cores	m	200
(iv) Sisaket Substation	- ditto -	- 600 V, CVV, 3.5 sq.mm x 2 cores	m	100
		- 600 V, CVV, 3.5 sq.mm x 6 cores	m	200
(v) Wattay Substation	- ditto -	- 600 V, CVV, 8.0 sq.mm x 4 cores	m	200
		- 600 V, CVV, 3.5 sq.mm x 2 cores	m	100
		- 600 V, CVV, 3.5 sq.mm x 6 cores	m	200
		- 600 V, CVV, 8.0 sq.mm x 4 cores	m	200
d) Cable Terminal Materials	- works of termination of control cables	- compression terminal for 3.5 sq.mm	pcs	2,000
		- compression terminal for 8.0 sq.mm	pcs	600
		- insulation tape (2 m/coil)	coil	100
e) Materials for Tentative Use of Cubicles				
(i) 22 kV Power Cables	- tentative works for utilizing cubicles for Thatluang and Wattay substations at Sisaket substation	- 22 kV steel tape armoring CV cables, 200sq.mm x 3cores	m	600
(ii) 22 kV Power Cables		- straight joint for the above cable	set	11
(iii) Control Cable		- indoor use cable termination materials	set	13
		- 600 V, CVV, 3.5 sq.mm x 2 cores	m	600
		- 600 V, CVV, 3.5 sq.mm x 6 cores	m	1,100
		- 600 V, CVV, 8.0 sq.mm x 4 cores	m	600
		- 600 V, CVV, 14.0 sq.mm x 2 cores	m	600
(iv) Termination of the Above		- compression terminal for 3.5 sq.mm, 8.0 sq.mm & 14.0 sq.mm with insulation tape	pcs	3,000
			coil	50

5.7 Equipment for Telemetering, Telesignalling and Telecommunication

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
(1) Replacement & Modification				
a) Phone Tong Substation	<ul style="list-style-type: none">- installation of remote station equipment- installation of interface panel- connection of existing contact & installation of transducer- control cabling- installation of Recording Watthour Meter	- 100 signalling elements & 50 metering elements	element	150
			panel	1
			panel	1
			panel	1
			piece	1
			piece	1
b) Thanaleng Substation	<ul style="list-style-type: none">- installation of remote station equipment- installation of interface panel- connection of existing contact & installation of transducer- control cabling- installation of Recording Watthour Meter	- 20 signalling elements & 20 metering elements	element	40
			panel	1
			panel	1
			panel	1
			piece	1
			piece	1
c) Thatluang Substation	<ul style="list-style-type: none">- installation of remote station equipment- installation of interface panel- controle cabling- installation of Recording Watthour Meter	- 12 signalling elements & 20 metering elements	element	32
			panel	1
			panel	1
			panel	1
			piece	1
d) Sisaket Substation	<ul style="list-style-type: none">- installation of remote station equipment- installation of interface panel- control cabling- installation of Recording Watthour Meter	- 20 signalling elements & 32 metering elements	element	52
			panel	1
			panel	1
			panel	1
			piece	1
e) Wattay Substation	<ul style="list-style-type: none">- installation of remote station equipment- installation of interface panel- control cabling- installation of Recording Watthour Meter	- 12 signalling elements & 20 metering elements	element	32
			panel	1
			panel	1
			panel	1
			piece	1
f) Sckpalouang Substation	<ul style="list-style-type: none">- installation of remote station equipment- connection of existing contact & installation of transducer- control cabling	- 16 signalling elements & 24 metering elements	element	40
			panel	1
			Panel	1

Item of Rehabilitation	Details of Rehabilitation	Specification for Items	Quantities	
			Unit	Qty
g) Sisaket Center	- installation of master station equipment		unit	1
	- installation of interface panel		panel	1
h) Power Line Carrier (PLC) Telephone System	- installation of System Diagram Board	- indoor use self-standing type	board	1
	- installation of recording meter panel	- - ditto -	panel	1
(i) 115 kV & 22 kV PLC	- control cabling		panel	2
	- installation of line trap	- 400 A	pair	5
(ii) Telephone System	- installation of coupling condenser		pair	5
	- installation of coupling filter		pair	5
	- installation of terminal equipment		set	12
	- installation of automatic exchanger	- for 30 subscribers including spares	set	1
	- installation of telephone set		set	20

5.8 Field Works

Professional techniques are required for inspections, repairs, replacements, adjustments and tests of substation equipment, tele-supervisory and tele-communication equipment in the project. Besides, the works include approaching live parts and operation during temporary energizing shutdowns, which has possibilities of causing injuries to workers and damages to equipment.

