Chapter 11
Overview of the Facility Design

Chapter 11 Overview of the Facility Design

11.1 Selection of Facilities

The power system plan up to the year 2030 was formulated in Chapter 9. Among the projects in the power system plan, the transmission line for the section Pakbo - Taothan[1] - Saravan (hereinafter referred to "the project") was selected as the most prioritized project. The purpose of the project is to extend the transmission network from the Central 2 region to the Southern region.

Currently, only two power stations, the Theun Hinboun hydro power station (IPP for export) and the Nam Theun 2 (for domestic power supply) are operating in the Central 2 region. As the interconnecting transmission system for the transmission of surplus power from the Central 1 region to the Central 2 regions, the 115 kV 2 cct transmission line for the section Pakxan - Thakhek - Pakbo is under construction. According to the power demand-supply balance of the Central 2 region up to the year 2030, however, the power supply shortage is expected to last only with the power development of the Nam Nguang 8, Tadslen, Nam Ngiep Regulating, Nam Theun 1 (for domestic supply), and the Xeneua hydro power station up to the year 2017 and the development of the Xeban Hieng 1 hydro power station in 2025. As a result of this chronic power supply shortage during the dry season, the Central 2 region has to rely heavily on power imports from Thailand through Thakhek and Savannakhet (Pakbo substation). In order to reduce the import power and improve the demand-supply balance in the Central 2 region during the dry season, it is considered effective to transmit surplus power from Southern region to the Central 2 region via the project.

The scope of the project encompasses construction of the interconnecting transmission line between the Central 2 and South regions and the substations in the section Pakbo - Taothan - Saravan. The project is outlined as follows:

a) Construction of the 115 kV transmission line facility with the double-circuit TACSR 240 mm^2 conductor in the section between the existing Pakbo substation and the Saravan substation, which is to be constructed by 2011 under the IDA fund in order to meet start of operations of the Houaylamphan hydro power station in 2014.

b) Extension of existing 115/22 kV Pakbo substation

d) Extension of newly planned 115/22 kV Saravan substation

e) Construction of new 115/22 kV Taothan substation

(1) 115/22 kV Taothan Substation

The reasons for making a plan of 115/22 kV Taothan substation are as follows.

- The installation of 115/22 kV Taothan substation can contribute the distribution loss reduction, the improvement of the system reliability and the promotion of the rural electrification by curtailing the length of the distribution feeders that have been fed from Champasak province.
- The installation of the switching station at the expected location of 115/22 kV Taothan substation will be strongly required for maintaining the power system stability. The installation of the substation at that location can improve the power system stability for the 115 kV transmission system.

[1] "Taothan" is the same station as "Napon" or "Nongsano" written in the system analysis study.

- The preparation of the installation of a substation has been partially progressed by EDL because General Manager of EDL has been requesting the installation of this substation and EDL themselves have already selected and acquired the land for this substation.

(2) Transmission Voltage

The transmission voltage applied for the project has been selected from the following reasons.

- 230 kV would be less required from the viewpoints of its cost because the effects on the reduction of power reserve margin is saturated around 100-200 MW in accordance with the existing power generation plan up to 2030 even in case of increasing the capacity of the interconnection between the south and the central shown by the detailed power supply demand balancing simulations in the Section 9.3.3.
- The 115 kV-designed transmission line will have an enough capacity to transmit the power parallel using the route from Xepon to Mahaxay around 2030.

(3) Type of Conductor

TACSR 240 mm^2 has been considered to be adopted from the following reasons.

- ACSR 240 mm^2 will provide the system with an enough capacity up to 2020, however, the power flow may increase due to the planned power stations with several MW between Saravan and Taothan substation after 2020.
- Although the power transmission from the thermal power station in Saravan around 2030 will be carried out mainly by the transmission line with 230 kV, the power flow of this project may increase because the portion of the power may pass through the transmission line of this project.
- Uncertain developed capacity in the south area after 2020 may cause the increase in power flow of this project.

It can be considered effective to give a flexibility of the capacity of the transmission line of this project at a certain degree.

(4) Commissioning Year

The commissioning year of this highest prioritized project should match the start of the operation of the Houaylamphan hydropower station that will be the first large power station in the south region after 2014. Houaylamphan hydropower station has been scheduled to be operated financed by China. The commissioning year of this highest prioritized projects has been assumed 2014 because Laos agreed with China on the construction of Houay Lamphan that has been expected operated in 2014 when the EDL Managing Director visited to China in August 2009.

11.2 Design Policy

11.2.1 Design Principle

Design of the project facilities has been conducted principally in pursuant of the Lao Electric Power Technical Standard (LEPTS) and in referrance to international technical standards such as the IEC, BS, DIN, JIS etc. as well as common practices adopted by international consultants to similar facilities in Lao PDR. This section states the basic criteria applied for design of the project facilities that were determined through discussions with EDL as discussed in Chapter 5.

11.2.2 Substation Locations

The locations of the substations for the Project have been determined through map studies and site investigations by the Study Team and EDL.

1) Pakbo Substation

Although there are two 115 kV substations in Savannakhet Province, i.e. Pakbo SS and Kengkok SS, Pakbo SS has been selected to be connected to the new 115 kV transmission line under the Project due to technical and economical reasons cited in Chapter 9. Two transmission line bays for two circuits are to be installed under the Project at Pakbo SS.

2) Taothan Substation

There is no 115 kV facilities in Taothan Village in Saravan Province. A 22 kV distribution line from Bang Yo SS in Champasak Province supplies Taothan Village. New Taothan SS including four transmission line bays, 115/22 kV transformer, 22 kV switchgear, etc. is to be constructed under the Project. Land for new Taothan SS, 200 x 200 m, has already been acquired by EDL.

3) Saravan Substation

A new 115/22 kV substation is to be constructed in the suburb of Saravan town by 2011 under the GMS Power Trade Project funded by IDA. Sufficient land for the new substation has been acquired by EDL. For easy and stable operations and maintenance of the substation, the 115 kV transmission line from Taothan SS will be connected to this substation with the installation of two transmission line bays.

11.2.3 Selection of Transmission Line Routes

The Section 13.1 of this report stated the selection of the transmission line routes for the Pakbo – Taothan section and the Taothan - Sravan section. The team with EDL counterparts visited the sections during January, May and August 2009. During these site visits, the Team received from the EDL branch offices various information regarding the local features, city and regional development plans, their proposed power system extension plans, etc. The branch offices also gave the team an adequate route of the line for each section regarding the human habitations or the UXO circumstances. The Land of Taothan substation was acquired by EDL themselves after discussions between the team and EDL. Based on this information and recommendation of the branch offices and the results of the team's examination on Environmental law, NBCA (National Bio-diversity and Conservation Area), land acquisition and compensation, and other factors, the recommended line routes as shown on the enclosed maps were selected.

Connections of the incoming and outgoing transmission lines at each substation were also recommended in this report taking into account the easiness of the system's future expansion. Those details are discussed in the Section 14.1.

11.2.4 Climatic Conditions

The Study Team has examined climatic conditions collected from the local authorities in detail. The conditions for the facility design of the Project are discussed in Section 5.1 of Chapter 5. The following is a summary of the climatic design criteria for the facilities.

a) Atmospheric Temperatures

Maximum air temperature:	45 ℃
Minimum air temperature:	0 ℃
Annual mean air temperature:	25 ℃

b) Air Density

Basic air density to be applied for insulation design in the country was presumed to be 0.12, which should vary upon altitude of the project land.

c) Wind velocity

In accordance with LEPTS, 10 minutes mean wind velocity for applying the facility design was computed to be 35 m/s. From the velocity, basic wind pressure was determined as follows:

Conductors and groundwires:	790 N/m^2
Insulator sets:	1,100 N/m^2
Steel towers:	2,290 N/m^2 including pressure to real structure

d) Annual Rainfall

The country is characterized by a tropical climate with two distinct seasons; the rainy season from the beginning of May to the end of September and the dry season from October through April. The maximum annual rainfall in the country is 4,000 mm, and that in the project area is 1,920 mm in Savannakhet Province and 2,768 mm in Saravan Province. Such rainfall during the rainy season was in particular taken into account for examining the construction schedule.

e) Lightning (Isokeraunic Level)

The maximum and mean number of thunderstorm days per year in the project areas are recorded respectively as 40 and 28 against the maximum 141 days recorded over the country. The isokeraunic level in the project area is however assumed to be 140 for safety design and takes into account the insulation design of the facilities.

f) Seismic

The Lao PDR is not a seismically active country. Besides, the wind load is heavier for structures than the seismic load. Thus, the seismic load is not a consideration for the design of the facilities of the Project.

g) Other Conditions

For design conditions, the maximum humidity is assumed to be 100%, and pollution level to be light.

11.2.5 Environment

The design of project facilities needs to comply with Lao PDR environmental legislations. An alignment of the transmission line and the selection of the substation site should be designed in accordance with the principles provided in the Regulation on Environment Assessment and Regulation on Implementing Environmental Assessment for Electricity Project that “project’s negative impacts should be avoided or minimized with mitigation measures”. Taking into account the natural environment and socio-economic conditions in the project area, the following environmental and social requirements need to be fulfilled during the project’s design phase.

- Minimize resettlement in the area of Transmission Line Right-Of-Way (TL ROW) and substation site.
- Avoid protected areas such as NBCA in the area of TL ROW and substation site
- Assess the distribution spread and socio-economic conditions of ethnic minorities in order to create a mitigation plan to minimize their disadvantages.

- Examine the UXO risk and plan a budget for the clearance accordingly. Plan a project's implementation schedule taking into account the time frame on the UXO survey and clearance in order to complete those activities before starting any construction work.
- Hold meetings with stakeholders such as people residing in project areas and relevant local/ central governments from the project's early stages in order to disseminate information and gather their opinions for the betterment of project design.

The IEE, which is an obligation for all development projects in the F/S phase, was conducted in order to achieve the aforementioned requirements. The survey was carried out in order to be able to comprehend the natural and social environment in the project area, assess any negative impacts resulting from the project and develop mitigation measures to minimize such impacts. The result of the survey was addressed in the IEE main report, Environmental Management Plan (EMP) and Resettlement Action Plan (RAP). In addition, through conducting IEE, three types of the stakeholder meetings were held. Those results were integrated into the project design. The results of the IEE survey and stakeholder meetings are described in Chapter 15.

11.3 Operational Reliability of System Facilities

The project constitutes an important part of the future domestic bulk power supply system. Therefore, N-1 criterion was applied to the design of the project for the purpose of sustainable stable operation of the facitilies. On the other hand, the facilities under the project were designed aiming at the least cost system for the target year of 2030.

New substation facilities, except the Taothan substation, are to be constructed at the existing substation site. The new facilities and their functions were determined in order to be fully coordinated to existing facilities and to be flexible for future extension. The design of the substation layout took into account existing substation equipment, transmission line feeders, and connections to existing distribution lines.

The route of the new transmission line was selected with various advice received from EDL, taking into account safety, easeness of maintenance works, stable operations, and quick recovery after line faults.

Fundamental items for the operation and maintenance of the new transmission line and substation facilities such as the periodical maintenance and the methodology of the inspections were recommended.

11.3.1 Results of Facility Design

Facility design for the selected project has been achieved on the basis of the aforementioned design policy. During the site study periods, the study team and the counterparts visited the selected project site for obtaining further detailed information and for discussing the facility design with the EDL's branch offices in the project area. EDL's information and advice given to the Study Team during the site visit were useful for the design. In fully reflecting on the detailed investigation of the site visit, the facility design has been conducted. Results of the facility design are stated in the succeeding chapters.

11.4 Basic Plan of the Project Implementation

The project constitutes an important part of the future domestic bulk power supply system. Therefore, N-1 criterion was applied to the design of the project for the purpose of sustainable stable operation of the facitilies. On the other hand, the facilities under the project were

designed aiming at the least cost system for the target year of 2030.

New substation facilities, except Taothan Substation, are to be constructed at the existing substation site. The new facilities and their functions were determined in order to be fully coordinated to existing facilities and to be flexible for future extension. The design of substation equipment layout took into account existing substation equipment, transmission line feeders, and connection to existing distribution lines.

The route of the new transmission line was selected with various advice received from EDL, taking into account safety, easeness of maintenance works, stable operations, and quick recovery after line faults.

Fundamental items for the operation and maintenance of the new transmission line and substation facilities were recommended.

11.4.1 Rationale of the Project Implementation

Through formulation of the master plan study for the optimum power system, the Project for the section of Pakbo - Taothan - Saravan has been selected and agreed on by DOE/EDL as the highest priority project to be implemented.

In consideration of the government's power plant development program, rural electrification program, and the present progress of various electrification projects, the Project that aims to interconnect the domestic power grid and save imported energy is expected as earliest as possible.

Following the TOR of this Study, the Study Team achieved basic facility design of the project for a step of an instant implementation of the Project. The facility design of the Project has been achieved on the assumption of ICB (International Competitive Bidding) base for both equipment/materials and local installation including commissioning tests.

11.4.2 Rationale of the Project Implementation

For the acceleration of the project implementation to be completed by 2014 as a step for the main purpose of this Project stated above, following programs are recommended to be urgently taken by EDL.

(1) Financial Arrangement for the Project

EDL shall arrange foreign and local financial resources required for implementing the selected project. This JICA report provides such all materials for preparing the proposal for seeking the financial source as necessity of the project, effects of the project, budget of the project, evaluation of the project, implementation schedule, and others. The swift arrangement of necessary procedures is recommended.

(2) Procedures for Obtaining Environmental Compliance Certificate (ECC) by WREA[2]

ECC is to be obtained through the following procedures.

- Project owner (EDL) submits the IEE report with RAP to the DPRA (DOE)
- The DOE reviews the IEE report and RAP before submitting it to the WREA
- WREA reviews the reports for the approval of issuing the ECC

In the event that WREA's conclusion regarding project impacts is severe, an EDL will be

[2] WREA: Water Resource and Environment Agency

required for conducting Environmental Impact Assessment (EIA)[3]

As for the transmission line project, the EDL submits the IEE report and the RAP after completing the F/S. In case the project that the transmission line route had not been completely specified and would be finalized in the D/D phase (this project fall into this case), the submitted RAP at this phase is treated as provisional because the RAP cannot be developed without finalizing the line route. Such a project has obtained an ECC with condition. With the finalized line route, the RAP is to be completed fulfilling all requirements in the D/D and submitted to the WREA through the DOE. After the approval of the RAP by the WREA, the ECC become effective and construction activities were able to make headway. A detailed implementation procedure of the RAP is addressed in Chapter 15.

(3) Additional Studies for the Project

The following studies will be further required prior to actual implementation of the project construction. These will be conducted by EDL themselves or other international institutions assisting the Project.

a) Detailed design of the project facilities,

b) Environmental assessment if further studies will be required,

c) Investigation of UXO circumstances for confirming the project area's safety,

d) Transmission line route survey for finalizing the quantities of the required facilities and for the project preparatory works by EDL, a project consultant or others,

e) Land acquisition and compensation for the transmission line routes by EDL as an implementation agency,

f) Preparation of bidding documents, and

g) Appointment of procurement committee, project implementation committee, management committee, etc. by DOE/EDL.

(4) Implementation Schedule and Project Budget

Implementation schedule of the Project should be prepared taking into account periods required for additional studies, bid floating, bid evaluation, contract negotiation and approval by concerned organizations, manufacturing of equipment/materials, transportation, and local construction works. Local particularity in the wet season affecting the field construction works was carefully examined. Budget for implementation of the project is estimated on the ICB base referring to the recent world market prices, the latest contract prices under the on-going projects and costs estimated for newly planned similar projects in Lao PDR.

The project schedule examined and the project budget estimated by the Study Team are detailed in Chapter 17.

[3] There has been no case of transmission line project required for conducting EIA.

Chapter 12
Transmission Line

Chapter 12 Transmission Line

12.1 Transmission Line Route

12.1.1 Outline of Line Route

The team conducted a field investigation for Pakbo Substation (SS) - Taothan SS - Saravan SS section and had a discussion with the EDL branch offices in January, May and August 2009. As a result of the investigation and discussion, the team selected the transmission line route for the section to be along with the existing 115 kV transmission line, the National Road Route No. 13 (Route 13) and No. 15 (Route 15) for reasons of being less inhabited, easy construction and convenient for maintenance work. The selected line route is shown on Figure 12.1-1. The route is aligned behind villages where habitats exist. The terrain surrounding the route is mostly flat or very gently waved and covered by bushes, paddy fields, croplands or thin forest.

The line section of the Pakbo SS - Taothan SS was selected on the southern side of the existing 115 kV transmission line and on the western side of Route 13. The reasons this side was selected are flat land, less trees, and less houses compared with the other side of the road.

- Pakbo S/S – Taothan S/S; 152.2 km
- Taothan S/S – Saravan S/S; 66.3 km
- Total length; 218.5 km

The line section of the Taothan SS - Saravan SS was selected on the north side of Route 15, because the Xe Dong River is parallel with the Route 15 and the lands are mostly flat and the trees are not tall.

(1) Pakbo SS - Taothan SS (Photo No.01-Photo No.16)

The existing Pakbo substation is located 7.5 km north of the Savanakhet town center, from which a 115 kV line to the Kengkok Substation and a 115 kV international interconnection line crosses over the Mekong River to Thailand. An overview of the selected transmission line route is as follows:

(a) The transmission line route runs over about 3 km forward the east parallel with the existing 115 kV line. It turns 2 km toward the north-east and returns 1.5 km toward the south-east again, because it has to avoid the Economical Zone (22,000 km^2) that is under development. The team decided on this route (Fig 12.1-2) after discussion with the developer in May 2009. The route comes back to the existing line and crosses over it, and then it runs parallel to the south side of the existing line. The route crosses Route 5 (5 km location from Pakbo SS) and Route 9 (23 km location from Pakbo SS) and achieves a brunch point with the existing line (35 km location from Pakbo SS). As for the route parallel with the existing line, a few houses exist at the road crossing point, but the terrain surrounding the route is mostly flat and covered by bushes, paddy fields, croplands or thin forests.

(b) Then the route runs toward the south-east over 50 km along the west side of Route 13 and crosses over 5 district roads, and then arrives at the Xe Banghieng River.

(c) After crossing 400 m width of the Xe banghieng River, the line runs toward the south-east over 70 km along the west side of the Route 13 and crosses over the Xe Nouan River and district road in the Phounangsavan village, and then reaches Taothan Substation. On the

way to the substation, since Route 13 exists between two NBCAs, the line has to approach Phou Xiang Thong NBCA that is located on the west side of the road. If the line passes the east side of the road, it can go away from the NBCA. However, construction costs increases when not straightly aligned with the route, because many villages and houses exist in the eastern areas.

(d) After getting to Taothan Village, the line turns eastward via a heavy angle tower and crosses over to Route 13, and then reaches the planned substation site. The route should be selected to avoid houses at Route 13.

(2) Taothan SS - Saravan SS (Photo No.17-Photo No.21)

The location for the Taothan substation is planned at 3.5 km north of Napong Village.

(a) The line runs toward the east over 15.5 km in paddy fields after crossing over Huayxeauk River and gets to the north side of Route 15 that goes to the Saravan town. Then the line arrives at Xe Dong River after passing through 19 km of paddy fields, bush and thin forest areas.

(b) The line crosses over 600 m width of Xe Dong River. Designed maximum span length of the transmission line should be determined at this span, because difference in elevation between two adjacent towers arises at the crossing point. Then the line also crosses over the Xeset River at 2 km from the Xe Dong River crossing, and reaches the planned Saravan substation site over 29 km after running close to and away from Route 15 through the bush and thin forest areas. Finally, the line crosses over Route 15 near to the substation.

The Taothan substation is planned at 3.5 km north of Napong Village.

(a) The line runs toward the east over 15.5 km in paddy field after cross over Huayxeauk River and gets to the north side of Route 15 that goes to Saravan town. Then the line arrives at Xe Dong River after passes 19 km through paddy field, bush and thin forest areas.

(b) The line crosses over 600 m width of Xe Dong River. Designed maximum span length of the transmission line should be determined at this span, because difference in elevation between two adjacent towers arises at the crossing point. Then the line also crosses over Xeset River at 2 km from Xe Dong River crossing, and achieves planned Saravan substation site over 29 km after runs closes to and away from Route 15 through the bush and thin forest areas. Finally, the line crosses over Route 15 nearby the substation.

12.1.2 Land and Environment

(1) Geology

A simplified Underground Land Survey (Kunzelstab Penetration Test) was conducted at 42 points by boring along the line route in April 2009. Representative geological conditions are shown in Figures 12.1-3 to 12.1-5. The following are the conditions along the line.