In order to achieve proper works in a limited time and to prevent troubles by unexperienced workers, the field works will be performed by a Japanese contractor.

Civil works such as remodelling of a part of building wall and cable ducts in Sisaket and Thanaleng substations, construction of foundations for additional equipment and for the replaced equipment after removal of the existing foundations (Phone Tong, Thatluang and Wattay substations) are required, which will also be carried out by a Japanese contractor using local products.

5.9 Training Program for Operation and Maintenance

In order to operate and maintain the rehabilitated substations properly, training to EDL's workers is programed on acquirement of function of equipment and substation, prevention of deterioration and faults of equipment, and restoration of failure. In addition, necessary drawings and manuals will also be prepared during the period of the project.

- (1) Field training on substation, tele-supervisory and tele-communication equipment:

During the field works at each substation EDL's technicians will engage themselves in actual works together with the Japanese contractor, through which they will be trained on composition, function and maintenance of various equipment.

- (2) Training on operation and maintenance of substations:

The consultant will train the technicians for operation of substation through daily and regular inspection and maintenance

of equipment following the manual stated below. Such training will be repeated to all operators, and crew.

(3) Provision of drawings:

There is no complete set of drawings of substations such as general layout drawing of each substation, electrical connection diagrams or drawings of individual equipment and facility. Missing of such drawings causes EDL various hindrances for operating and maintaining the substations and repairing the faulty equipment. The consultant will prepare those with cooperation of EDL during the project implementation.

(4) Preparation of operation and maintenance manuals:

There are no operation and maintenance manuals of substations in EDL at present. Since the manual is indispensable for proper operation and maintenance of the facilities, the consultant will prepare the manuals for each substation.

CHAPTER 6 EXECUTION OF THE PROJECT

6.1 Organization of the Project Execution

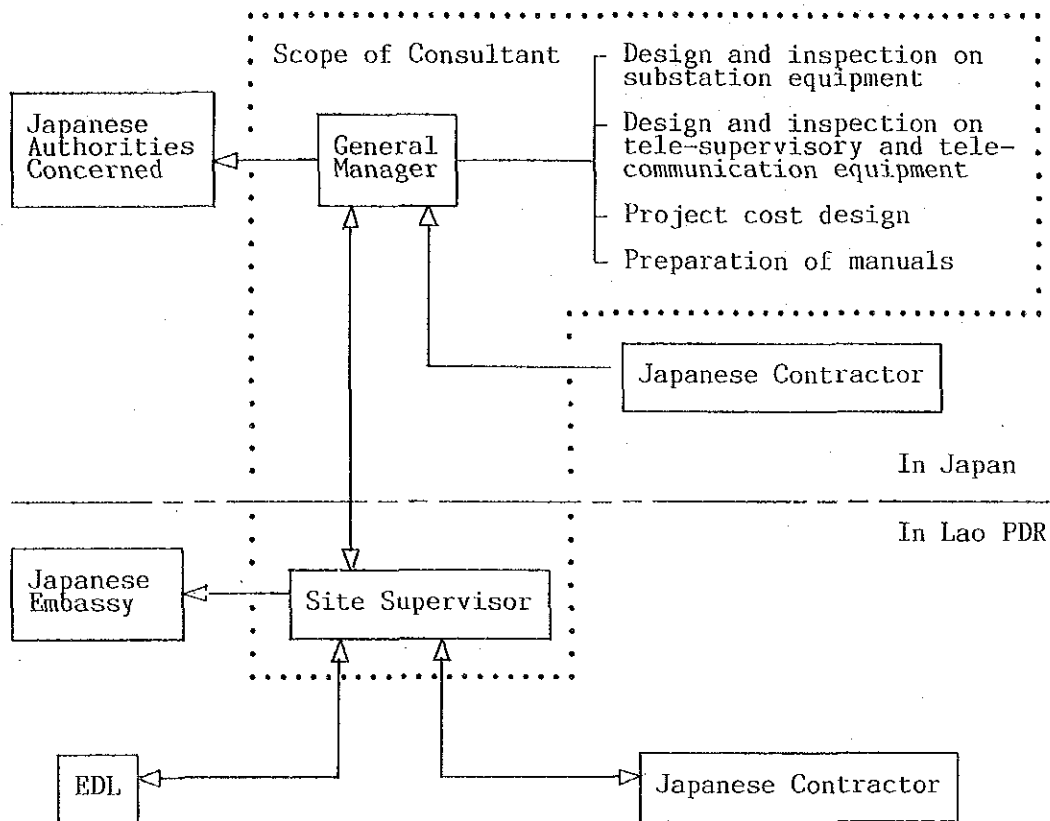
The Government of Lao PDR appointed EDL as the executing agency of the project.