(a) For most of the line route from Pakbo SS to Saravan SS, no water was found in the soil and very firm sandstones, siltstones and clays whose soil bearing capacity was 400-1,200 kN/m^2 were confirmed. (Figure 12.1-3)

(b) Little weak silts and clays whose soil bearing capacity was 200-400 kN/m^2 were confirmed at Paksong Village point (69 km location from Pakbo SS) and Huayxeauk River point (6 km location from Taothan SS).

(2) Toporogy and Land Use

The Project is located in the Mekong Floodplain, where the topography of the land is generally flat and low-lying. The land use between the Pakbo and Taothan Substation is comprised of

Forest Land 57% (Mixed Deciduous Forest 14% and Dry Diptrocarp and Unstocked Forest 43%) and Rice Paddies and Plantations comprise 43%. The land use between the Taotan Substation and Saravan Substation is comprised of Forest Land 40% (Mixed Deciduous Forest 3%, Dry Diptrocarp and Unstocked Forest 37%) and Rice Paddy and Plantation 60%.

(3) Environmental and Social Impacts on the Project Area

Any negative impacts on the social environment such as resettlements will be minimal. The selection criterion for the transmission line route was to avoid residential areas. Consequently, areas along the transmission line route are not populous. During a time of IEE conduction, 33 residential and/or commercial structures were identified on the transmission line route. However, the line was re-aligned so that no settlements are impacted. At this stage, it is estimated that 544 towers each with a footprint of 52.99 m^2 will require approximately 2.8 ha across the ROW. Thus some agricultural impacts are to be expected. Negative impacts on the natural environment will also be minimal. The transmission line route is aligned along with Route 13 and Route 15, which allowed for minimal road construction. There is a very limited amount of forest cleaning required for the ROW because most of the parts in the project area are composed of primarily rice paddies and unstocked forests. Along with the National Road 13 between Pakbo and Taothan, the transmission line route passes near 2 NBCA s, namely Phou Xieng Thong NBCA and Xe Bang Nuan NBCA. Since the line is not adjoined NBCA, the direct impact on biodiversity and/or wild animals is not anticipated. However, the area needs to be monitored constantly in order to assess cumulative impact and develop mitigation measures as appropriate. With adequate monitoring, any anticipated negative impact will be minimized. According to the IEE results, if there were any national protected areas, historical and cultural heritages or scenic spots, they were identified on the transmission line route. Overall, the potential magnitude assessment of the impact indicates that environmental impacts are expected to be minor. The transmission line route has been selected to minimize impact on environmental and social resources. With adequate compensation and the implementation of management and mitigation measures, residual environmental and social impacts are likely to be minor.

12.2 Design of Transmission Lines

Design of transmission lines for the Project is carried out in the following flow, in conformity with the selected line route and the conceptual design described in Chapter 5.

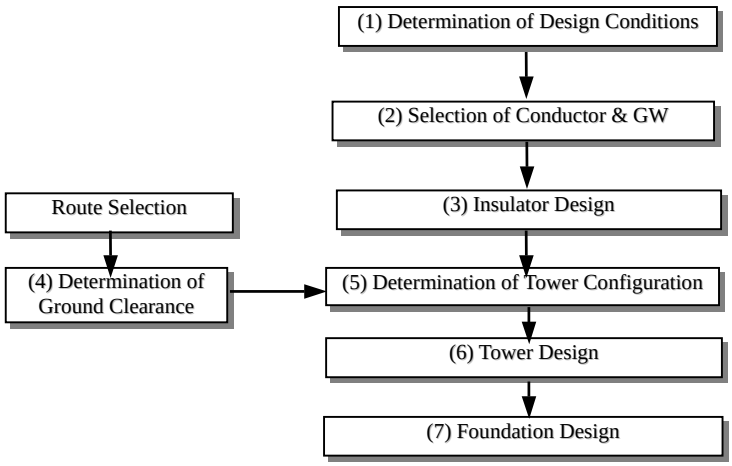


Figure 12.2-1 Flow of Design for the Project

12.2.1 Determination of Design Conditions

In addition to the climate conditions described in Section 5.1.2, the following conditions were applied to the design for the Project.

(1) Stringent Condition and EDS (Every Day Stress) Condition

Condition	Temperature	Wind
Stringent	10 ℃	35 m/s
EDS	25 ℃	still air

(Temperature; Meteorological observation data in Laos, Wind; LEPTS)

(2) Pollution Level

Light Pollution (IEC60071-2 Table I)

(3) Safety Factors

Required minimum safety factors for the Project are determined complying with LEPTS as follows:

(a) Conductor/Ground-Wire

2.5 to UTS (Ultimate Tensile Strength) in stringent condition
5.0 to UTS for EDS condition at supporting point

(b) Insulator string

2.5 to RUS (Rated Ultimate Strength) for maximum working tension at supporting point

(c) Tower

Normal condition = stringent condition: 1.5 to yield strength of materials
Broken-wire condition = normal condition + breakage of one ground-wire or one phase conductor: 1.0 to yield strength of materials

(d) Foundation

Normal condition = stringent condition: 2.0 to yield strength of foundations
Broken-wire condition = normal condition + breakage of one ground-wire or one phase conductor: 1.33 to yield strength of foundations

12.2.2 Conductor and Ground-Wire Design

Design conditions of the conductor and ground-wire for the Project are as below:

Table 12.2-1 Design Conditions of Conductor and Ground-Wire

Loading condition	Wind velocity	Wind pressure	Conductor temperature	Safety factors
Stringent condition	35 m/sec	790 N/ m^2	10 ℃	2.5 (40%UTS)
EDS condition	0 m/sec	0 N/ m^2	25 ℃	5.0 (20%UTS)

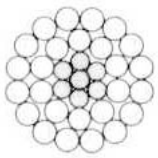
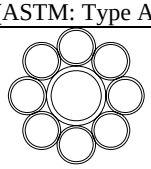
(1) Conductor and Ground-Wire

For conductor, TACSR/AS 240 mm^2 were selected as shown in Section 11.1

Since this transmission line will become the main transmission system that connects between the Central-2 and Southern area in Laos along with the Paksan – Pakbo transmission line, the facility specifications of these facilities should be as standardized as possible from the viewpoints of reliability and safety.

Therefore, the TACSR 240 mm^2 (ASTM: T-Hawk), AS 70 mm^2 (ASTM: A220) and OPGW 70 mm^2 (ASTM: Type A) are applied for the whole line section the same as the Paksan - Pakbo transmission line facilities.

Table 12.2-2 Conductor and Ground-Wire

Type	Conductor	Ground-Wire	
	TACSR 240 mm^2 (ASTM: B549)	AC 70 mm^2 (ASTM: A220)	OPGW 70 mm^2 (ASTM: Type A)
Figure			
Component of stranded wires	Al: 26/3.439mm St: 7/2.675mm	AC: 7/3.5 mm	AC: 8/3.2 mm OP unit: 1/5.0
Total area of aluminum wires	280.8 mm^2	67.35 mm^2	77.89 mm^2
Overall diameter	21.78 mm	10.5 mm	11.4 mm
Weight	929.5 kg/km	426.5 kg/km	470.1 kg/km
Ultimate tensile strength	81.7 kN	77.3 kN	80.2 kN
Modulus of elasticity	75,800 N/ mm^2	149,000 N/ mm^2	142,000 N/ mm^2
Coefficient of linear expansion	$20.0*10^{-6}$/℃	$12.9*10^{-6}$/℃	$13.8x10^{-6}$/℃
DC resistance at 20	0.1155 Ω/km	1.12 Ω/km	0.834 Ω/km
Allowable current	816 A	-	

(2) Maximum Working Tension and Every Day Stress (EDS)

As a maximum span length is measured to be 600 m at the crossing point of the Xe Dong River, the maximum design span length is assumed to be 650 m in consideration of elevation differences between the two adjacent towers at that crossing section. Therefore, the maximum tension of the conductor and the ground-wire for the Project will occur in a 650 m span. The values of the maximum working tensions and the EDS of both the conductor and the ground-wire satisfy the determined safety factors as shown in Table 12.2-3.

The working tension of the ground-wire is determined so that its sag becomes less than 80% of the conductors' sag under EDS conditions at the standard span length (400 m) for avoiding a reverse flashover from ground-wire to the conductors and direct lightning strokes to conductors.

Table 12.2-3 Maximum Working Tension and Every Day Stress (Span Length=650m)

Type	UTS	Tension		Safety Factors
TACSR 240 mm^2	81.7 kN	Maximum Tension	30.8 kN	2.65＞2.5
		EDS condition	15.9 kN	5.14＞5.0
AC 70 mm^2	77.3 kN	Maximum Tension	16.8 kN	4.60＞2.5
		EDS condition	8.6 kN	9.00＞5.0
OPGW 70 mm^2	80.2 kN	Maximum Tension	18.4kN	4.36＞2.5
		EDS condition	9.6 kN	8.35＞5.0

12.2.3 Insulator Design

Insulator type, number of insulator units and insulator assembly for the Project are determined based on the preliminary design discussed in Section 5.2.2.

(1) Insulator Type and Size

(a) Type:
The standard disc type porcelain insulator with ball and socket complying with the IEC 60305 is applied to the transmission lines for the Project.

(b) Size:
Table 12.2-4 and Figure 12.2-2 show the selected insulator size and its strength, respectively.

Table 12.2-4 Insulator Size

Size	Height	Diameter	R.U.S.*
250 mm disc	146 mm	255 mm	120 kN

(*: RUS: Rated Ultimate Strength)

(2) Number of Insulator Unit

(a) Pollution level
Pollution level was assumed “Light” classified in the IEC 60071-2 (Table I). The required creepage distance/phase to phase voltage for the “Light” level is 16 mm/kV.

(b) Standard lightning impulse withstand voltage
Standard lighting impulse withstand voltage for 115 kV equipment is 550 kV and the minimum clearance at 550 kV is 1,100 mm as classified in IEC 60071-2.

(c) Number of insulator units per string: 10 units
From the necessary creepage distance of insulators, the number of insulator units per string of the standard string is 7 units. While, from the standard lightning impulse withstand voltage, the number of insulator units per string of the standard set is 8 units. Therefore, the number of insulator units per string was determined to be 10 units adding 2 units for maintenance allowance. Standard insulator sets applied to the existing and planned 115 kV lines in Lao PDR also have 10 units per string.

(3) Insulator assembly
A single string of 120 kN insulators has been applied to both the suspension and tension insulator assembly for the Project. Insulator fittings also have to maintain the same strength of insulators.

Table12.2-5 Insulator Assemblies

Conductor	Maximum Tension (Span length: 650 m)	Suspension and tension insulator assemblies	Safety factor
TACSR 240 mm^2	30.8 kN	Single strings of 120 kN	3.90＞2.5

However, in case a transmission line for the Project crosses over important roads or wide rivers as shown in Table 12.2-6, 120 kN double insulator assemblies are applied to both towers in the

crossing section (either suspension or tension tower) for safety reasons.

Table 12.2-6 Important Crossing Section

Section	No.	Important crossing point	Length from Pakbo SS
Pakxan – Taothan	1	115kV transmission line	4.5 km
	2	National Road Route No. 5	5 km
	3	National Road Route No. 9	23 km
	4	District Road in Ban Poxal	37 km
	5	District Road in Ban Donpho	46 km
	6,7	District Road in Ban Nong-Nokkhian 1,2	59 km
	8	District Road in Paksong District	69 km
	9	Xe Banghieng River	92 km
	10	Xe Nouan River	108 km
	11	District Road in Ban Phouangsavan	112 km
	12	National Road Route No. 13	152 km
Taothan - Saravan	13	District Road in Taothan	153 km
	14	Huayxeauk River	158 km
	15	Xe Dong River	187 km
	16	Xeset River	189 km
	17	National Road Route No. 5	215 km

(4) Configuration of Insulator assembly

Tentatively designed dimensions and configurations of insulator assemblies are shown in Table 12.2-7 and Figures 12.2-3 and 12.2-4.

.Table 12.2-7 Size of Insulator Assembly

	Items	Values
Suspension Insulator Assembly	Number of 250 mm Insulator	Single: 10 units、Double: 20 units
	Length of 250 mm Insulator	1,460 mm
	Arcing Horn Gap	1,240 mm
	Single Insulator Assembly Length	1,960 mm
	Double Insulator Assembly Length	2,110 mm
Tension Insulator Assembly	Number of 250 mm Insulator	Single: 10 units、Double: 20 units
	Length of 250 mm Insulator	1,460 mm
	Arcing Horn Gap	1,240 mm
	Single Insulator Assembly Length	2,150 mm
	Double Insulator Assembly Length	2,500 mm

12.2.4 Ground Clearance

The most severe state for the ground clearance of conductors will occur when the conductor's temperature rises to 120 ℃ under still air conditions. As for the Project, the minimum height of the conductor above ground will be determined as shown below.

Table 12.2-8 Minimum Height of Conductor above Ground

Classification	Applied areas for the Project	Height	Reason
Areas where people rarely enter or will enter, such as mountains, forests, waste fields, etc.	Bush lands, forests, grass lands and narrow-rivers	7.0 m	5.48 m (LEPTS) + 1.5 m (margin) = 7.0 m
Areas where people enter or will enter frequency	Paddy fields with mosaic of croplands, general roads and wide-rivers	7.5 m	5.98 m (LEPTS) + 1.5 m (margin) = 7.5 m
Areas where distribution line exists or will be planned	National and district roads	8.0 m	6.48 m (LEPTS) + 1.5 m (margin) ≒ 8.0 m

12.2.5 Determination of Tower Configuration

Basic dimensions of suspension and tension type towers for the Project are decided in examining the conductor clearance diagrams based on the preliminary design described in Section 7.2.4.

(1) Insulation Design

Insulation gaps for standard and abnormal states are worked out as below. These gap lengths are used for clearance between the conductor and tower, between conductors, and between conductors and ground wires.

Table 12.2-9 Insulation Gaps

Characteristic	Items	Values	Reasons
Voltage	Nominal voltage	115 kV	Complying with IEC60038
	Highest voltage	123 kV	Complying with IEC60038
Lightning Impulse	Length of 250 mm insulator	1,460 mm	146 mmx10 units=1,460 mm
	Arcing horn gap	1,240 mm	Insulator strings length*0.85≒1,240 mm (85% of length of insulator string)
	Standard insulation gap	1,400 mm	Arcing horn gap x 1.115≒ 1,400 mm (111.5% of arcing horn gap)
Commercial frequency	Abnormal state insulation gap	200 mm	Complying with IEC60071-1, 60071-2
	Abnormal state phase gap	400 mm	Complying with IEC60071-1, 60071-2

(2) Clearance Design

(a) Clearance between the Conductor and the Tower

The length of the cross-arms and the vertical separation between the cross-arms are determined from conductor clearance diagrams applying values in Table 12.2-9 and Figure 5.2-2.

Table 12.2-10 Swinging Angle of Conductor and Applied Clearance

Wind Velocity	10 m/sec	35 m/sec
Swinging angle of conductor	10 deg	60 deg.
Applied clearance	Standard clearance	Abnormal clearance

Table 12.2-11 Values of Clearance Diagram

Tower type	Item	Formulas and values
Suspension tower	Insulator assembly length	146 mmx10units+500 mm(Fitting length) ≒2,000 mm
Tension tower	Jumper conductor depth	1,240 mm (Arcing horn length)x1.2 + 100 mm (Margin for changing the shape of jumper conductor)≒1,600 mm
Suspension and tension tower	Standard clearance (Swinging angle 10 deg)	1,400 mm (Standard insulation gap) + 150 mm (Step bolts length) = 1,550 mm
	Abnormal clearance (Swinging angle 60 deg)	200 mm (Abnormal state insulation gap) + 150 mm (Step bolts length) = 350 mm

(b) Separation between conductors and between conductors and ground-wires

Minimum separation between two conductors and between conductors and ground-wires are determined to satisfy the following values when conductors will swing by the wind blowing.

- Between two conductors: 450 mm
  (Abnormal state phase gap; 400 mm + Conductor's diameter; around 50 mm)
- Between the conductor and ground wire: 250 mm
  (Abnormal state insulation gap; 200 mm + Conductor's and ground wire's diameter around; 50 mm)

(3) Insulation design of ground-wires

Number and shielding angle to conductors of ground-wire are determined as below:

- Number: 2
- Maximum shielding angle: Under 5 deg.

(4) Standard Height of Lower Arm

The following is a standard height of the lower arm (Standard span length; 400m, Passing Area; General Area)

Table 12.2-12: Standard Height of Lower Arm

Item	Suspension Tower	Tension Tower	Values
Maximum Conductor Sag	14.7 m	14.7 m	V=0 m/s, Temp=120
Length of Insulator Set	2.0 m	-	
Conductor Height	7.5 m	7.5 m	General area
Margin	0.3 m	0.3 m	
Height of Lower Arm	24.5 m	22.5 m	

(5) Tower Configurations

Configurations of the following 7 standard types of towers are determined based on the aforementioned design conditions. (See Figures 12.2-5 to 12.2-6)

Table 12.2-13 Tower Configurations

Tower	Suspension Tower		Tension Tower				
Line Horizontal Angle	0～3°		0～15°	0～15°	0～30°	0～60°	0～40°（Dead End）
Type	A1	A2	B1	B3	C1	D1	DE
Height [m]	34.5	37.5	33.9	39.9	33.9	33.9	33.9
Arm Length [m]	6.2	6.2	6.2	6.2	6.8	6.2	6.2
Width of tower [m]	7.2	7.5	7.8	9.5	7.8	7.8	7.8
Body Extension [m]	24.5	27.5	24.0	30.0	24.0	24.0	24.0
Applied Areas*	Ⅰ	Ⅱ	Ⅰ	Ⅲ	Ⅰ	Ⅰ	Ⅰ
Number of Figure	Fig 13.2-5	Fig 13.2-5	Fig 13.2-5	Fig 13.2-5	Fig 13.2-6	Fig 13.2-6	Fig 13.2-6

Area I: Except national roads (bush, forests, grass lands, paddy fields with mosaic of croplands, general roads and rivers)
Area II: National roads
Area III: 115 kV transmission line

12.2.6 Tower Design

Towers for the Project were provisionally designed for the estimation of tower weights and foundation loads. High tensile steels were also applied to towers and bolts, and all of the tower members must be galvanized for preventing rusting.

(1) Tower Design Conditions

Tower design is carried out for the 7 standard towers classified in Tables 12.2-13, based on the following design conditions and span length.

(a) Wind pressure

Conductor 790 N/m^2
Insulator strings 1,100 N/m^2
Tower 2,290 N/m^2 (including pressure on its rear structures)

(b) Standard span length and applied maximum span length

Table 12.2-14 Design Span Length

Tower	Type	Standard Span Length	Design Span Length
Suspension	A1	400 m	650 m
	A2	400 m	650 m
Tension	B1	400 m	650 m
	C1	400 m	650 m
	D1	400 m	650 m
	D2	400 m	650 m
	DE	400 m	500 m

(c) Loading conditions and safety factors

Table 12.2-15 Loading Conditions and Safety Factors

Loading conditions	Loads	Safety factor
Normal condition	Maximum load (35 m/sec)	1.65 to yield strength of material
Abnormal condition (Broken wire condition)	Maximum load + one ground wire or one phase conductor breakage load	1.1 to yield strength of material

(2) Results of Tower Design

The following is summary of the results of tower design.

Table 12.2-16 Tower Weights and Foundation Loads Transferred from Towers

Tower	Suspension		Tension				
Line Horizontal Angle	0～3°		0～15°		0～30°	0～60°	0～45°（Dead end）
Type	A1	A2	B1	B3	C1	D1	DE
Weight [ton]	6.0	7.0	8.5	11.1	10.4	11.6	13.8
Foundation Compression Load [kN/Leg]: Normal	376	380	648	657	713	882	1,102
Foundation Tensile Load [kN/Leg]: Normal	312	313	565	566	627	772	964

12.2.7 Foundation Design

A simplified underground land survey was conducted at 42 points by boring along the line route. The results were that since no water was found in the soil and normal sandstones, siltstones and clays whose soil bearing capacity was 200～1,200 kN/m^2 confirmed for the whole line, it can be assumed that normal pad and chimney type foundations are applicable to all towers in the Project.

Dimensions, concrete volume, reinforcement volume, excavation volume and back-filling volume of the pad and chimney type foundations were worked out on the basis of the loads transferred from towers shown in Table 12.2-16.

(1) Foundation Design Conditions

The foundation design was carried out for 7 standard towers classified in Table 12.2-16, based on the following design conditions.

(a) Soil conditions

Soil - I: Soil bearing capacity is 600 kN/m^2 ～.
Soil - II: Soil bearing capacity is 400～599 kN/m^2.
Soil - II: Soil bearing capacity is 200～399 kN/m^2.

(b) Loading conditions and safety factors

Table 12.2-17 Loading Conditions and Safety Factors

Loading conditions	Loads	Safety factor
Normal condition	Maximum load (35 m/sec)	2.0 to yield strength of foundation
Abnormal condition (Broken wire condition)	Above maximum load + one ground wire or one phase conductor breakage load	1.33 to yield strength of foundation

(2) Results of Foundation Design

Summary of the results of foundation design and tentative foundation configurations are as shown in Table 12.2-18 and Figures 12.2-7 to 12.2-9, respectively.

Table 12.2-18 Results of Foundation Design

Tower	Comp-ression Load [kN]	Tensile Load [kN]	Applied C & T Load [kN]	Geology								
				Type Ⅰ			Type Ⅱ			Type Ⅲ		
				Concrete /Tower [m^3]	Rein-forcement /Tower [ton]	Exca-vation /Tower [m^3]	Concrete /Tower [m^3]	Rein-forcement /Tower [ton]	Exca-vation /Tower [m^3]	Concrete /Tower [m^3]	Rein-forcement /Tower [ton]	Exca-vation /Tower [m^3]
A1	376	312	～400	7.0	0.5	44.8	9.9	0.7	75.0	13.4	1.2	115.2
A2	380	313										
B1	648	565	500～700	12.4	1.3	87.5	17.0	1.9	139.4	22.8	2.3	202.2
B3	657	566										
C1	713	627	700～800	16.2	1.9	123.0	19.0	2.3	161.8	26.2	3.1	243.2
D1	882	772	800～900	21.8	2.9	181.4	28.6	3.9	255.5	37.7	5.4	368.6
DE	1,102	964	900～1100	31.3	4.2	235.4	39.7	7.4	335.8	50.7	7.4	466.6

12.2.8 Crossing Point of 115 kV Pakbo - Kengkok Line

The crossing point of new and existing line is assumed at almost the center of the span between the No.14 and 15 existing tower (5 km point from Pakbo SS). The new line crosses the upper existing line to be construed to a new tall tower at the center of the span. The conductor height of the new line should be determined so that the clearance between the lower conductor of the new line and the ground-wire of the existing line can be kept at more than 250 mm. (Fig12.2-10)

12.2.9 Quantities of Line Materials

Quantities of line materials are estimated from the results of the above design for the Project.

(1) Number of Towers and Total Weight of Towers

As seen in the route map (Figure 2.2-1), various kinds of towers (type-B1, C1, D1, DE) are required for deviation from the line route. The proper tension type tower was located at every angle at the deviating points of the line route pursuant to its angle. Thus, the number of tension type towers necessary for the line was initially determined. Suspension type towers are to be positioned between those tension towers. The number of suspension type towers (type-A1) was derived from a line distance between those tension towers divided by a standard span length of 400 m. For such sections as crossing over the national road, taller towers will be required for keeping necessary ground clearance of conductors. A2 type towers were applied for such sections. A B3 type tower was also applied at the crossing point of the existing 115 kV line. The total number of towers required for the Project was thus worked out. Table 12.2-19 summarizes the number of towers and weight of towers for the Project.

Table 12.2-19 Number of Towers and the Total Weight of Towers

Type	Weight [ton]	Pakbo – Taothan		Taothan - Saravan		Total	
		Towers [Unit]	Total Weight [ton]	Towers [Unit]	Total Weight [ton]	Towers [Unit]	Weight [ton]
A1	6.0	324	1,944.0	142	852.0	466	2,796.0
A2	7.0	14	98.0	4	28.0	18	126.0
B1	8.5	36	306.0	16	136.0	52	442.0
B3	11.1	1	11.1	0	0	1	11.1
C1	10.4	4	41.6	2	20.8	6	62.4
D1	11.5	4	46.0	1	11.5	5	57.5
DE	13.8	2	27.6	2	27.6	4	55.2
	Total	385	2,474.3	167	1,075.9	552	3,550.2

(2) Quantities of Conductor and Ground-Wire

Quantities of conductors and ground-wires (GW) for the Project were computed by the Number of conductors or the GW x Route Length [km] x 1.05 （allowance for sag and margin for stringing works）.

Table 12.2-20 Quantities of Conductor and Ground-Wire

Type	Number [Unit]	Pakbo - Taothan		Taothan - Saravan		Total
		Route Length [km]	Quantity [km]	Route Length [km]	Quantity [km]	Quantity [km]
TACSR 240 mm^2	6	152.2	958.9	66.3	417.7	1,376.6
AC 70 mm^2	1	152.2	159.8	66.3	69.6	229.4
OPGW 70mm^2	1	152.2	159.8	66.3	69.6	229.4

(3) Quantities of Insulators and Insulator Assemblies

Quantities of insulators and insulator assemblies for the Project were computed from the number of suspension and tension towers, including the number of double string assemblies that are applied to important crossing sections as shown in Table 12.2-6.

Table 12.2-21 Quantities of Insulators and Insulator Assemblies

Tower	Item	Quantity [Unit]	Pakbo - Taothan		Taothan - Saravan		Total
			Tower [Unit]	Subtotal Quantity [Unit]	Tower [Unit]	Subtotal Quantity [Unit]	Quantity [Unit]
Suspension	Insulator	60	320	19,200	139	8,340	27,540
	Single String Set	6		1,920		834	2,754
	Insulator	120	18	2,160	8	960	3,120
	Double String Set	6		108		48	156
Tension	Insulator	120	42	5,040	18	2,160	7,200
	Single String Set	12		504		216	720
	Insulator	240	5	1,200	2	480	1,680
	Double String Set	12		60		24	84
Total	Insulators			27,600		11,940	39,540
	Insulator Sets			2,592		1,122	3,714

(4) Quantities of fittings of Conductor and Ground-Wire

Quantities of fittings of conductor, ground-wire and OPGW for the Project were worked out as below.

(a) Vibration Dampers of Conductor, Ground-Wire and OPGW

Two dampers are installed in each conductor, each GW and each OPGW in every span.

(b) Compression Sleeve of Conductor and Ground-Wire

Number of compression sleeves of conductor＝Conductor quantities[km]/2.0 km (standard length of conductor per drum)

Number of compression sleeves of GW＝GW quantities[km]/2.0 km (standard length of GW per drum)

(c) OPGW joint box

Number of joint boxes of OPGW＝OPGW quantities[km]/5.5 km (standard length of OPGW per drum)

(d) Ground-Wire and OPGW fittings

Suspension ground-wire fittings will be installed on suspension towers and tension ground-wire fittings will be installed on tension towers and gantries.

Table 12.2-22 Quantities of Fittings of Conductor and Ground-Wire

Fittings	Pakbo - Taothan	Taothan - Saravan	Total
Conductor Dampers	4,608	1,992	6,600
GW Dampers	768	332	1100
OPGW Dampers	768	332	1100
Conductor Sleeves	480	209	689
GW Sleeves	80	35	115
OPGW Joint Boxes	29	13	42
Suspension GW Fittings	338	147	485
Tension GW Fittings	47	20	67
Suspension OPGW Fittings	338	147	485
Tension OPGW Fittings	47	20	67

(5) Quantities of Tower Foundations

Quantities of seven types of steel-reinforced concrete foundations are summarized to classify into three types of soil conditions in Table 12.2-23 below.

Table 12.2-23 Quantities of Tower Foundations

Soil*	Foundation	Concrete Volume / Tower	Pakbo - Taothan		Taothan - Saravan		Total
I	A-I	7.0 [m^3]	336	2,352.0 [m^3]	144	1,008.0 [m^3]	3,360.0 [m^3]
	B-I	12.4 [m^3]	34	421.6 [m^3]	16	198.4 [m^3]	620.0 [m^3]
	C-I	16.2 [m^3]	6	97.2 [m^3]	2	32.4 [m^3]	129.6 [m^3]
	D-I	21.8 [m^3]	4	87.2 [m^3]	1	21.8 [m^3]	109.0 [m^3]
	DE-I	31.3 [m^3]	2	62.6 [m^3]	2	62.6 [m^3]	125.2 [m^3]
II	A-II	9.9 [m^3]	2	19.8 [m^3]	2	19.8 [m^3]	39.6 [m^3]
III	B-III	22.8 [m^3]	1	22.8 [m^3]	0	0 [m^3]	22.8 [m^3]
		Total	385	3,063.2 [m^3]	167	1,343.0 [m^3]	4,406.2 [m^3]

(*Soil-1: 600 kN/m^2 ～, Soil-II: 400 - 599 kN/m^2, Soil-III: 200 - 399 kN/m^2)

(6) Spare Parts, Tools and Measuring Instruments

The Project's transmission line design specifications are common to the whole line. Since the EDL branch offices will carry out the remaining line maintenance work after the project's completion, spare parts, tools and measuring instruments must be provided in consideration of the common stock among branch offices. Although item particulars and their quantities will be determined during the detailed design stage of the Project, it has been assumed that the principal items will be as follows.

(a) Line Materials for Maintenance:

Complete set of standard towers, galvanized steel materials and bolts for replacement

damaged members, spares of conductors / GWs and their fittings, insulators and their fittings, etc.

(b) Tools and Measuring Instruments:

Insulator replacing devices, repair tools, insulated earthing rods, insulation resistance testers, equipment for maintenance staff and vehicles for facility inspections etcetera.

An estimated cost of spare parts, tools and measuring instruments for the Project is assumed to be about 5% of the total cost of line materials.

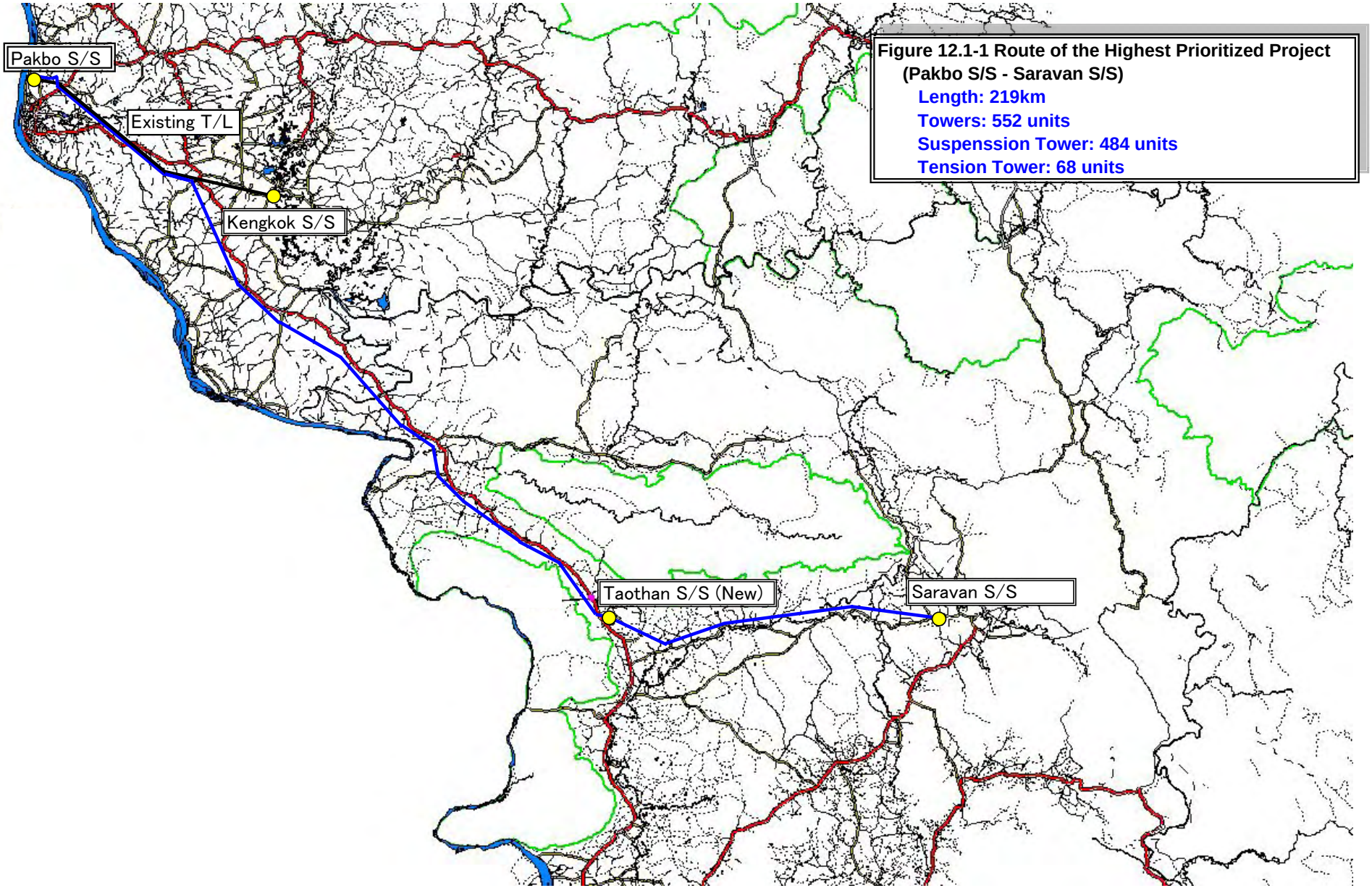


Figure 12.1-1 Route of the Highest Prioritized Project
(Pakbo S/S - Saravan S/S)
Length: 219km
Towers: 552 units
Suspenssion Tower: 484 units
Tension Tower: 68 units

Figure 12.1-2: Avoiding Route for Planned Special Economic Zone

CONE PENETRATION TEST

PROJECT:	Salavanh-Pakbo, 115kV Transmission Line and Substation Project
	BSP Electric Construction And Installation Company Limited.
Point No.	P 28 (Angle Point Ban Hinkok)
Date:	4-Apr-09
Operator:	Souvannapheum
Ground Condition:	Flat Are
Coordinate:	N = E =
Water Table:	None
	El. =

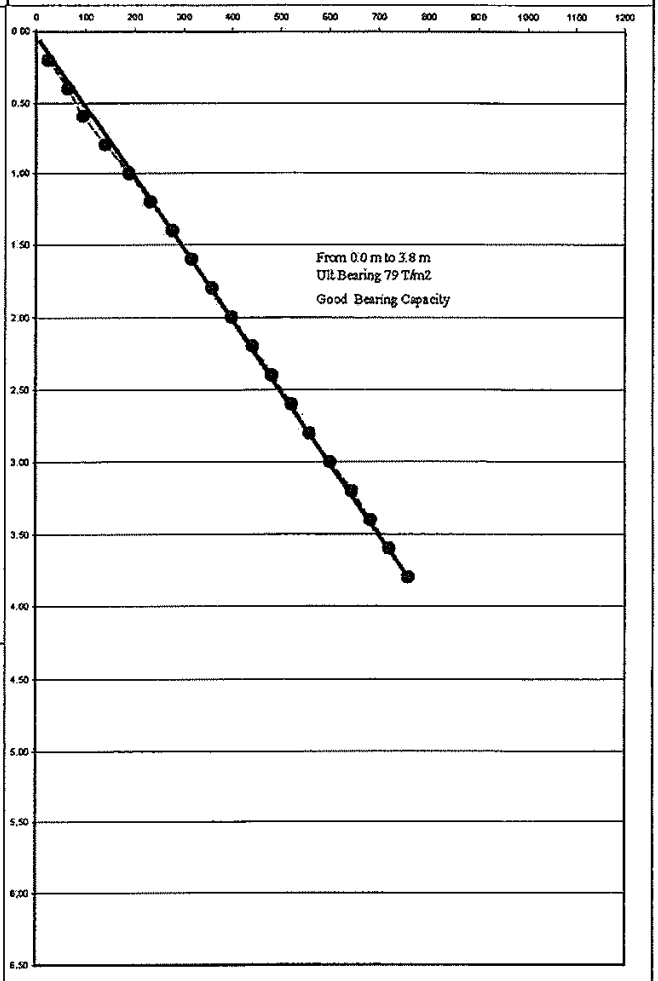
DEPTH (m) FROM	TO	Blows count Blows/20cm No.	Assume. Blows No.	Average blows/layer Blows/20cm	Ultimate Bearing Capacity for 2m pad T/m2
0.00	0.20	24	24		
0.20	0.40	40	64		
0.40	0.60	30	94		
0.60	0.80	46	140		
0.80	1.00	47	187		
1.00	1.20	44	231		
1.20	1.40	45	276		
1.40	1.60	40	316		
1.60	1.80	42	358		
1.80	2.00	40	398		
2.00	2.20	43	441		
2.20	2.40	40	481		
2.40	2.60	41	522		
2.60	2.80	36	558		
2.80	3.00	42	600		
3.00	3.20	45	645		
3.20	3.40	37	682		
3.40	3.60	38	720		
3.60	3.80	39	759	40	79
3.80	4.00				
4.00	4.20				
4.20	4.40				
4.40	4.60				
4.60	4.80				
4.80	5.00				
5.00	5.20				
5.20	5.40				
5.40	5.60				
5.60	5.80				
5.80	6.00				
6.00	6.20				

Soil Description:

From 0.0m - 1.0m Top Soil (Silt Clay)

From 1.0 m - 3.8 m Silt Clay, with Clay and Laterite And Silt Stone Brown Color and Rock Sand Stone on Bottom.

GRAPH



Conclusion : Soil Layer 1 from Top - 1.0m Good Soil Layer Silt Clay With Clay, Gray Color

Layer 2 From 1.0 - 3.8 m Good Soil Layer (Silt Clay With Clay, Laterite And Silt Stone Brown Color)

And Rock Sand Stone On Bottom

Figure 12.1-3: General Soil Condition of the Whole Route

CONE PENETRATION TEST

PROJECT: Salavanh-Pakbo, 115kV Transmission Line and Substation Project

BSP Electric Construction And Installation Company Limited.

Point No. P 36 (Angle Point Pakxong)

Date: 4-Apr-09 Operator: Souvannapheum

Ground Condition: Flat Are

Coordinate: N = E =

Water Table: None El. =

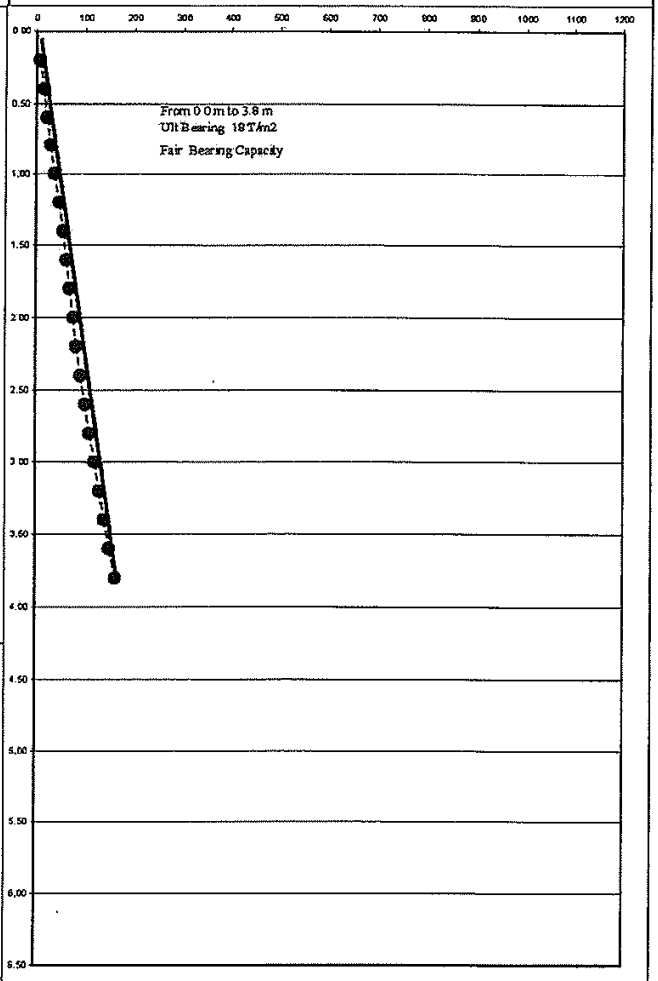
DEPTH (m) FROM	TO	Blows count Blows/20cm No.	Assume. Blows No.	Average blows/layer Blows/20cm	Ultimate Bearing Capacity for 2m pad T/m2
0.00	0.20	6	6		
0.20	0.40	9	15		
0.40	0.60	6	21		
0.60	0.80	8	29		
0.80	1.00	8	37		
1.00	1.20	10	47		
1.20	1.40	8	55		
1.40	1.60	7	62		
1.60	1.80	6	68		
1.80	2.00	8	76		
2.00	2.20	6	82		
2.20	2.40	9	91		
2.40	2.60	9	100		
2.60	2.80	9	109		
2.80	3.00	10	119		
3.00	3.20	10	129		
3.20	3.40	10	139		
3.40	3.60	11	150		
3.60	3.80	12	162	9	18
3.80	4.00				
4.00	4.20				
4.20	4.40				
4.40	4.60				
4.60	4.80				
4.80	5.00				
5.00	5.20				
5.20	5.40				
5.40	5.60				
5.60	5.80				
5.80	6.00				
6.00	6.20				