The appointment to EDL is appropriate for EDL's rich experiences on operation and maintenance of substations and also for the present excellent financial status which will continue with receipts for domestic energy sales and exported energy expected to increase after completion of the project.

As seen in "Organization of EDL" on Figure-2, a new department is established under Technical Division for executing the rehabilitation project. The supreme responsible person for the project is the general manager of EDL, and the manager of technical division and the manager of the substation rehabilitation department are directly to manage the project. During the project execution, a Japanese consultant will contact the manager of the department.

For executing the project EDL will select a Japanese contractor in competitive bid under assistance of the Japanese consultant and entrust the contractor to supply of equipment and materials and installation, adjustments and tests on them.

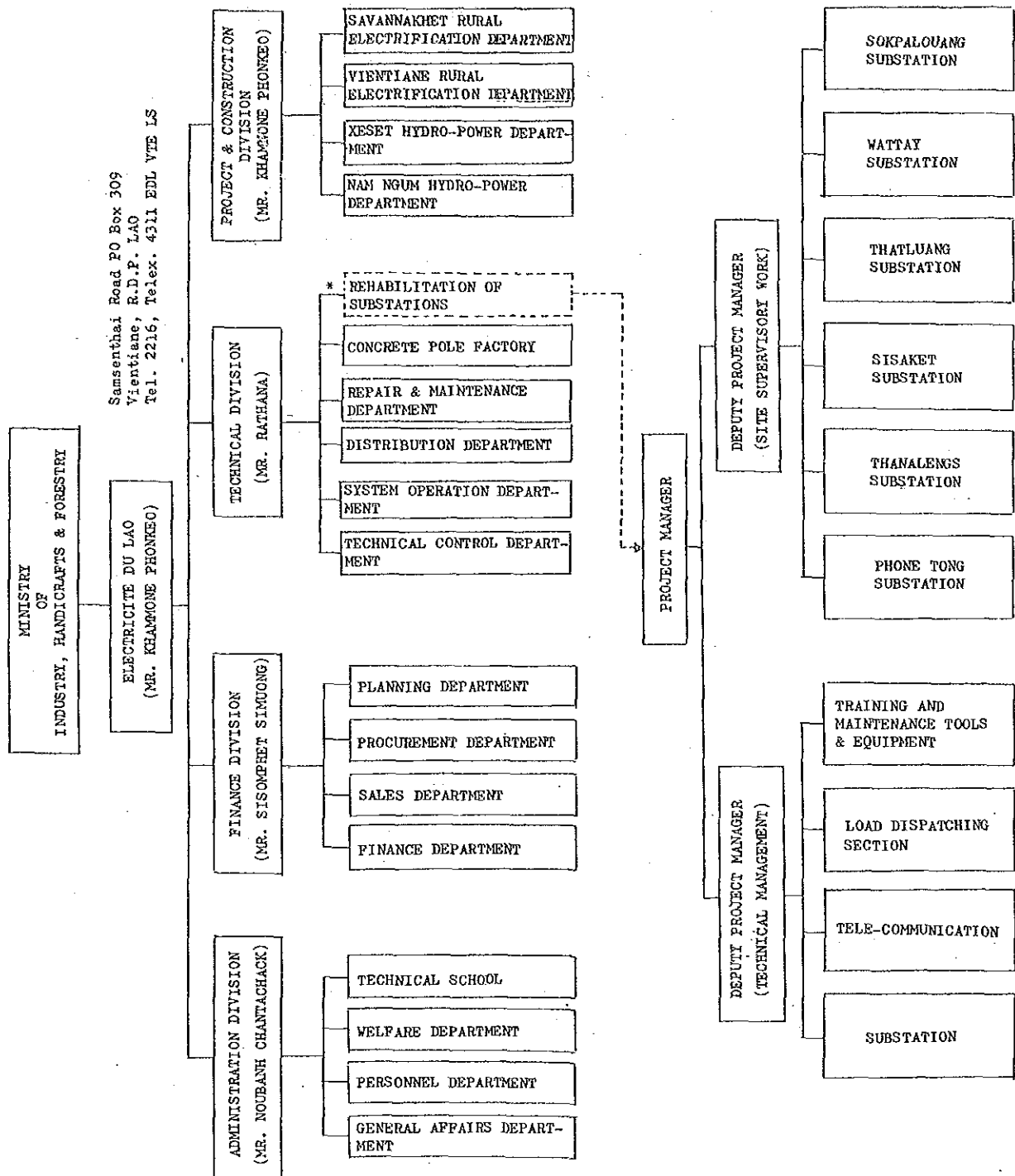
The project will be executed under the following organization.