Soil Description:

From 0.0m - 1.0m Top Soil (Silt Clay)

From 1.0 m - 3.8 m Silt Clay, with Clay

GRAPH



Conclusion : Soil Layer 1 from Top - 3.8m Good Soil Layer Silt Clay With Clay, Gray Color

Figure 12.1-4: Soil Condition at Crossing Point of Paksong District Road

CONE PENETRATION TEST

PROJECT:	Project of New Interconnection Transmission Line in Southern Provinces in Lao PDR	BSP Electric Construction And Installation Company Limited.	
Point No.	P 12 (Crossing Huayxeuk river)	Date: 2-Mar-09	Operator: Souvannaphoum
Ground Condition:	Flat Are	Coordinate: N =	E =
Water Table:	None	EL =	

Soil Description:

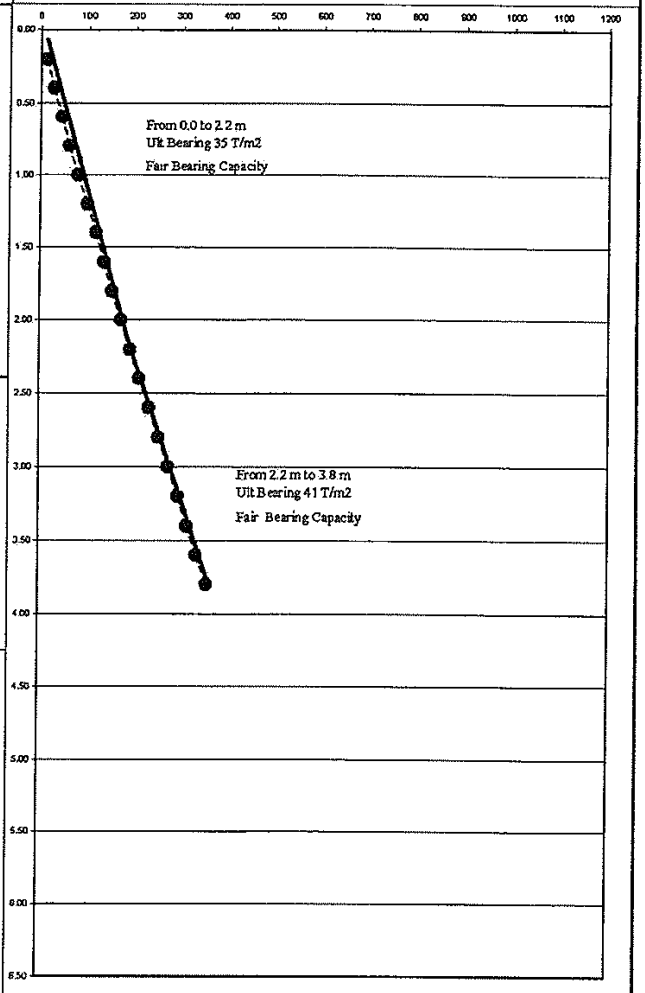
From 0.0m - 1.0m Top Soil (Silt Clay)

From 1.0 m - 2.2 m Silt Clay, Silt Clay with Clay, Gray Color

From 2.2 m - 3.5 m Clay, Gray Color

DEPTH (m) FROM	TO	Blows count Blows/20cm No.	Assume. Blows No.	Average blows/laye blows/20c	Ultimate Bearing Capacity for 2m pad T/m2
0.00	0.20	12	12		
0.20	0.40	15	27		
0.40	0.60	17	44		
0.60	0.80	16	60		
0.80	1.00	18	78		
1.00	1.20	20	98		
1.20	1.40	18	116		
1.40	1.60	18	134		
1.60	1.80	17	151		
1.80	2.00	19	170		
2.00	2.20	20	190	17	35
2.20	2.40	20	210		
2.40	2.60	21	231		
2.60	2.80	20	251		
2.80	3.00	20	271		
3.00	3.20	21	292		
3.20	3.40	20	312		
3.40	3.60	20	332		
3.60	3.80	22	354	21	41
3.80	4.00				
4.00	4.20				
4.20	4.40				
4.40	4.60				
4.60	4.80				
4.80	5.00				
5.00	5.20				
5.20	5.40				
5.40	5.60				
5.60	5.80				
5.80	6.00				
6.00	6.20				

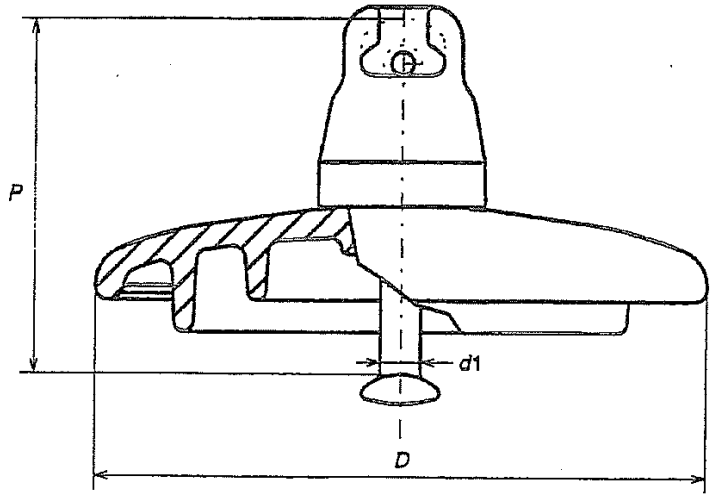
GRAPH



Conclusion : Soil Layer 1 from Top - 2.2m Fair Soil Layer Silt Clay With Clay, Gray Color

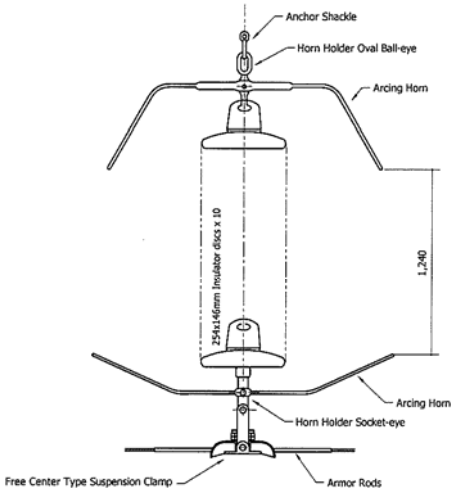
Layer 2 From 2.2 - 3.8 m Fair Soil Layer (Clay And Gray Color

Figure 12.1-5: Soil Condition at Crossing Point of Huayxeauk River

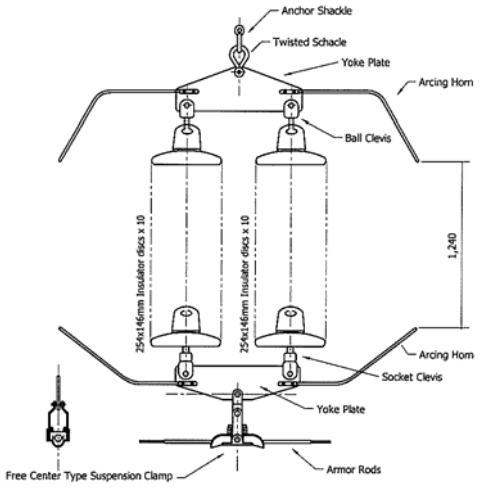


Designation	Electromechanical or mechanical failing load kN	Maximum nominal diameter of the insulating part D mm	Nominal spacing P mm	Minimum nominal creepage distance mm	Standard coupling according to IEC 120 d1
U 120 B	120	255	146	295	16

Figure 12.2-2: Standard Porcelain Insulator of Ball Socket Type



Single Suspension Set



Double Suspension Set

Figure 12.2-3: Suspension Insulator Set

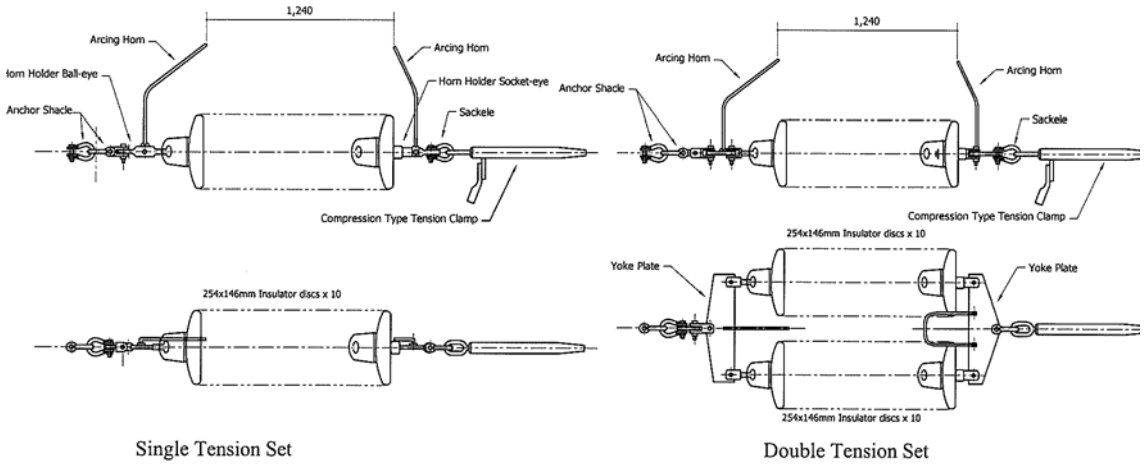
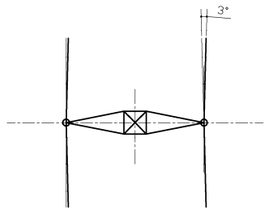
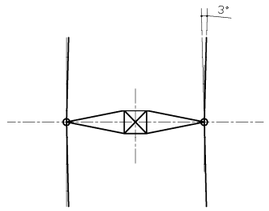


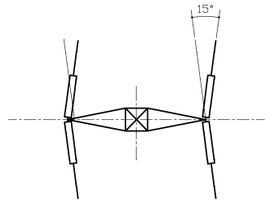
Figure 12.2-4: Tension Insulator Set



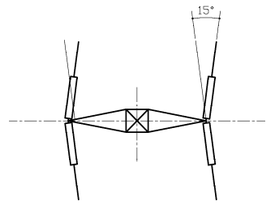
0 ° to 3°



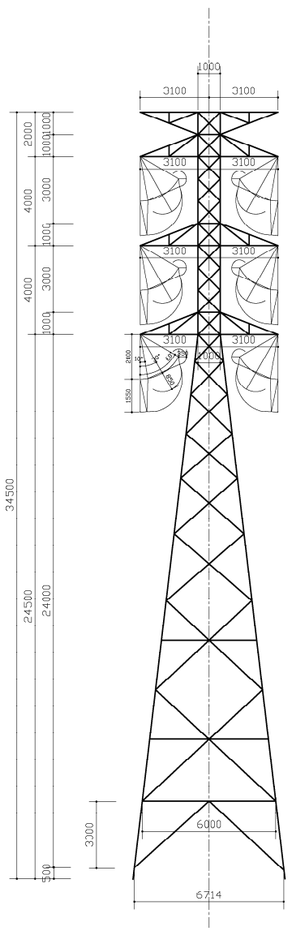
0 ° to 3°



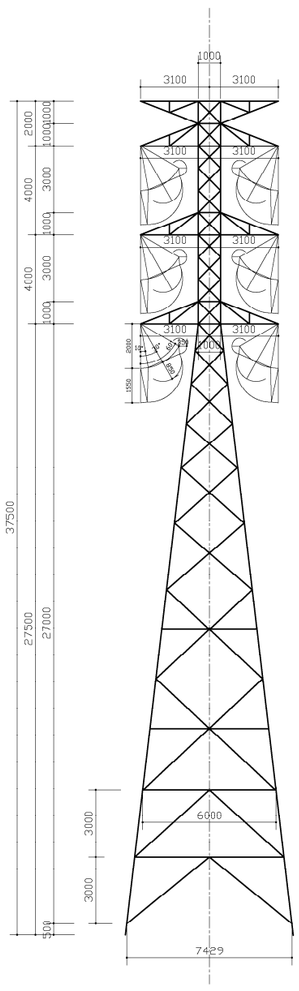
0 ° to 15°



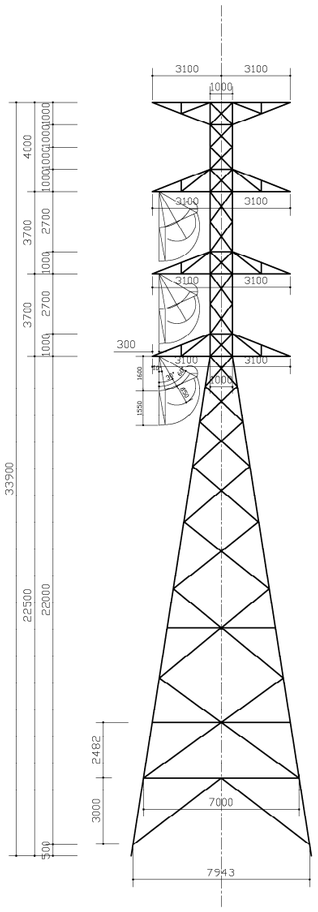
0 ° to 15°



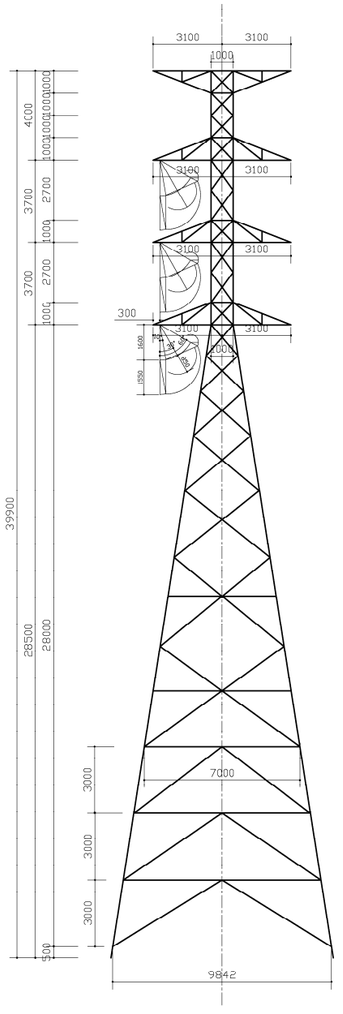
Type A1 Tower



Type A2 Tower

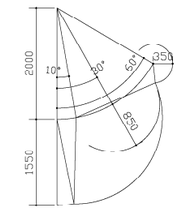


Type B1 Tower

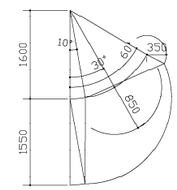


Type B3 Tower

Clearance Diagram

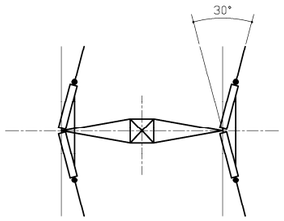


Suspension Type Tower

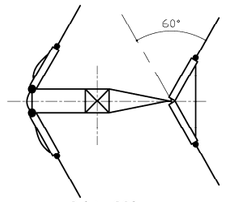


Tension Type Tower

Figure 12.2-5: Typical Tower of A1, A2, B1 and B3 Type

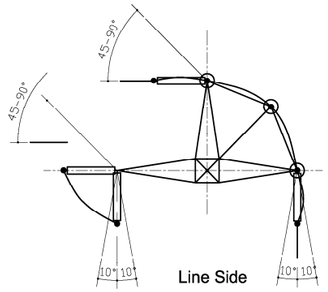


0 ° to 30°

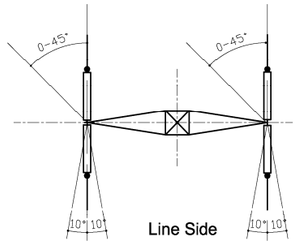


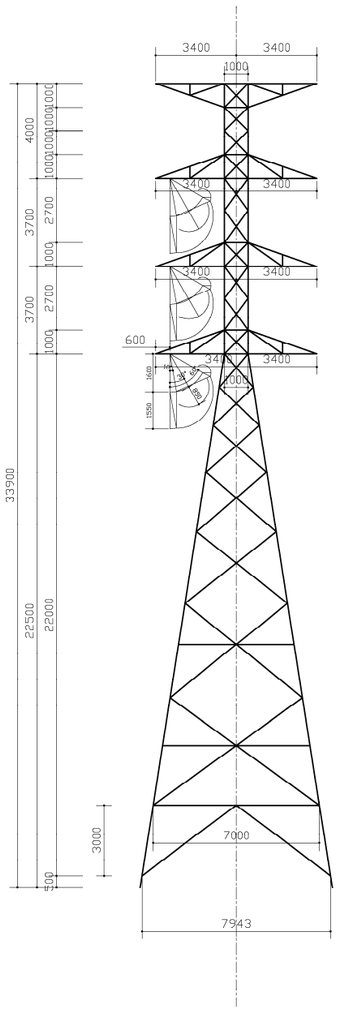
0 ° to 60°

Substation Side (Slack Span)

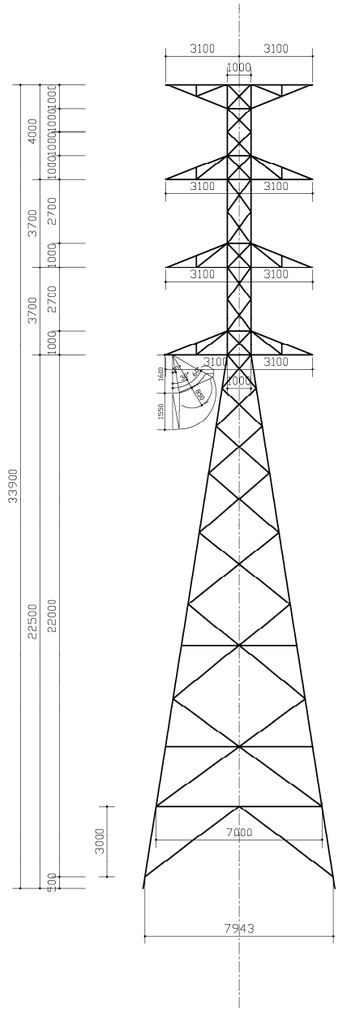


Substation Side (Slack Span)

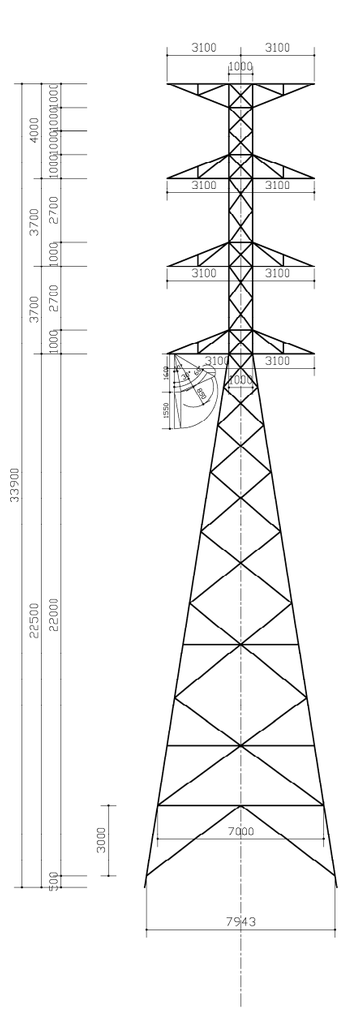




Type C1 Tower

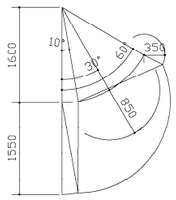


Type D1 Tower



Type DE Tower

Clearance Diagram



Tension Type Tower

Figure 12.2-6: Typical Tower of C1, D1 and DE Type

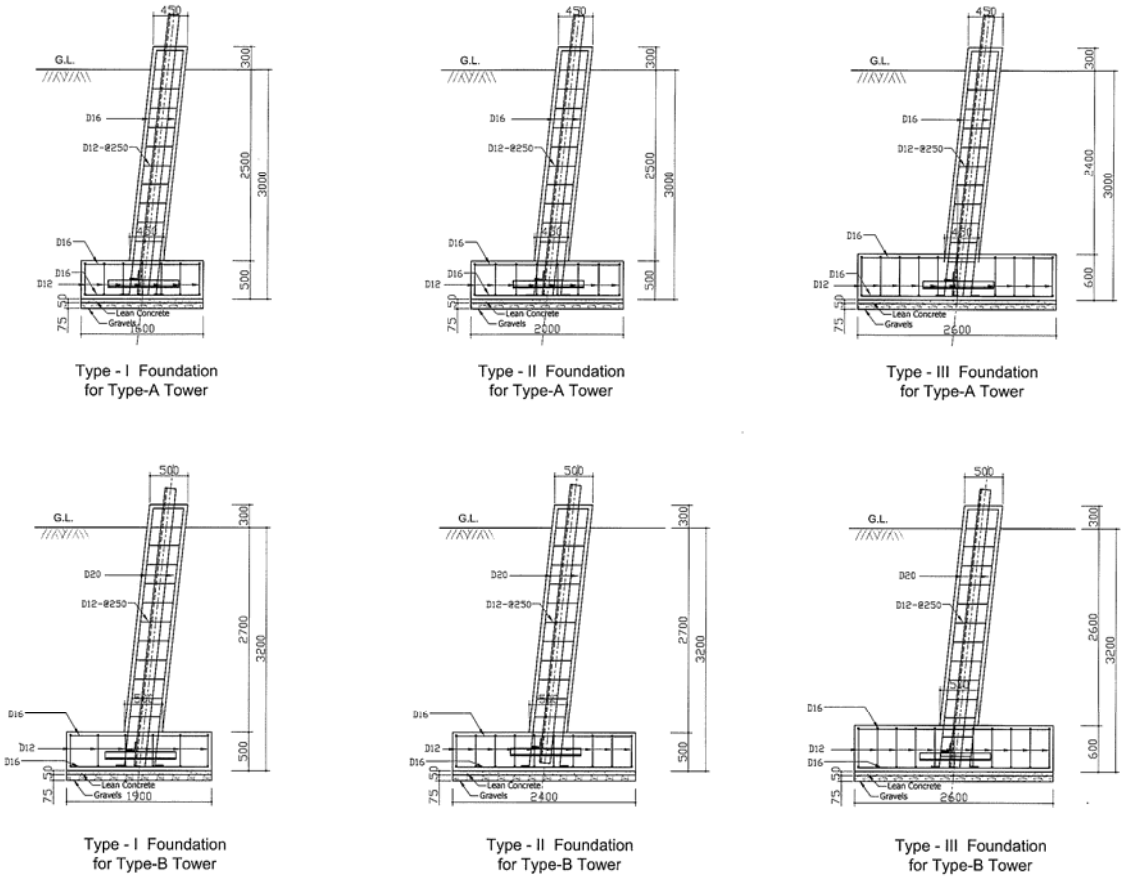


Figure 12.2-7: Typical Foundations for Tower Types A and B

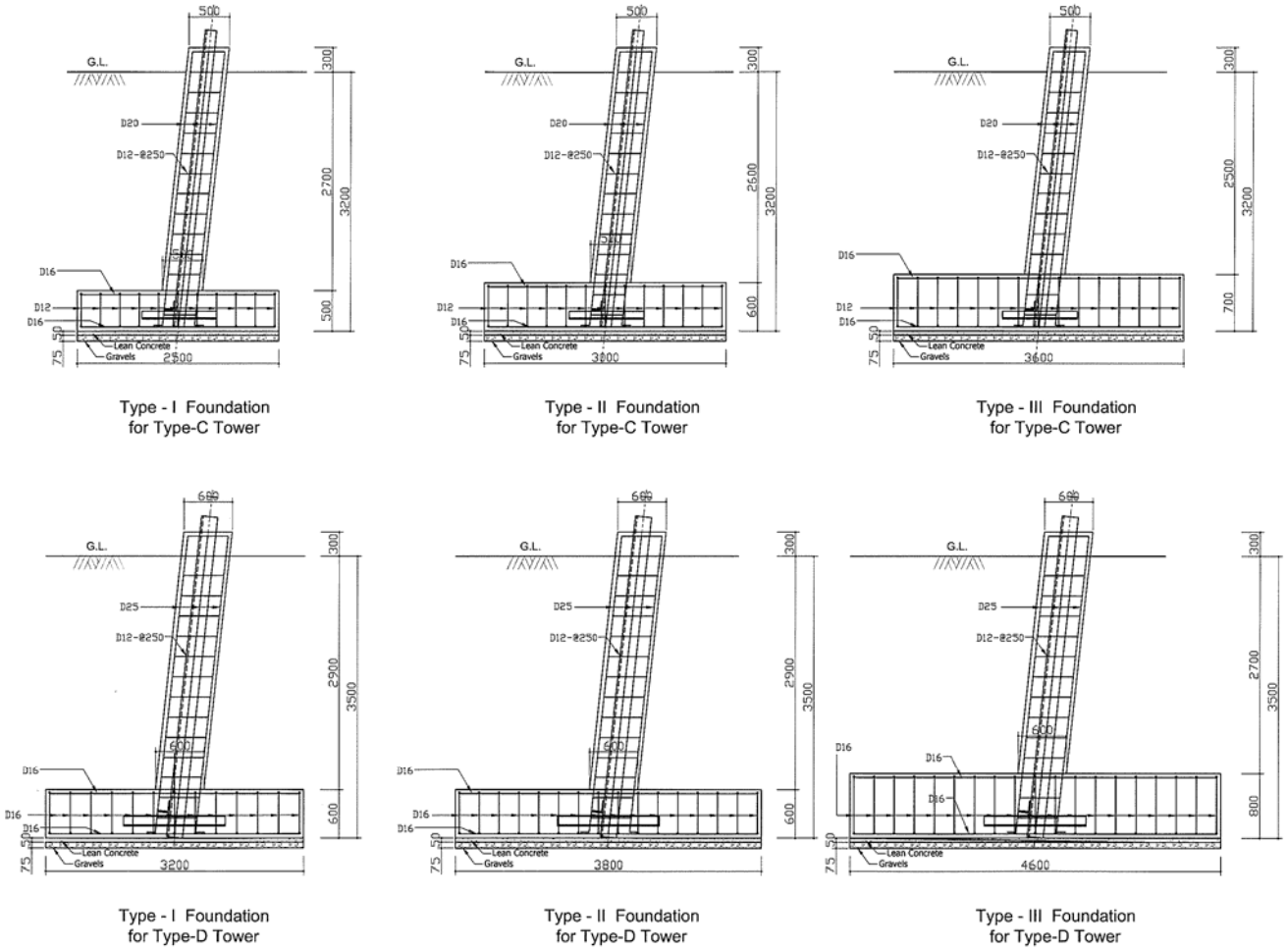


Figure 12.2-8: Typical Foundations for Tower Types C and D

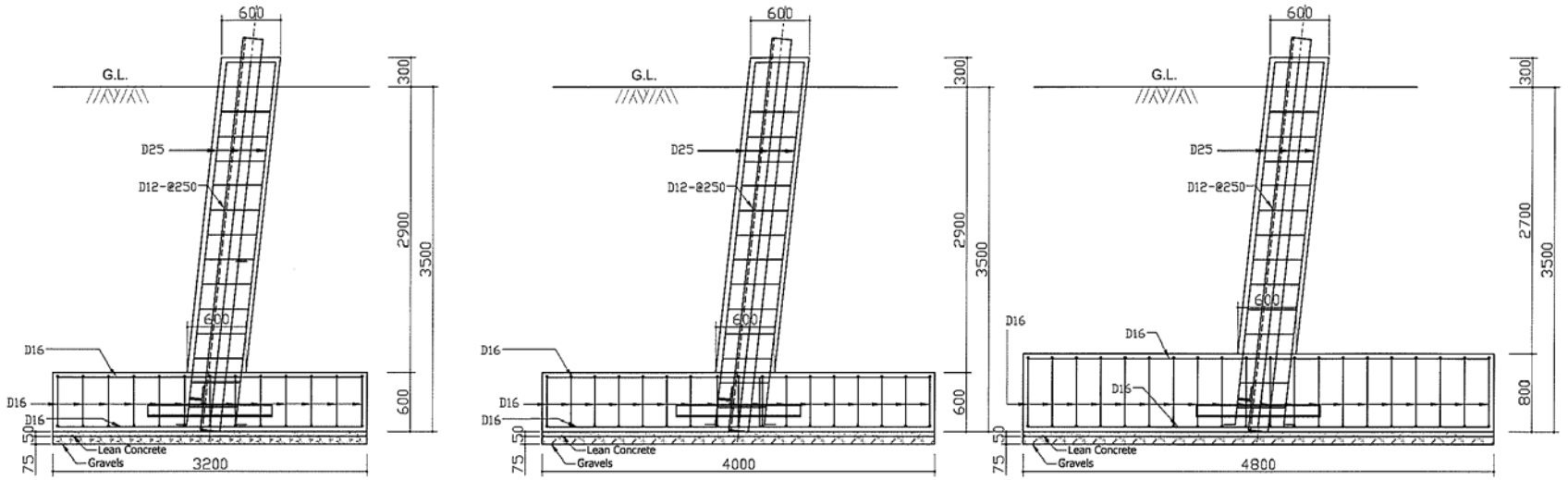


Figure 12.2-9: Typical Foundations for Tower Types DE

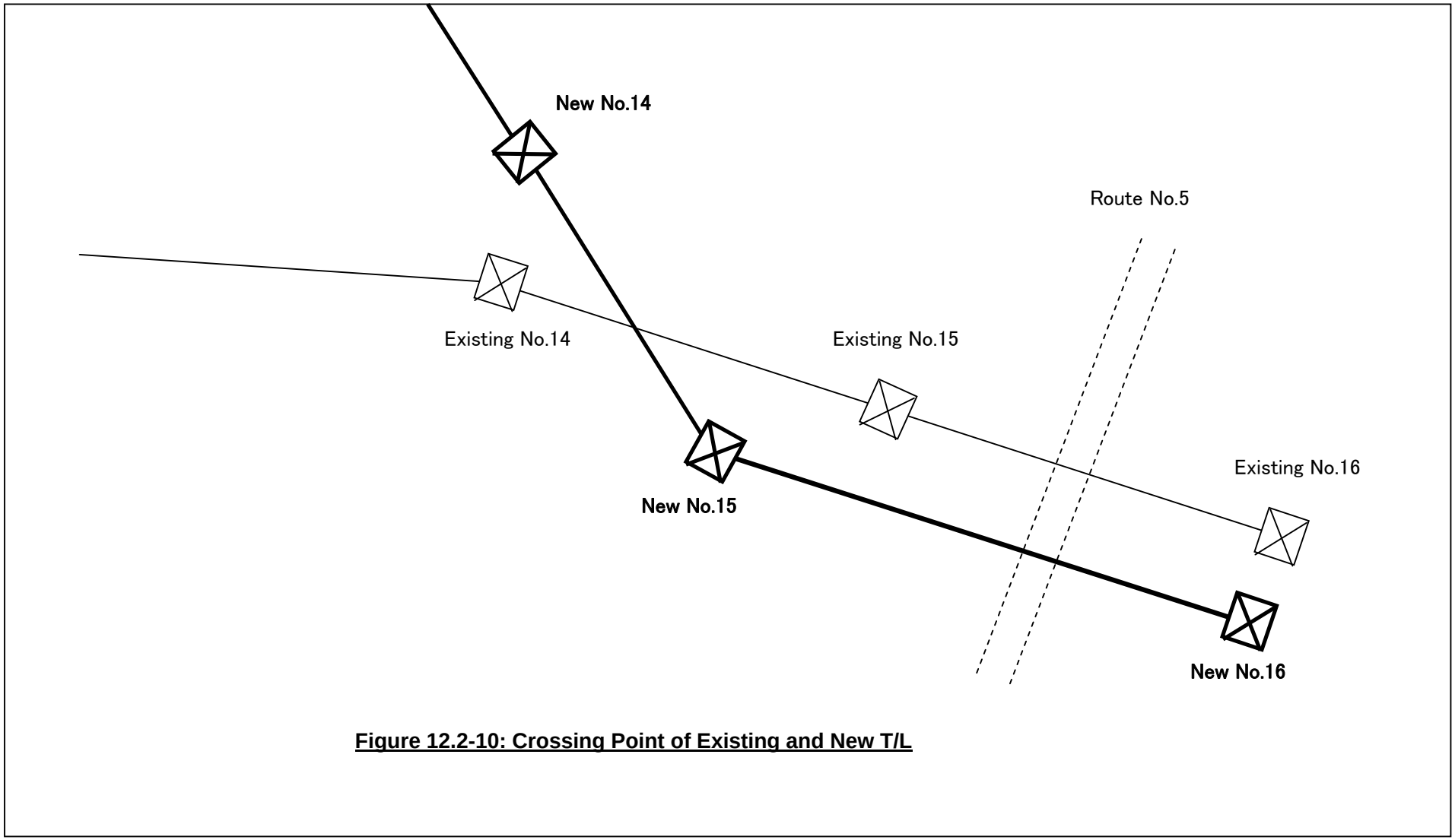


Figure 12.2-10: Crossing Point of Existing and New T/L

Chapter 13
Substation Facilities of the Project

Chapter 13 Substation Facilities of the Project

13.1 Design Concept

In addition to the general concept of the preliminary design described in Section 5.3 in Chapter 5, the design concept focusing on the Project is explained in this section.

(1) Utilization of the Existing Substations

Savannakhet, Taothan and Saravan areas are to be connected with the 115 kV transmission line under the Project. The existing 115 kV substation is in service only in Savannakhet, while there are no 115 kV substations in Taothan and Saravan as of October 2009.

Pakbo Substation in Savannakhet is now under augmentation of two transmission line bays under the Greater Mekong Power Network Development Project (GMPNDP) funded by JICA. Even after the project completion, two transmission line bays for the Project will be able to be installed with extension of 115 kV switchyard. Construction of a new 115 kV substation is planned in Saravan by 2011 under the Greater Mekong Subregion Power Trade Project (GMSPTP) funded by IDA. In the new Saravan Substation, the land space for the transmission line bays for the Project has already been secured. In other words, although new construction of Taothan Substation is necessary for the Project, the effective utilization of the existing substations in Savannakhet and Saravan is possible.

(2) Coordination to the Existing Substation Facilities

The specifications and the layout of the existing substation facilities in Lao PDR are not standardized but different among substations depending on the time of construction or the facility designers. Accordingly, the specifications and layout of the facilities for the Project should be determined by coordinating with the existing facilities in each substation.

(3) Busbar System

Both Pakbo SS, which is under reinforcement, and Saravan SS, which is under construction, are to be equipped with a main and transfer busbar system. Taothan SS is planned to have four transmission line bays and one transformer bay installed for the Project and has accordingly secured an appropriated of land space to achieve such ends in the future. Further, Taothan SS is also to be equipped with the main and transfer busbar system to assure the easiness of switching operations and system reliability.

(4) Main Transformer and 22 kV Facilities

Regarding the transformer capacity to be installed in new Taothan SS, capacity has been determined to meet the Study Team's demand forecast for Taothan SS up to 2030. As a result of the discussion with EDL, the unit number of main transformers in Taothan SS has been determined as one unit. The number of 22 kV distribution feeders in Taothan SS is to be four feeders including a spare feeder as the EDL's standard number for one main transformer.

The necessity of 22 kV facilities reinforcement in both Pakbo and Saravan substations has not been recognized. Accordingly, the replacement and/or reinforcement of 22 kV facilities in both substations have not been considered under this Project.

13.2 Substation Sites

13.2.1 Pakbo Substation

Figure 13.2-1 Location of Pakbo Substation

The existing Pakbo SS commenced operations in 1996 to import electric energy from Thailand to distribute it to Savannakhet City. As shown in Figure 13.2-1, Pakbo SS is located approximately 7 km north of Savannakhet City in Savannakhet Province. Pakbo SS is now under reinforcements under the GMPNDP funded by JICA including installation of two 115 kV transmission line bays and upgrading the single busbar system to the main and transfer busbar system. The Project plans to install two transmission line bays to new Taothan SS. However, present land space for the substation is insufficient to fulfil such plans. Expansion of the Pakbo SS land is necessary. The adjacent land to be expanded is available and owned by EDL, and there are no inhabitants around the Pakbo SS area.

13.2.2 Taothan Substation

As shown in Figure 13.2-2, the planned site for new 115 kV Taothan SS is located 13 km north of Napong Village, junction of Route No. 13 and Route No.15. The Saravan Provincial Government owns the land of the planned site and EDL has already acquired approximately 200

x 200 m of land area for new Taothan SS.

Figure 13.2-2 Location of Taothan Substation

13.2.3 Saravan Substation

New Saravan SS including the two transmission line bays for Xeset-1 Hydropower Station is under construction under the Greater Mekong Subregion Power Trade Project funded by the IDA and will be commissioned in 2011.

As shown in Figure 13.2-3, Saravan SS is located near Nadonkhouang Village, approximately 10 km west of Saravan City.

Planned land space for Saravan SS is wide enough to secure four additional transmission line bays in the future including bays for Taothan SS. Therefore, the extension of land space to install two transmission line bays is not necessary under the Project.

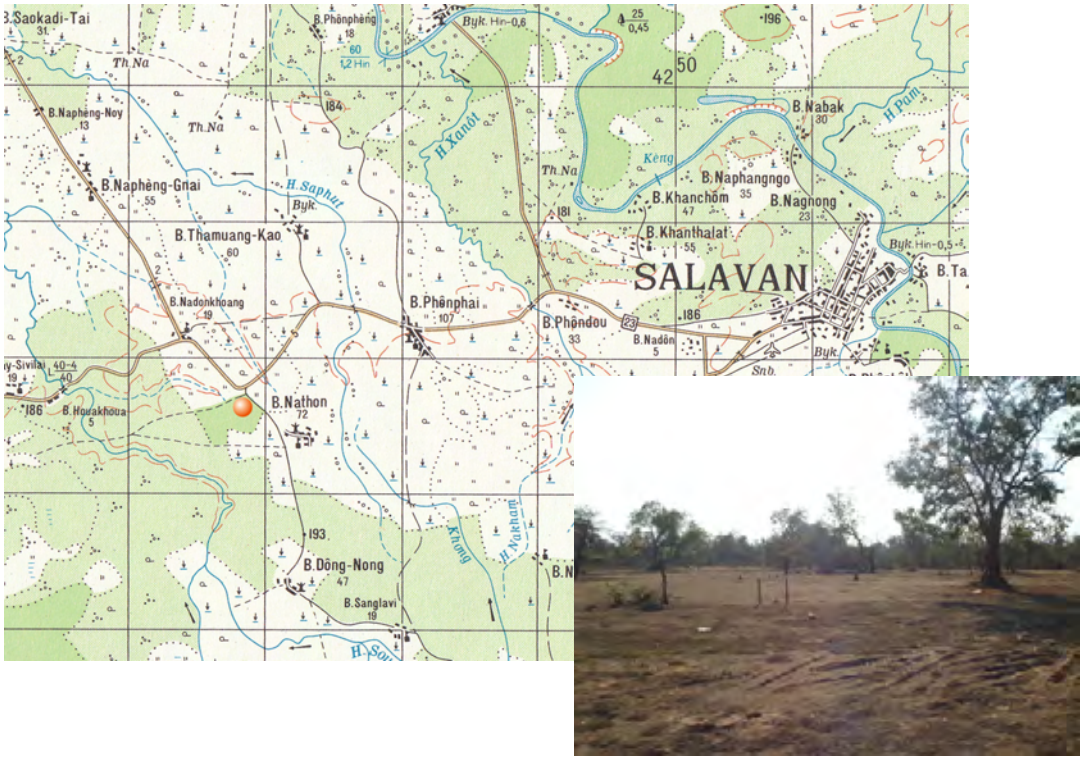


Figure 13.2-3 Location of Saravan Substation

13.3 Design for Pakbo Substation

13.3.1 General

Pakbo SS is now under construction of two additional transmission line bays under the GMPNDP funded by JICA and will be commissioned in January 2011. Therefore, the design for Pakbo SS under the Project is to be focused on the substation facilities after the GMPNDP is completed.