6.2 Scope of the Work

Scope of the substation rehabilitation project covered under Japan's Grant Aid Program is mainly for the following works:-

- (1) Inspection, cleaning and adjustment of the existing equipment and ancillaries
- (2) Repair of deteriorated or damaged parts of equipment and ancillaries
- (3) Replacement of deteriorated, incapable or damaged equipment
- (4) Installation of additional equipment for reinforcing the protection of the existing facilities
- (5) Field training of EDL's workers on the above inspection, repair, replacement and installation of the equipment and ancillaries



- (6) Supply of vehicles for operation and maintenance use
- (7) Supply of spare materials, tools and testing equipment for maintenance of substations
- (8) Preparation of drawings and manuals for operation and maintenance of substations
- (9) Field training of EDL's workers on operation and maintenance of substations

While, the major undertakings to be taken by Lao PDR for executing the project are as follows:-

- (1) To furnish data, drawings and documents necessary for the detailed design
- (2) To ensure transportation through Thailand, unloading and customs clearance at port of disembarkation in Lao PDR for equipment, apparatus, materials, vehicles and tools necessary for the project including tax exemption and customs clearance of the products
- (3) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contract such facilities as may be necessary for their entry into Lao PDR and stay therein for the performance of their work
- (4) To issue traffic certificates and other certificates necessary for execution of the project to the consultant and contractor
- (5) To bear the advising commission of authorization to pay and the payment commission to the Japanese foreign exchange bank for the banking services based upon the banking arrangement
- (6) To bear necessary expenses for other works than those not included in the Japan's Grant Aid Program for this project
- (7) To properly maintain the rehabilitated equipment and substations after completion of the project

- (8) To arrange labour forces and construction machineries to Japanese consultant and contractor for the project: (Since foreigners are unable to employ local workers directly at present and there are no suppliers of construction machineries in the area, EDL is requested to arrange the labour forces and machineries.)
- (9) To issue certificates for purchasing fuel for vehicles and machineries for Japanese consultant and contractor
- (10) To secure necessary shutdowns on the substations and distribution lines to meet the execution program of the project

The Consultant will assist EDL for technical management of the project following the principle of Japan's Grant Aid Program and take charge for the undermentioned works:

- (1) To confirm the basic design on the project and the project budget through the field survey for the detailed design
- (2) To prepare the detailed design and the execution program in prior to the preparation of the tender documents
- (3) To prepare the tender documents, to evaluate the results of tendering and to attend the negotiation and contract between EDL and the tenderer or the contractor
- (4) To study and approve the contractor's drawings, to inspect products before shipment and to supervise installation, adjustment and tests on equipment and apparatus
- (5) To confer with EDL and the contractor on the business concerned with the project
- (6) To prepare the reports and certificates for progress of the project
- (7) To issue the completion certificate and to commission the project

- (8) To prepare drawings and manuals necessary for operation and maintenance of substation equipment, tele-supervisory and tele-communication equipment.
- (9) To train EDL's workers for operation and maintenance of substations during the period of the field works

The contractor will carry out the following undertakings:-

- (1) To manufacture substation equipment and materials related to the project
- (2) To test the above-mentioned products in the factories in the presence of the consultant
- (3) To bear packings for export and transportation of the products from the factories to each substation in Vientiane area
- (4) To test the substation equipment and to repair the parts where necessary
- (5) To repair, replace, install, adjust and test of substation equipment at site
- (6) To manufacture the tele-supervisory and tele-communication equipment and to test the products in the factories in the presence of the consultant
- (7) To bear packings for export and transportation of the products from the factories to each substation in Vientiane area
- (8) To replace, adjust and test the equipment in the abovementioned (6) at site
- (9) To manufacture materials, tools and vehicles for maintenance use, to test the products in the factories in the presence of the consultant, to bear packings for export and to transport the products from the factories to EDL's store in Vientiane
- (10) To insure all the products and field activities for the abovementioned works

- (11) To train EDL's employees on maintenance of equipment supplied under the project during the period of the field works

6.3 Plan of Execution

The project will be executed in the formation and scope of works as stated in (6.1) and (6.2) above. The following are problems which may occur in the project execution, countermeasures against the problems and training program for EDL's employees.

(1) Problems and countermeasures for the field execution

The rehabilitation work requires professional experiences as stated in the preceding (5.8). Since there is no such experienced contractor in Lao PDR, a Japanese Contractor will undertake the field works.

Since circumstances require foreigners to employ local workers through the Government, the Japanese contractor is to employ workers arranged by EDL's employees, especially from among operators and maintenance crew of substations. This is an opportunity for them to learn actual composition or function of equipment and to turn familiar with repair and maintenance. The same arrangement was employed for the rehabilitation project of No.1 and 2 turbines and generators in the first Nam Ngum power station, which was successfully completed.

This project is also expected to proceed smoothly and effectively in the manner.

For executing the project, shutdowns for a period of 8 hours to several days are required on substations and lines. However, there are 3 circuits of 115 kV transmission line providing a sufficient capacity, and therefore the rehabilitation works on 115 kV equipment in Phone Tong and Thanaleng substations can be achieved without hindrances to domestic customers and also electric power export to Thailand by shutting down the transmission lines alternately.

Month after Exchange of Notes	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Exchange of Notes	▽	▽																							
Contract of Consultant	▽	▽																							
Detailed Field Survey																									
Detailed Design																									
Preparation of Tender Documents																									
Tendering																									
Contract for Execution																									
Design and Approval on Manufacturing Drawing																									
Manufacturing																									
Transportation to Site																									
Field Execution																									
Field Test and Commissioning																									
Training																									

▬ : substation equipment (1st contract)

▬ : equipment for the tele-metering, tele-signaling and tele-communication (2nd contract)

▬ : (installation under 2nd contract)

While, 22 kV distribution lines from each substation are interconnected with each other in the system; consequently, even if a line normally supplying energy to an area is shutdown at a substation, energy is to be supplied to the area through another route. On the other hand, simultaneous shutdown of all direct 22 kV lines from Phone Tong substation to each substation is to cause troubles to the system. However it is also solved by arranging to shutdown 5 circuits of 22 kV secondary transmission lines alternately. Thus, shutdowns of the lines and substations required for the project will not affect the energy supply to the system at all.

Since urgent rehabilitation of substations is required, the project shall be immediately implemented after the Exchange of Notes is concluded between both Governments.