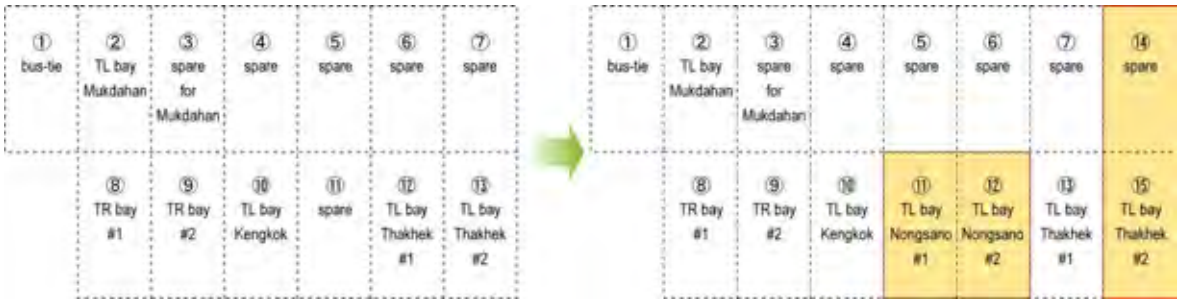
The general profile of Pakbo SS after completion of GMPNDP is as follows.

i)	Location	Savannakhet City in Savannakhet Province
ii)	Year of commissioning	1996
iii)	Busbar system	Main and transfer busbar system
iv)	Main transformers	115/22 kV, 20 MVA transformer 2 units
v)	115 kV switchgear	transformer bay: 2 bays transmission line bay: 4 bays（1 x Mukdahan SS (EGAT), 1 x Kengkok SS, 2 x Thakhek SS）
vi)	22 kV feeders	8 feeders

13.3.2 Design and Scope of Works

The installation of two transmission line bays connecting Taothan SS is necessary in Pakbo SS. As shown in Figure 13.3-1 (a), there are five spare rooms, at #④, #⑤, #⑥, #⑦ and #⑪ in the

figure, for the TL bays on the 115 kV switchyard after the GMPNDP. However, to avoid the crossing of the other transmission lines, the TL bays for Taothan SS prefer to be installed at #⑪ and #⑫. Therefore, discussion result with EDL is that the northern side of the 115 kV switchyard is to be extended (rooms #⑭ and #⑮ in the figure) and two TL bays of Thakhek SS at #⑫ and #⑬ are to be replaced at #⑬ and #⑮, respectively. The land for the extension is owned by EDL. After the replacement, 115 kV TL bays for Taothan SS are to be installed at #⑪ and #⑫ in a line under the Project.



(a) after the GMPNDP (b) under the Project

Figure 13.3-1 Pakbo Substation, 115 kV Switchyard Layout Plan

The scope of works for Pakbo SS under the Project is as follows;

a) Extension of gantries and busbars
- Extension of gantries at #⑭ and #⑮ including overhead bus work
- Extension of tubular busbars (main and transfer busbars)

b) Replacement of 115 kV TL bays for Thakhek SS (from #⑫ and #⑬ to #⑬ and #⑮)
- Installation of new 115 kV switchgear at #⑮
- Replacement of incoming line from the dead-end tower of Thakhek SS line

c) Installation of two TL bays for Taothan SS at #⑪ and #⑫
- Installation of new 115 kV switchgear at #⑪, diversion of the existing switchgear at #⑫ (A TL bay consists of 1 set of circuit breakers, 2 sets of disconnecting switches, 1 set of disconnecting switch with earthing switch, 1 set of current transformers, 1 set of capacitor voltage transformers, and 1 set of surge arresters.)
- Installation of protection relay and control panels in the substation control building

d) Civil and erection works
- Foundation work
- Erection work
- Extension of the 115 kV switchyard (filling, compaction)
- Extension of the service road in the substation
- Extension of the external guard fence
- Wiring work
- Grounding work including extension of the existing grounding mesh
- Extension of cable trench, etc.

e) Procurement of accessories including conductors, cables, insulators, etc., and special tools and measuring instruments for operation and maintenance

f) Procurement of spare parts

As a result of the design for Pakbo SS, the following drawings are attached in Appendix 13:

- Drawing No. SS_PKB_01: Pakbo Substation, Single Line Diagram
- Drawing No. SS_PKB_02: Pakbo Substation, Layout
- Drawing No. SS_PKB_03: Pakbo Substation, Section

13.4 Design for Taothan Substation

13.4.1 General

The general profile of new Taothan SS to be constructed under the Project is as follows.

i)	Location	Taothan Village in Saravan Province
ii)	Busbar system	Main and transfer busbar system
iii)	Main transformers	115/22 kV, 20 MVA transformer 1 unit
iv)	115 kV switchgear	transformer bay: 1 bays
		transmission line bay: 4 bays （2 x Pakbo SS, 2 x Saravan SS）
v)	22 kV feeders	Distribution feeders: 4 feeders
		Station service TR 100 kVA×1 unit
		Static Capacitors: 5 MVar x1 unit、2.5 MVar×1 unit

13.4.2 Design and Scope of Works

Taothan SS is to be newly constructed under the Project including one 115/22 kV main transformer, four TL bays for both Pakbo SS and Saravan SS, 22 kV switchgear, etc.

As shown in Drawing No. SS_TOT_02, land space for new Taothan SS is planned as 110 m× 90 m, which is enough space for an additional four TL bays in the future as well as for the installation of necessary 115 kV and 22 kV facilities under the Project.

The scope of works for Taothan SS under the Project is as follows;

a) Cleaning of trees and other vegetation from the complete substation area and cutting, filling, leveling and compacting of the substation area

b) Installation of one 115/22 kV 20 MVA main transformer and one 22/0.4 kV 100 kVA station service transformer

c) Construction of 115 kV outdoor switchyard

- Installation of four 115 kV transmission line bays (A TL bay consists of 1 set of circuit breakers, 2 sets of disconnecting switches, 1 set of disconnecting switch with earthing switch, 1 set of current transformers, 1 set of capacitor voltage transformers and 1 set of surge arresters.)
- Installation of one 115 kV main transformer bay (A TR bay consists of 1 set of circuit breakers, 2 sets of disconnecting switches, 1 set of disconnecting switch with earthing switch, 1 set of current transformers and 1 set of surge arresters.)
- Installation of one 115 kV bus-tie bay (A bus-tie bay consists of 1 set of circuit breakers and 2 sets of disconnecting switches.)
- Main and transfer busbars including supporting structures, tubular busbars, and one set of capacitor voltage transformers, etc.

- Installation of gantry structures for the above switchgear including overhead bus work

d) Construction of 22 kV outdoor switchyard

- 4×distribution feeders
- 1×main transformer feeder
- 1×station service transformer feeder
- 2×static capacitor banks （2.5 + 5 MVar）

e) Installation of communications equipment

- Optic fiber communications system including ODF, multiplexer, etc.
- Telephone system including PABX
- VHF radio communications system

f) Construction of station control building

- Substation Automation Control System
- Protection relay and control panels for 115 kV equipment
- Protection relay and control panels for 22 kV equipment
- Communications equipment room
- Battery room (110 V and 48 V)
- Lighting and air-conditioning system, etc.

g) Civil and erection works

- Foundation work
- Construction of oil pit
- Erection and installation of electric equipment
- Construction of station service road
- Construction of cable trench
- Grounding work including installation of grounding mesh
- Lightning protection work including installation of overhead shield wires
- Construction of guard house
- Construction of main gate and external guard fence
- Construction of station lighting system
- Wiring work
- Construction of cable trench, etc.

h) Procurement of accessories including conductors, cables, insulators, etc., and special tools and measuring instruments for operation and maintenance

i) Procurement of spare parts

As a result of the design for Taothan SS, the following drawings are attached in Appendix 13:

- Drawing No. SS_TOT_01: Taothan Substation, Single Line Diagram
- Drawing No. SS_TOT_02: Taothan Substation, Layout
- Drawing No. SS_TOT_03: Taothan Substation, Section (1)
- Drawing No. SS_TOT_04: Taothan Substation, Section (2)

13.5 Design for Saravan Substation

13.5.1 General

Saravan SS is now under new construction under the GMSPTP funded by the IDA and will be

commissioned in 2011. Therefore, the design for Saravan SS under the Project is to be focused on the substation facilities after the GMSPTP.

The general profile of Saravan SS after completion of GMSPT Project is as follows.

i)	Location	Nadonkhouang Village in Saravan Province
ii)	Busbar system	Main and transfer busbar system
iii)	Main transformers	115/22 kV, 20 MVA transformer 2 units
iv)	115 kV switchgear	transformer bay: 2 bays transmission line bay: 2 bays for Xeset-1 HPS
v)	22 kV feeders	8 feeders

13.5.2 Design and Scope of Works

The installation of two transmission line bays connecting Taothan SS is necessary in Saravan SS. As shown in Figure 13.5-1, land space for two TL bays for the Project has already been secured at the 115 kV switchyard in Saravan SS.

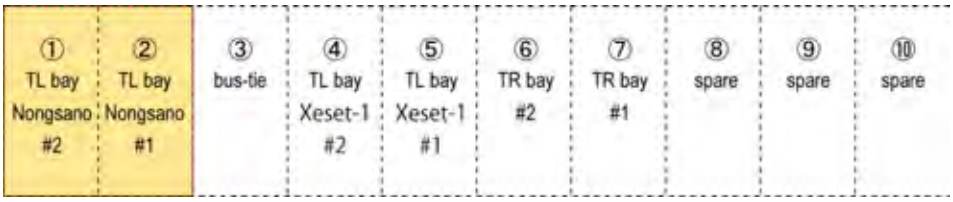


Figure 13.5-1 Saravan Substation, 115 kV Switchyard Layout Plan

The scope of works for Saravan SS under the Project is as follows;

a) Extension of gantries and busbars
- Extension of gantries at #① and #② including overhead bus work
- Extension of tubular busbars (main and transfer busbars)

b) Installation of two TL bays for Taothan SS
- Installation of new 115 kV switchgear at #① and #② (A TL bay consists of 1 set of circuit breakers, 2 sets of disconnecting switches, 1 set of disconnecting switch with earthing switch, 1 set of current transformers, 1 set of capacitor voltage transformers, and 1 set of surge arresters.)
- Installation of protection relay and control panels in the substation control building

c) Civil and erection works
- Foundation work
- Erection work
- Wiring work
- Grounding work
- Extension of cable trench, etc.

d) Procurement of accessories including conductors, cables, insulators, etc., and special tools and measuring instruments for operation and maintenance

e) Procurement of spare parts

As a result of the design for Saravan SS, the following drawings are attached in Appendix 13:

- Drawing No. SS_SRV_01: Saravan Substation, Single Line Diagram
- Drawing No. SS_SRV_02: Saravan Substation, Layout
- Drawing No. SS_SRV_03: Saravan Substation, Section

13.6 Major Equipment

13.6.1 General Electrical Requirements

General electrical requirements for 115 kV and 22 kV equipment for the Project are as follows:

i)	Nominal system voltage	115 kV	22 kV
ii)	Rated voltage (r.m.s. value) (Highest voltage for equipment)	123 kV	24 kV
iii)	Rated frequency	50 Hz	50 Hz
iv)	Insulation level		
	Rated short-duration power-frequency withstand voltage (r.m.s. value)	230 kV	50 kV
	Rated lightning impulse withstand voltage (peak value)	550 kV	125 kV
	Minimum clearance of phase-to-earth	1,100 mm	270 mm
	Standard clearance of phase-to-earth	1,400 mm	350 mm
	Minimum clearance of phase-to-phase	1,400 mm	350 mm
	Standard clearance of phase-to-phase	2,300 mm	700 mm
v)	Rated current	1,250 A	1,250 A
vi)	Rated short-duration withstand current (3 sec)	40 kA	25 kA

13.6.2 Specification and Quantity of the Major Equipment

(1) Specifications of Transformers

a) 115/22 kV main transformers

1)Rated power (continuous) 16,000/20,000 kVA (ONAN/ONAF)
2)Number of phase 3 phase
3)Rated frequency 50 Hz
4)Rated voltage ratio (High/Medium/Tertiary voltages) 115/22/15 kV
5)Connection Star - Star - Delta
6)Vector group notation YNyn0+d1
7)Short-circuit impedance 10% (10 MVA base at 75°C, rated tap)
8)Cooling ONAN/ONAF
9)Insulation levels
i) HV line terminal and neutral LI / AC* 550 / 230 kV
ii) LV line terminal and neutral LI / AC* 125 / 50 kV
* LI: Lightning impulse withstand voltage, AC: Short duration AC withstand voltage

10) Temperature rise limit
i) Winding (measured by resistance method) 60 °C
ii) Top oil (measured by thermometer) 55 °C

11) On-load Tap Changing Equipment
i) Step ± 8 x 1.25%

ii) Number of tap steps 17 taps

b) 22/0.4 kV auxiliary transformers

1)Rated power (continuous) 100 kVA
2)Number of phase 3 phase
3)Rated frequency 50 Hz
4)Rated voltage ratio 22/0.4 kV
5)Connection Delta - Star
6)Vector group notation Dyn11
7)Short-circuit impedance 4% (100 kVA base at 75°C, rated tap)
8)Cooling ONAN
9)Insulation levels
i) HV line terminal and neutral LI / AC* 125 / 50 kV
ii) LV line terminal and neutral LI / AC* - / 3 kV

* LI: Lightning impulse withstand voltage, AC: Short duration AC withstand voltage

(2) Specifications of switchgear

All main facilities installed under the Project should be of outdoor type. Major specifications of the equipment are as follows.

		115 kV equipment	22 kV equipment
a)	**Circuit breakers (3 -phase)**	SF6 gas type Rated voltage: 123 kV Rated normal current: 1,250 A Short-circuit breaking current: 40 kA Operation sequence: O-0.3s-CO-3min-CO Rated insulation level (IEC 60694) - Rated short-duration power-frequency withstand voltage (rms): 230 kV - Rated lightning impulse withstand voltage (peak): 550 kV	SF6 gas type （3-pole） Rated voltage: 24 kV Rated normal currents: 630 A, 1,250 A Short-circuit breaking current: 25 kA Operation sequence: O-0.3s-CO-3min-CO Rated insulation level (IEC 60694) - Rated short-duration power-frequency withstand voltage (rms): 50 kV - Rated lightning impulse withstand voltage (peak): 125 kV
b)	**Disconnecting switches (DS) (3 phase)**	Two-column rotary type with horizontal operation Rated voltage: 123 kV Rated continuous current: 1,250 A Rated short-duration withstand current: 40 kA Rated insulation level (IEC 60694) - Rated short-duration power-frequency withstand voltage (rms): 230 kV - Rated lightning impulse withstand voltage (peak): 550 kV 110 V DC motorized and manual operation	Two-column rotary type with horizontal operation Rated voltage: 24 kV Rated continuous currents: 630 A, 1,250 A Rated short-duration withstand current: 25 kA Rated insulation level (IEC 60694) - Rated short-duration power-frequency withstand voltage (rms): 50 kV - Rated lightning impulse withstand voltage (peak): 125 kV 110 V DC motorized and manual operation
c)	**DS with earthing switch (3 phase)**	same as item b)	same as item b)
d)	**Current transformers**	Rated voltage: 123 kV TL bay: 800-400/1/1/1/1 A, 5P20 & cl. 0.5, 25VA TR bay: 200-100/1/1/1/1 A, 5P20 & cl. 0.5, 25VA	Rated voltage: 24 kV TR bay: 600-300/1/1/1 A, 5P20&cl. 0.5, 25VA DL bay: 200-100/1/1 A, 5P20&cl. 0.5, 25VA Bus-tie: 600-300/1/1 A, 5P20&cl. 0.5, 25VA
e)	**Voltage transformers**	Capacitive Type Voltage ratio: 115 /√3 kV, 110 /√3 V, 110 /√3 V Accuracy and burden; -secondary (measurement): 0.5, 100 VA -tertiary (protection): 3P, 100 VA Coupling capacitance: 8,800 pF	Inductive Type Voltage ratio: 22 /√3 kV, 110 /√3 V, 110 /√3 V Accuracy and burden; -secondary (measurement): 0.5, 100 VA -tertiary (protection): 3P, 100 VA
g)	**Surge arresters**	ZnO type with surge counter Rated voltage: 123 kV Rated voltage (rms): 96 kV Rated discharge current: 10 kA	ZnO type with surge counter Rated voltage: 24 kV Rated voltage (rms): 21 kV Rated discharge current: 10 kA

h) Capacitor banks -

Rated voltage: 24 kV
Rated short-duration power-frequency withstand voltage (rms): 50 kV
Rated lightning impulse withstand voltage (peak): 125 kV
Rated capacity: 2.5 & 5 Mvar

Since new Saravan SS is under designing stage by the contractor as of October 2009 under the GMSPTP, specifications of the 115 kV facilities of Saravan SS might be altered, and they should accordingly be confirmed in the detailed design stage of the Project.

(3) Quantity of Major Equipment

With reference to the single-line diagrams and layout drawings for each substation, the quantity of the main facilities for each substation required for the Project is shown in the following table.

Table 13.6-1 Quantity of Major Equipment

	major equipment	Pakbo SS	Taothan SS	Saravan SS
1)	Transformers			
a)	115/22 kV main TR	-	1 unit	-
b)	Auxiliary TR	-	1 unit	-
2)	115 kV switchgear			
a)	Circuit breakers (3 phase)	2 units	6 units	2 units
b)	Disconnecting switches (3 phase)	4 units	12 units	4 units
c)	DS with earthing switch (3 phase)	2 units	5 units	2 units
d)	Current transformers	2 sets	5 sets	2 sets
e)	Voltage transformers	2 sets	5 sets	2 sets
f)	Surge arresters	2 sets	5 sets	2 sets
3)	22 kV switchgear			
a)	Circuit breakers (3 phase)	-	7 units	-
b)	Disconnecting switches (3 phase)	-	7 units	-
c)	DS with earthing switch (3 phase)	-	5 units	-
d)	Current transformers	-	5 sets	-
e)	Voltage transformers	-	2 sets	-
f)	Surge arresters	-	5 sets	-
g)	Capacitor banks	-	1 set	-

13.6.3 Protection Relay System

The following protection relay systems are to be applied to the Project:

a) 115 kV transmission line protection
- Main protection: distance relay phase & earth
- Back-up protection: directional over-current & earth fault relay
- Auto-reclosing relay
- Breaker failure relay
- Syncrhro check relay

b) 115 kV busbar protection
- Ratio differential relay
- Under voltage protection

c) 115/22 kV main transformer protection
- Restricted earth fault relay
- Ratio differential current relay

- Over current relay
- Over current ground relay (51N)
- Directional earth fault relay
- Breaker failure relay
- Syncrhro check relay
- Automatic voltage regulation (AVR) relay
- Buchholz relay (2 steps)
- Pressure relief device for main tank
- Temperature detectors for winding
- Temperature detectors for oil (2 steps)
- Dial type thermometers for indicating top oil and winding temperatures
- Dial type oil level indicator for conservator
- Low oil level for transformer
- Tap changer failure protection
- Oil pressure relay for OLTC
- Pressure relief device for OTLC
- Low oil level for OTLC
- Cooling fan failure protection
- Circulation pump failure protection
- Circulation oil flow failure protection

d) 22 kV busbar protection

- Over-voltage and under-voltage protection

e) 22 kV feeder protection

- Instantaneous and inverse-time over current and earth fault protection
- Auto-reclosing
- Frequency load shedding arrangement

f) 22 kV capacitor bank protection

- Overload protection relay
- Over-voltage protection

13.6.4 Spare Parts and Tools

Spare parts, tools and measuring devices for the O&M of each substation should be procured and stored for each substation and the EDL's branch office in each Province, which controls the substation. Accordingly, items and quantities to be procured will be decided during the detailed design stage.

Costs for procurement of spare parts, tools and measuring devices will be estimated 5% of the total cost of substation facilities for each substation.

Chapter 14
Implementation and Operation Plan

Chapter 14 Implementation and Operation Plan

This chapter discusses the specific implementation and operation plans for the Project.

14.1 Implementation Policy

14.1.1 Overall Policy

Preparatory works for project acceleration such as the acquisition of the environment certificate for from WREA, arrangement of funds, employing project consultants, etc. are to be the next required project steps.

The followings are the envisioned undertakings allotted to the implementation agency (EDL) and consultants, after project implementation is assured.

(1) Implementation Agency of Lao PDR

The agency for the Project of Lao PDR will be EDL under the supervision of the DOE of the MEM. In particular, the project office organized under the Transmission Line and Substation Department of EDL will be responsible for project implementation. The project office will organize a new team for the Project in assuring its implementation.

EDL will be responsible for the following during implementation.

a) Organizing a new Project Implementation Unit for the Project,

b) Coordination among the related ministries and provincial authorities for smooth implementation of the Project,

c) Acquisition of the right to enter designated project areas and acquisition of land/compensation of houses within the transmission line's right-of-way,

d) Prior securing of the environmental certificate for the Project from the WREA,

e) Appointment of the Project consultants, and cooperation with /assistance to them,

f) Close communication with institution(s) of the Project fund on bidding, contracts, procurement, project progress, and other information,

g) Proper actions for necessary procedures on facility import for the Project,

h) Issue of payment certificates for consultants and contractors,

i) Claim management of contractors, local people, and others,

j) Prosecution of the commissioning test of the Project,

k) Education and training of employees for operation and maintenance for transmission line and substations,

l) Proper and operations and maintenance of the facilities after commissioned, and

m) Removal of UXO if required.

EDL should secure budget and staffs to execute the above duties.

(2) Project Consultants

The consultants will be responsible for the following particulars.

a) Detailed design of the Project including a field survey and transmission line route investigation,

b) Preparation of the design report for the Project and submission to EDL,

c) Preparation of the bidding documents for the Project and submission to EDL,

d) Evaluation of proposals forwarded by bidders and assistance to EDL evaluation committee in selecting prospective bidders for the contracts,

e) Assistance to EDL in contract negotiations with prospective bidders and in conclusion of the contracts,

f) Examination on manufacturing/working drawings and various communications from the contractors for approval,

g) Inspections and tests for equipment and materials to be carried out at the contractors' factories prior to shipment,

h) Project management and supervision of the contractors' field works,

i) Preparation of O&M manuals of completed facilities and the completion report,

j) Inspection on facilities immediately prior to before expiration of the guarantee period for facilities and

k) Transfer of knowledge to EDL staffs in charge of the Project.

(3) Contractors

The Project will be executed in full-turn-key contracts. The contractors should be fully responsible for the following works in strict compliance with all terms in the contract documents.

a) Manufacturing design of equipment and materials required for completion of the Project,

b) Manufacturing and tests of the equipment and materials,

c) Packaging and transportation to the site of the equipment and materials,

d) Survey for UXO remanence before excavation work for steel tower foundation,

e) All civil/building works and installation of equipment and materials,

f) Verification of proper functions of all the facilities completed,

g) Commissioning of the facilities to EDL,

h) Transfer of knowledge to EDL through their working period for construction, maintenance and operation of the project facilities.

14.1.2 Procurement of Facilities

(1) Mode of Procurement

Although the Project comprises two components: transmission line and substation, the Project will be in principle executed under one contract of transmission line and substation, and the contractors will be selected through ICB (International Competitive Bidding) mode for full-turn-key basis.

(2) Origin for Procurement

The origin of the facilities/equipment for the Project will not be limited in principle, because of the ICB-based procurement. However, contractors for each contract lot should be carefully selected taking into account their qualifications for quality control of goods, production capacities, experience in similar projects, remedial claims of their previous contracts, financial status of the contractor and their major subcontractors, and others. Bidding documents prepared by the consultants will specify bidder's qualification and its evaluation criteria.

There is no manufacturer of electrical equipment available required for the Project at present in Lao PDR, but some construction materials, such as concrete can be procured in the country. Some consulting firms i.e. for the environment and survey started their business for the study on local situations. Joint ventures with foreign firms for the construction sector have also been established, especially some firms for investigation of UXO has been developed so far. Accordingly, the participation of Lao enterprises to the Project deems to be limited to environmental monitoring, transmission line route surveys, UXO investigation and removal, supply of labors, building works, normal civil works, and supply of concrete materials. All major equipment and materials should be imported.

(3) Guarantee Period of Facilities

It will be specified in the contract documents that the contractors should guarantee all functions of the facilities provided under the Project for the certain period after commissioning. Besides, it is also recommended that the contractors will train on the job site of EDL's operators and maintenance staffs during the construction period and a certain period after commencement of substation operations. A special term will be included in the contract documents as one of the contractor's duties.

14.2 Particular Conditions

(1) Management System of EDL for the Project

The Project will be executed in parallel with the construction of other similar projects funded by the IDA, ADB and others. As the number of staffs of the EDL's Project Offices and the TL & SS Department is limited, less experienced staffs might be assigned to manage and supervise the Project. The project consultants should advise the dispatched staffs on their jobs by giving technical and managerial details of the works at every opportunity.

(2) Safety of Construction Works

Substation works under the Project are planned for extension of the two existing substations. As most of the field works will be carried out under live conditions or tentative de-energized conditions of the existing facilities in the substations, the contractors for the Project should carefully and always work taking into full account workers' accidents, damages to the existing facilities, unscheduled system supply interruptions, etc. Transmission line works exciiding 200 km areas will have such various kinds of operation as on high towers, in deep foundation excavated pits, with special stringing tools, or frequent travelling on highways/small village roads, etc. There are many opportunities for fatal accidents and damage to public facilities. It has been observed that local workers use to take less care of such construction works without any safety tools to protect themselves. For preventing unexpected accidents, a term for the safe works should be specified in the contract documents.

(3) UXO

It has been reported that there will be less remanence of the UXO along the transmission line route selected for the Project except for some areas in Saravan Province. However, careful

investigation of the UXO is needed at the areas where its remanence is mentioned in the UXO map prior to the field works. In case that remanence is confirmed by investigation, it should be immediately notified to the related authorities, people and project workers, and entrance into the area should be prohibited until completion of clearance and safety confirmation. Also in the event that UXO would be found during works, the same steps should be taken.

(4) Procurement and Transportation of Equipment and Materials

Most of equipment and materials as well as measuring instrument, heavy machinery and tools for construction use for the Project will be imported though Thailand. EDL should take care of prior arrangements for the import of those goods to ensure the smooth work progress of the Project, and also arrange for re-export of the instruments, machinery, and tools after completion of the works.

(5) Prevention of Disturbance to Environment during Construction

About 20% of the selected transmission line route is to pass through paddy fields and cultivated lands. These lands may be subject to violent trampling via materials and worker transportation during the construction period. The contractors will be ordered to limit their access routes to the working sites, to restore disturbed lands, and to compensate crops, which should be specified in the contract documents. Some towers will be erected on the hill slopes. Land cutting for tower foundations may cause the collapse of surrounding lands. Such places should be firmly protected by stone or concrete walls. It has been planned that the transmission line will cross over the National Road Route No. 13 at seven points along the whole line section and over many provincial and village roads and paths. Such preventive measures to accidents as provision of scaffoldings or arrangement of watchmen during the conductor stringing operation should be taken to protecting passengers, cattle, or vehicles from accidents. All these measures to prevent environmental or social disturbance should be specified in the contract documents to be the responsibility of the contractors.

14.3 Scope of Works

Equipment/materials for the Project and construction works at the site will be procured in the ICB full turn-key base. EDL will be responsible for special particulars required for the project execution. The following table shows major works allotted for the contractors and EDL. EDL should arrange its staffs and budget around the execution of the allotted works.

Table 14.3-1 Scope of Works

	Contractors	EDL
Procurement of Goods	- Design and manufacture of goods	- Examination on drawings &
	- Factory tests of goods	documents from contractors
	- Packing for export & transportation	- Pre-arrangement for customs
	- Storage of goods at site	clearance of imported goods
		- Issue of payment certificates
Construction	- Civil & building works for the Project	- Securing of land for the Project
	- UXO survey/remove	- Acquisition of right for tree clearing
	- Overall construction of line facilities	- De-energizing schedule
	- Overall construction of substations	- Dispatch of inspectors
	- Commissioning test	- Issue of payment certificate
		- Acceptance of completion

14.4 Plan of Supervision

The following staffs from EDL and the consultants will perform procurement, management and supervision of the Project after the contracts between EDL and the contractors that would have been concluded.

(1) EDL Staffs

a) Project manager in the EDL's project office of TL & SS Department is to be assigned throughout whole project period. (He will be also a counterpart of the consultants.)

b) Staffs of the EDL's environment office for monitoring environmental measures taken by the contractors are to be timely dispatched to the sites. Persons from the related province and/or district may also monitor the situation.

c) Transmission line inspectors including persons from EDL branch offices: at least one civil work inspector throughout the contractors' civil works, at least two inspectors for tower erection and stringing operation, for each working section of the contractors. Those inspectors should be responsible not only for the supervision of the contractors' work but also for communication and negotiation with local authorities on the matters over which EDL has responsibility. Depending on number of the contractors' working groups, EDL will need many inspectors for the Project. As the number of working groups will be defined in the contract negotiation, EDL may arrange for inspectors at the time.

d) The contractor may simultaneously execute works of three substations. EDL's inspectors will be lined up with one person for civil/building works and one person for electrical works per each substation. OJT participants for the O&M of each substation under the Project are separate from the inspectors.

e) In addition to the aforementioned inspection team and trainees, a procurement committee, project implementation unit, management committee, and bid evaluation committee will be organized as a standard rule of EDL for project implementation and perform each duty for the Project. As demanded, EDL sections concerned the customs of imported goods, payment procedures, and communications with other authorities will execute their duties for the Project

(2) Consultants

a) Detailed Design and Preparation of Bidding Documents

The consultants will execute the detailed design, cost estimate and detailed implementation plan for the Project through discussions with EDL and in accordance with results of the field survey and investigation. Design report prepared by the consultants will cover whole results of the design. After approval of the report by the funding institutions or in parallel with report preparation, the consultants will produce bidding documents for the Project. A team leader, transmission line engineer, substation engineer, and survey engineer from among the consultants will work at this stage. In the short-term, experts for the environment, the communications system and cost estimate experts will also join the works.

b) Public Bid and Contract
The consultants will carry out assistance to EDL during public announcements of the bid, bid opening, bid evaluation, contract negotiation and preparation of the contract documents. A team leader, transmission lines engineer and substation engineer will be in charge of the works.

c) Procurement Management
The consultants will manage all works for examinations on the contractors' drawings and designs, and inspection/tests of equipment/materials at the contractors' factory. A team

leader, transmission lines engineer and substation engineer will be in charge of the work.

d) Supervision of Contractors' Field Works
Through the whole period of the Contractors' field works, the consultants will supervise all the field works. The consultants will have responsibility for education of EDL's operators and maintenance people for the facilities after completion of the Project. A team leader, two transmission line engineers, and one substation engineer (one more engineer to be added, in case) will be residing on the site through the contractors' field works. A communications engineer may be assigned for the short term.

e) Commissioning Test and Inspection for Defect Liability Period
After completion of the construction of all facilities, the consultants will supervise the contractors' commissioning tests of individual facilities for the transmission line and substations, and for also the system's operation test combining both the transmission line and the substation. Further, the consultants will check and approve the project completion report and O&M manuals of the completed facilities to be submitted by the contractors, and assist EDL with their procedures for issuing the taking-over certificates to the contractors. Immediately before the expiration of the defect liability period of the Project facilities, the consultants in conjunction with EDL will inspect all the project-related facilities for issuing the final certificates to the contractors.

14.5 Quality Control Plan

(1) Quality Control of Equipment and Materials

a) Design and Manufacturing Drawings
The consultants will examine design, manufacturing drawings, and quality control manuals to be submitted for approval by the contractors in accordance with the contract documents, for confirming quality of the proposed equipment and materials. If needed, the consultants will not approve the proposals of the contractors and order to re-design to fully comply with the contract specifications.

b) Inspection and Tests of Equipment and Materials
Major equipment and materials manufactured for the Project will be inspected and tested at the contractors' factories prior to shipment to the Project site for assuring their qualities. EDL staffs will be witness to those factory inspections and tests.

(2) Quality Control during Construction

a) Construction Drawings
The consultants will order the contractors to submit the construction drawings, construction schedules, and plans for quality control of the works for the consultants' approval, and manage quality control of the works done by the contractors.

b) Tests of Materials
The consultants will order the contractors to test samples of concrete and re-bars to be used for foundations and buildings at a reputed local laboratory. The contract documents will specify the duties of the contractors to be carried out compression tests on concrete pieces sampled by the consultants from mixing batches.

c) Control of Field Works
During the construction period of transmission line works (foundations, tower erection and stringing operation) and substation works (land expansion, foundations, expansion works of substation building and installation of equipment), the consultants and EDL inspectors will care damages on equipment and materials, and order to repair or replacement of the

damaged equipment and materials if found. Prior to issue of payment certificates to the contractors, the consultants and EDL inspectors will inspect not only progress but also quality of all facilities claimed by the contractors in their application for the payment.

d) Commissioning Tests
The consultants and EDL will finally confirm the quality of the facilities by the comprehensive commissioning inspection and tests to be carried out before the taking-over of the facilities.

14.6 Implementation Schedule

Figure 14.6-1 shows the overall implementation time schedule of the Project.

The period from appointment of the project consultants to the conclusion of the turn-key contracts for both transmission line and substations is assumed to be 12 months. The period from the conclusion of the contracts to the taking-over of the facilities is assumed to be 24 months making total implementation period to be 36 months after appointment of the project consultants.

Prior to commencement of excavation work for tower foundations, investigation of UXO remanence and clearance of UXO if found should be performed safety. The investigation for UXO will be conducted for the sections only for possible remanence but not for the whole line route. If found in the section, all the works in the area will be postponed until the complete clearance of the UXO. The remanence of UXO should affect the overall implementation schedule of the Project.

14.7 Organization for Operation and Maintenance

14.7.1 Present Organization

Section 4.6 of this report stated the present (as of October 2009) EDL organization and general functions assigned for each department. The Distribution Department of the head office manages and controls the operation and maintenance of the 115 kV transmission lines and substations as well as the MV and LV distribution networks in the country. EDL Branch Offices carry out actual operations and maintenance works of all 115 kV facilities together with the MV and LV networks in their territory.

The Distribution Department receives all daily information for operations and maintenance of facilities from all branch offices and gives necessary instructions to the offices. Power Line Carrier (PLC) and public telephone facilities are used for daily and emergency communications between the Distribution Department and branch offices. Besides, official reports from branch offices and instructions from the Distribution Department made through telephone facilities are confirmed in writing. The Transmission Line and Substation Department and/or Technical Department of the head office is to dispatch 2～3 persons of its staffs to a branch office for supervising major repair works of substation and distribution facilities when deemed necessary.

While, responsible territory for maintenance of the existing 115 kV transmission lines is extended to the boundaries of the provinces where the lines run. The transmission line maintenance group of each branch office has full responsibilities for the facilities existing in its territory.

Phonetong Substation, the largest substation in the country with four 30 MVA main transformers (115/22 kV), organizes a 3-shift operation system (four operation groups)

consisting of three operators per shift. Other substations also organize also a 3-shift operation system, but the number of operators per shift differs from Phonetong Substation depending on its scale. Each substation reports its daily operations and maintenance work to the head office. Relatively important repairs are carried out under the supervision of head office staffs.

The existing 115 kV transmission lines operating in Lao PDR are maintained through patrol, inspection and repair by the maintenance staffs from the branch offices. The maintenance program of transmission lines is planned so that the same section and same facility should be inspected at a minimum rate of twice a year. In thick tree and grass areas, inspections are particularly carried out before and after the rainy season for preventing ground faults of the lines due to the touching of trees, bamboos, or grasses to the energized parts of the lines. Clearing of those trees, bamboos, and grasses are carried out by local people sublet of the EDL branch office.

Spare parts for substations and transmission lines are stored in substations or branch offices. The quantity of spare parts stocked for transmission lines, particularly insulators, based on past experience has a six-month usage period. While, items and quantities of spare parts for substations are based on those recommended by the consultant in charge of the substation and EDL's experience for consumption. A supplement of the parts are made in such a way that branch office proposes items and quantities to the Distribution Department of the head office and the Managing Director of EDL approves the procurement.

EDL does not find any serious issues with the present organization and procedures for operation and maintenance of transmission lines and substations in the current system and also the future system after the progress of the ADB and IDA projects.

14.7.2 Reinforcement of Operation and Maintenance of High Voltage System

The four (4) power regions of Lao PDR are to be interconnected when the Project is completed. The interconnected system should be more systematic, stable, and economical during operations and maintainance. For stable and economical operations of the national power system including power stations, transmission lines, substations, and distribution networks, as well as power export and import, the Load Dispatching Center (LDC) will be indispensable in the near future. EDL is planning to construct the LDC with the IDA's financial assistance and is in the process of selecting a design consultant as of October 2009.

The high voltage power systems including the 115 kV and 230 kV system and the MV/LV networks in the country will be broadly extended before the commissioning of the Project. In consideration of the circumstances, the following measures will be required for stable and sustainable operations of the facilities to be completed for the Project.

a) Education to O&M Persons of Transmission Lines and Substations
   Additional manpower almost equivalent to the amount of current manpower for O&M work of HV transmission lines and substations will be required in the near future. Basic technological education to those recruits will be conducted at the EDL training center in Vientiane at first. Then, they will be further trained for actual operation and maintenance work on transmission lines and substations in existing HV facilities. EDL shall initiate such education and training to those recruits from here and onwards.

b) OJT of EDL's Staffs during Project Implementation
   In addition to the aforementioned education, those who have completed the training center course will participate in the construction works of transmission lines and substations if such opportunities become available. Through the OJT (On the Job Training), they will further understand the functions, characteristics, and components of various equipment, inspection/test methods, and others. In the contracts for the Project, a special term shall be

provided for the OJT of EDL persons by the contractors and for O&M instructions of the facilities for a certain period at the initial operation stages of the new facilities by the consultants and contractors.

c) Procurement of Measuring Instruments, Spare Parts and Tools
The measuring instruments and tools for use in operations and maintenance are common for equipment from different manufacturers. Procurement of these instruments and tools will take into special account those tools that are commonly used at a large number of substations in order to save project costs. Since, spare parts for the substation equipment are different among manufacturers even under the same technical specifications, procuremen shall be determined through discussions with EDL and the consultants concerned.

d) Standardization of Recording Format of Operation Data
For simplification of EDL's work processes and database preparation of operations and maintenance of substations by computers, the recording format for operation of substations shall be standardized and computerized. The database will be easily and quickly standardized and processed by EDL's computer office. A standard format is recommended also for efficient analysis of the statistics of the system operation.

e) Development of Communications among Power Systems
PLC (Power Line Carrier) telephone facility is provided on all the existing 115 kV transmission lines and 22 kV lines in Vientiane City. This facility is also necessary for future transmission lines for SCADA (supervisory control data acquisition) operations and quick reporting, instructions, fault treatment, and others among the branch offices, substations, power stations and the head office. Development of the communications system will be utilized for the operations of future LDC. For various projects, facilities should be developed under a common equipment design policy for smooth interconnection among the different systems.

f) Aggressive Utilization of EDL's Training Center
As stated in Section 4.6, the training center provides modern educational facilities and lecturers on all fields of the power system. Staff training for new transmission lines and substations should commence as early as possible at this center. In addition to the center's standard curriculum, it is recommended to provide a program for EDL's standard O&M manuals for HV transmission lines and substations to be lectured by staff from the head office. Besides serving as remedial training for the present O&M staffs from the branch offices, it will also prove in dispensable in letting them recognize anew the importance of O&M works and of strict compliance to the instructions in the manuals. It is also strongly recommended that the trainees undergo a special course for studying the Laotian Electric Power Technical Standard (LEPTS) for understanding the fundamentals pertaining to the planning and design of the facilities.

14.8 O&M Manuals and Education

EDL provides the standard O&M manuals (Lao version) for 115 kV transmission lines and substations. The manuals have been revised as needed based on prior faults occurrence and measures taken for their restoration. The revised manuals are explained in detail to staff of each substation, transmission line group, and branch office. Present O&M manuals have been prepared based on the manuals submitted by related consultants and suppliers of the projects. The contracts of the contractors for the Project should also include a term for duty of submission of the O&M manuals. The present EDL's standard manuals seem adequate. However, in implementing the Project, review of the standard manuals is recommended taking into account the O&M organization and particular circumstances unique to this Project,

referring to the following draft contents of the manuals.

(1) Maintenance Manual for Transmission Lines

a) Organization and duty/responsibility of maintenance group

b) Job classification of maintenance (daily, emergent and particular patrols and inspections) and their objectives

c) Detailed work items and objectives in the line patrol and frequency of the patrol

d) Job classification of line inspections (initial, periodical, particular and special inspections) and their objectives

e) Detailed work items of the line inspections and frequency of the inspections

f) Measures for faults and restoration of faults

g) Safety measures and special attentions for the works

(2) Maintenance Manual for Substations

a) Organization and duties/responsibilities of the maintenance group

b) Details of routine operational works and records

c) Areas needing special attentions during daily operations

d) Job classification of maintenance (daily, periodical and special patrols) and their objectives

e) Detailed work items and objectives during the patrol as well as the patrol frequency

f) Job classification of line inspections (initial, periodical, detailed and special inspections) and their objectives

g) Detailed work items, methods and frequency of separete inspections for all equipment

h) Measures for faults and restoration of faults

i) Safety measures and work areas requiring special attention

Generally, O&M manuals for a completed substation are to be prepared and submitted to EDL by the related contractors with the consultant's approval before the commissioning of the substation. Manuals submitted by the contractor should cover technical specifications, characteristics, composition of components, dismantling and inspection procedures, adequate frequencies of parts replacement, etc. of all equipment installed in the substation in detail. The contract for the Project should also include the contractor's duty for execution of OJT to EDL's operators during equipment installation, tests of various facilities and initial operation of the substation under the supervision of the contractor.

Having those EDL employees, who are anticipated to become operators and maintenance crew of the facilities after commissioning of the Project, participate in project construction is an effective training program. Another effective program for training of substation O&M is to have supplier experts jointly operate and maintain the substation for a certain period during the initial stages of operations.