(2) Training on operation and maintenance of substations

Training program stated in the preceding (5.9) will be implemented by both the consultant and the contractor through the period of field works at site.

The consultant will conduct over the actual operation and maintenance of each substation and overall system management of substations. Drawings necessary for maintenance will also be prepared by the consultant.

The contractor will conduct over training on the compositions, functions inspections and repairs of individual equipment installed in the substations through the actual field works by the contractor on inspection, repair, installation, adjustment and test of the equipment. The contractor will also submit to EDL and explain to the trainees detailed drawings and manuals of equipment supplied by him.

Thus, the training program to be conducted by both the consultant and the contractor will cover the whole operation and maintenance of substations from handling individual equipment to overall substation system.

6.4 Plan of Procurement and Transportation of Equipment

(1) Procurement of equipment

Materials procurable in the country are those for civil and architectural works only.

All equipment and materials other than those procurable locally will be manufactured in and transported from Japan, as stated in Chapter 5.

(2) Transportation

Lao PDR imports all kind of goods through the neighboring countries due to the landlocked situation. Cargoes for this project will be landed at the port of Bangkok, from where the cargoes will be delivered on trucks to Nong Khai, a border town of Thailand along Mekong river, and then the cargoes will transit over the river by ferry boats to the port of Thanaleng in the country. Customs formalities are necessary at both Nong Khai and Thanaleng. The cargoes from the port of Thanaleng to each substation will be transported by trucks on paved roads.

Packings for equipment and materials supplied under the project are not special but normal timber-enclosed type used for substation and telecommunication equipment.

Taking account of 2 to 3 weeks for marine transportation from Japan to Bangkok, 2 weeks at least at the port of Bangkok for unloading and customs formalities and about 2 weeks for land transportation from Bangkok to the sites in Vientiane area, necessary period for cargo transportation is estimated at 2 months from Japan to the substation sites.

Both substation and tele-supervisory equipment with telecommunication equipment will be transported in two or three shipments respectively, according to their manufacturing schedules.

6.5 Schedule of Execution

As seen on the time schedule on page 65, the manufacturing of the substation equipment will take 5 months and that of

tele-metering, tele-signalling and tele-communication equipment will take 8 months. Consequently, 21 months for the former equipment and 20 months for the latter equipment are required from conclusion of the Exchange of Notes by the both Governments to completion of the project. Supply of the substation equipment and ancillaries is scheduled during the first year because they are more urgently needed for restoration of the substations, while in the second year, installation of the substation equipment and supply and installation of tele-metering, tele-signalling and tele-communication equipment are scheduled.

Meteorological records in the attached Table-1 show that rainy season in the country is normally from May to October. Even if the case that installation of most of the equipment for the project is to be achieved during the rainy season, apprehensions for delay of the project due to rain will be solved by adjusting the field work schedule for outdoor and indoor works.

In order to shorten the execution period, a prior notice of the Government of Lao PDR to Thailand is expected to be arranged so as not to cause delay and troubles for unloading and transportation of the cargoes in Thailand.

Commissioning of the works will be made per each substation completed, after inspection on all equipment and synthetical test of the substation.

6.6 Plan of Operation and Maintenance

Current organization of EDL for operation and maintenance of the substations is as seen in the following table. Each substation is operated by three (3) shifts. A shift consists of 2 to 5 operators and duty of a shift is 12 hours, which are deemed not hard taking account of the scale of the substation.

Repairing work for the failed equipment is performed by Repair and Maintenance Department.

Operation and maintenance of the rehabilitated substations are also managed by the same organization and system, to which no

particular problem exists. However, it is recommendable that the present three shifts system will be improved to four shifts system for safer operation in future when a number of operators will be available.

Substation	Nos.of Shift	Chief of Shift	Operators/Shift	Maintenance Crew
Phone Tong	3	1	4	
Sisaket	3	1	4	
Thanaleng	3	1	2	
Sokpalouang	3	1	3	25
Thatluang	3	1	2	
Wattay	3	1	2	
(52 km)	3	1	1	
<hr/>				
Total		21 (for 3 shifts)	54 (for 3 shifts)	25