The most important factor in the proper operations and maintenance of facilities is to strictly adhere to all articles stipulated in the manuals. This depends on the awareness of those employees in charge as well as daily employee education conducted by responsible EDL staffs. From this perspective, EDL's management and related consultants should pay special attention to how to best raise employee moral by emphasizing the importance of operations and maintenance works. Further, management efforts should be concentrated on developing in their employees the hab

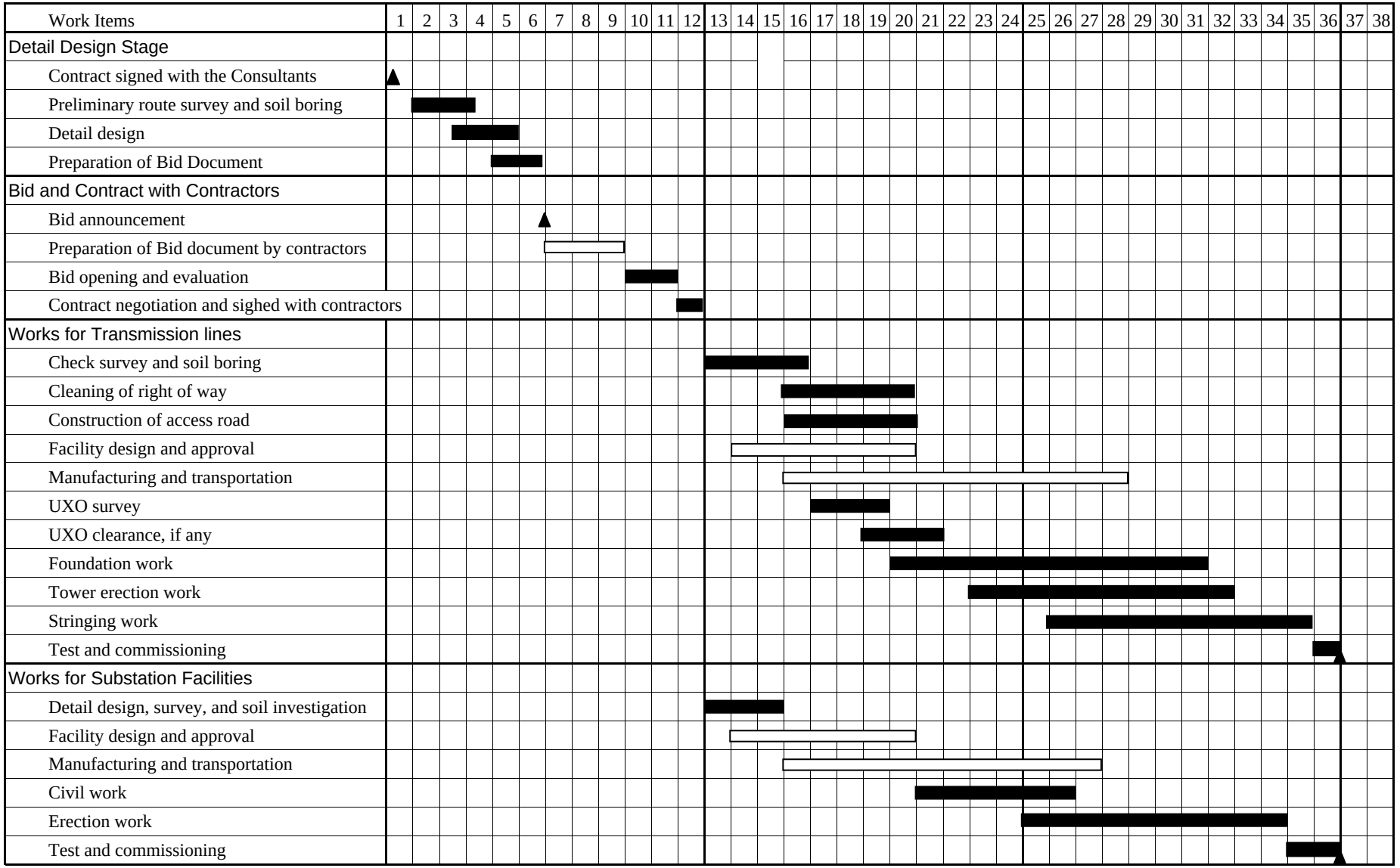


Figure 14.6-1: Implementation Schedule

Chapter 15
Initial Environmental Examination of Highest Prioritized Project

Chapter 15 Initial Environmental Examination of Highest Prioritized Project

15.1 Outline of Environmental and Social Consideration Study for Highest Prioritized Project

In the Lao PDR, national legislation stipulates that all development projects must obtain an ECC issued by Water Resources and Environment Administration (WREA) before starting construction activities. In order to obtain an ECC, the project owner needs to conduct an Evnrionmental Assessement (EA) at the F/S phase. In conducting EA, environmental impact resulting from the project is to be assessed and the mitigation measures needs to be developed for minimizing negative impact on environment. Environmental Assessment is to be divided into two types, Initial Environemtnal Assesment (IEE) and Environmental Impact Asssessment (EIA). As the Regulation on Environment Assessment stipulates the obligation of conducting EA for all development projects, the project owner submits a Project Description to enable Development Project Responsible Agency (DPRA) to conduct environmental screening. Depenting on the result, the project owner is to be required to conduct IEE. The IEE reports are to be reviewed by Department of Energy (DOE) and WREA. If any severe negative impacts are predicted during the conduction of IEE, the further assessment, EIA is to be required by WREA. Upon acceptance of the IEE, an ECC is issued. Followed by this provision, the project owner, EdL conducted an IEE for the highest prioritized project supported by JICA Study Team. To present, the transmission line projects have been required conducting only IEE.

Through the IEE, information on the natural environment and socio-economic situation within a designated project area was collected. Based on that information, anticipated negative impacts were accessed and the result was integrated into IEE report. The IEE report including the Resettment Action Plan (RAP) and Environmental Management Plan (EMP) are attached as Appendixes in this report.

A local consulting firm conducted the IEE of the project from June to August 2009. The summary of the IEE as well as the process and procedures for implementing the environmental and social considerations for the project are addressed in this section.

15.1.1 Project Alternatives

Throughout the design process, a number of different alternatives have been considered. Alternatives that have different environmental and social impacts are discussed in the sections below.

(1) Transmission Line Alternatives

Three different alignments were considered for the proposed transmission line (Table 15.1-1):

Option 1: Pakbo Substation to a new Taothan Substation to Saravan Substation

Option 2: Pakbo Substation to Kengkok Substation to a new Taothan Substation to Saravan Substation

Option 3: Pakbo Substation to a new Xepon Substation to Saravan Substation

The first 37 km from Pakbo Substation to Ban Natuey-Noi (where Road 13 S meets the road to the Champhone District centre) is the same for all three options. From there, option 3 heads east, initially along The National Road Route No. 9 to Sepon Substation, and then from there it heads southeast to Saravan Substation along Road 1G. Option 2 initially heads southeast to

Kengkok station and then rejoins Option 1 near Pakxong.

Option 1 has the smallest number of villages within 500 m of ROW among the three options. Options 1 and 2 pass near Phou Xian Thong NBCA (400 m distance in between), although those Options are not adjacent to the NBCA. The area required for the ROW and the Substation site are estimated almost the same for three options. As for the UXO, Options 1 and 2 are low risk, but Option 3 is partly high risk. Option 1 is estimated as having the lowest construction costs required. Overall, Option 1 was selected as the highest prioritized option taking into account its lowest possibility of resettlement as well as its lowest construction cost.

Table 15.1-1 Comparison of Transmission Line Alternatives

	Option 1	Option 2	Option 3
Resettlement	19	30	28
Biodiversity(Distance from NBCA)	400 m from Phou Xian Thong NBCA	400 m from Phou Xian Thong NBCA	1 km from Xe Bang Nouan NBCA
Land required for ROW and Substation site (ha)	551	581	524
UXO Risk	Low	Low	Partly High
Cost(USD)	39,988[1]	40,387	40,707

Resettlement: Number of villages within 500 m of ROW
Biodiversity: Distance between Transmission line and NBCA
Land required for ROW and Substation site: Total area required for ROW and Substation site
UXO risk: Possible UXO contamination within project area

(2) Substation Alternatives

Xepon Substation: In relation to the Option 3 transmission line alternative, the construction of Xepon Substation had been considered. However, since it was not selected as a prioritized project, evaluation in light of environmental and social considerations was not discussed.

Nongnou Substation: It is one of the substation site candidates for the prioritized transmission line project. It is located in Lakhonpheng District of Saravan Province and is 3 km northeast to Taothan Substation site. The site is composed of the Dry diptrocarp Forest and the Unstocked Forest. There is no fixed asset on the site. It requires 1ha of land acquisition.

Taothan Substation: Same as Nongnou Substation, it is one of the substation site candidates for the prioritized transmission line project. About 10% of the land is Eucalyptus plantation and the rest is cleared land.

As Saravan Province is the owner of the planned Taothan Substation site, EDL, in consultation with the Saravan Provincial Government, agreed to give the land to EDL. Consequently, EDL has selected Taothan Substation Site because this site does not necessitate any land acquisition.

(3) Without-Project Alternative

The consequences for not proceeding with the Project are summarized as follows:

- The land, water and air impacts associated with the construction and operation of the proposed transmission line and substations will not occur.
- Landowners who are directly affected by the Project will not receive compensation. Any local community concerns regarding the loss of land and other assets will be alleviated.
- The Lao PDR will spend additional money importing electricity to the Central 2 grid.

Considering the minor environmental and social impacts resulting from the Project and taking

[1] This is the cost estimated at the time of IEE, June 2009.

account of the financial burdens the Lao PDR would suffer, not-proceeding with the Project is not realistic.

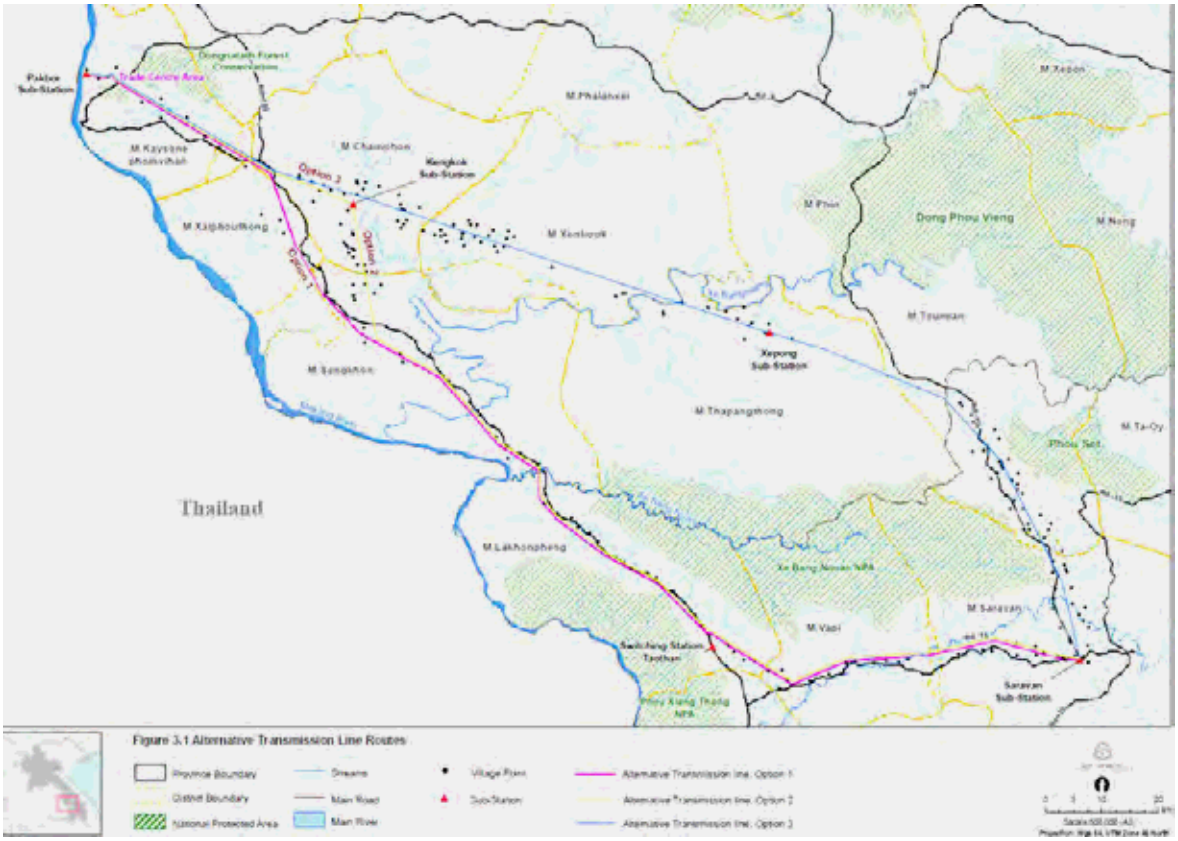


Figure 15.1-1 Alternatives for Transmission Line Route

(Source: Earth Systems Lao (2009), IEE Report)

15.1.2 Natural and Social Environment within Project Area

(1) Natural Environment

Land Use: Vegetation along the proposed transmission line route is generally fragmented and degraded with the majority of the vegetation along the route having been cleared for agricultural land such as rice paddies. Land usage in the project area is shown in Table 15.1-2 and a map of land usage in the project area is shown in Figure 15.1-2.

In the Lao PDR, 115kV transmission line Right-Of-Way (ROW) is 25 m (12.5 m from the center line). Fixed assets, more than 3 m tall is not allowed within ROW and tall trees within 12.5 m are on both sides needs to be tremmed and pruned at or below 3 m. Trees and other agricultural assets less than 3 m tall such as rice paddy are allowed in ROW. On government land, any trees that have the potential to grow above 3 m needs to be cleared. On private land, trees that can survive at less than 3 m need to be pruned and maintained below this height. There is no legislation stipulated for these conditions, however, these clearance policies have been practiced in EDL.

In studying the land usage map as well as the information collected during site survey, about 544.3 ha is estimated to be impacted resulting from securing ROW. 544.3 ha of the impacted

area consists of 9% Mixed Deciduous Forest, 40% Unstocked Forest (Degraded Forest[2]), 50% Rice paddies and 1% Tree plantation land. The area directly impacted from ROW tree clearance is estimated to be about 50ha based on the site survey through IEE, the land usages map (Figure 15.1-2) and satellite image.

According to the Forestry Law (2007), forests and forestlands other than protected forests and conservation forests are categorized as production forests. In the project area, forests which consists of the deciduous forest and dry diptrocarp and unstocked forest, fall under this category. Before logging trees in production forests for infrastructure construction, a logging survey is required for all tree species with circumference over 15 cm and the results are to be submitted to the government for consideration and approval of the logging[3].

Agricultural patterns in the project area are dominated by traditional Lao Loum lowland sedentary agriculture practices. A small amount of upland rotating agriculture is practiced.

All villages have been issued Land Certificate for Agricultural Land and those lands are imposed with a Land Certificate Tax.[4]

Protected Areas: There is no NBCA, protected area nor conservation area at the provincial and district level in the project area. The transmission line route passes in between the boundaries of the two NBCAs (Phou Xieng Thong and Xe Bang Nuan). The route does not run adjacent to the NBCAs, however, it goes 400 m close to some part of Phou Xieng boundary. Direct impact to the biodiversity of the NBCA is not predicted, however, cumulative impacts to the area need to be constantly monitored and mitigation plans developed as deemed appropriate.

Scenic Spot, Historic and Cultural Heritage: There is no scenic spot or historic and cultural heritage identified within the designated project area.

Table 15.1-2 Land Usage in the Project Area

District	Line distance on village land (meters)	Total area of TL ROW (m^2)	Estimated land (Forest land)		Estimated land (Agricultural land)	
			Mixed deciduous forest	Dry diptrocarp and unstocked	Rice Paddy	Plantation
Champhone	25382	634550	0%	86%	14%	0%
Kaysone	4654	116350	36%	16%	43%	4%
Xaiphouthong	23786	594650	3%	32%	65%	0%
Songkhone	54327	1358175	17%	39%	44%	0%
Lakhonpheng	52803	1320075	9%	48%	44%	0%
Vapi	31952	798800	1%	21%	78%	0%
Salavan	24814	620350	0%	35%	65%	0%
Total	217718	5442950	9%	40%	50%	1%

(Source : Earth Systems Lao (2009), IEE Report)

[2] Degraded Forest area are previously forested areas in which the crown density has been reduced to less than 20% because of logging, shifting cultivation or other heavy disturbance (Forestry Inventory and Planning Department, 2002)

[3] Article 18, Forestry Law 2007

4 The Land Use Certificate is one of the legal proofs on ownership of a land and the written information on the Certificate is a basis for calculating compensation.

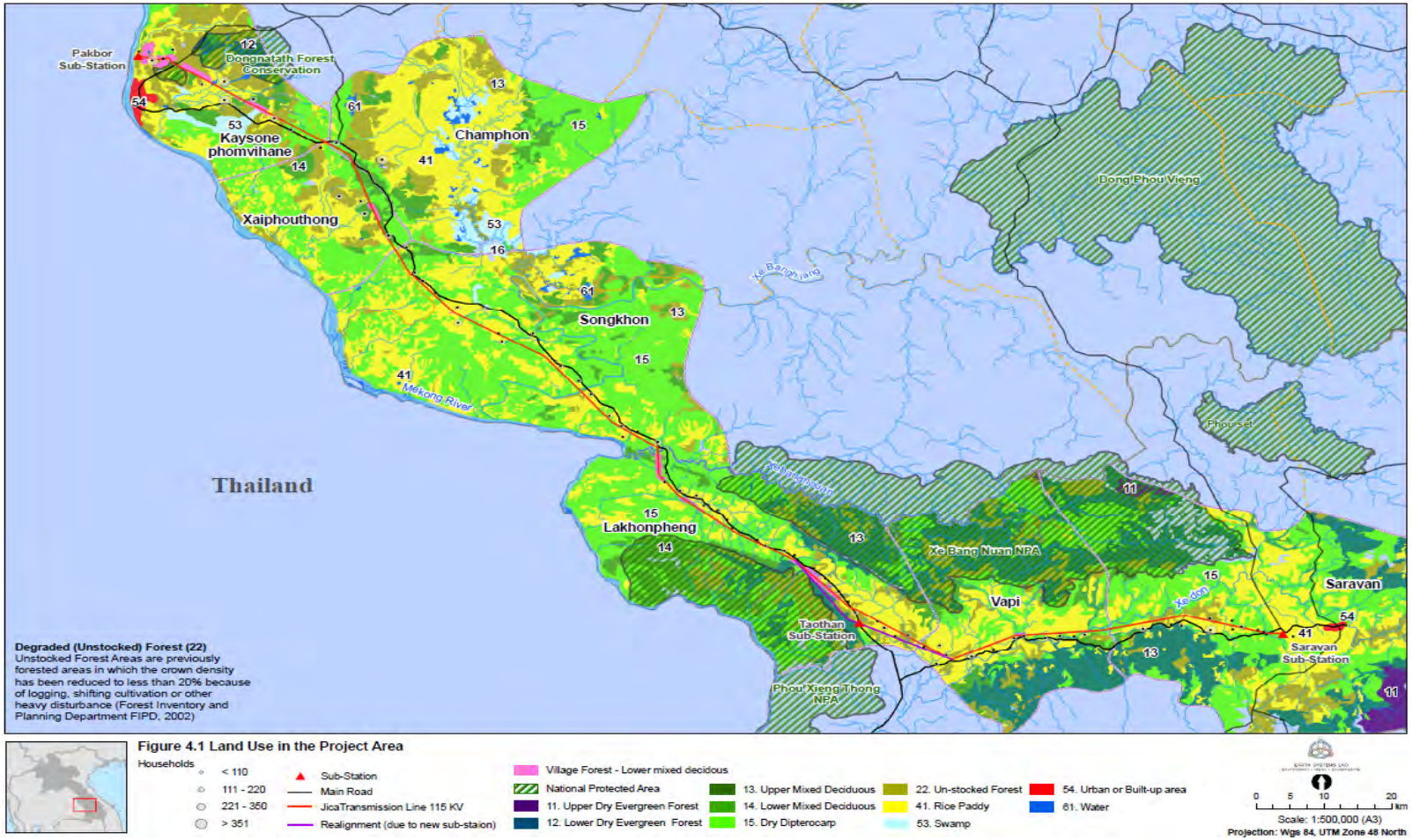


Figure 15.1-2 Land Usage in the Project Area

(Source: Earth Systems Lao (2009), IEE Report)

15.1.3 Social Environment within Project Area

Ethnic Minority People: About 92% belongs to Lao-Tai linguistic family (the majority in the Lao PDR) and 8% consisting of Ethnic Minority groups such as Katan, Ta-Oy, Xuay and Suiy which all belong to Mon-Khmer linguistic family. Village level survey revealed that all ethnic groups have a long history in the local area with the minority groups generally being absorbed into mainstream Lao-speaking society and are treated as Lao citizens within the administration and civic society minus any discrimination.

Local Economy: More than 80% of the workforce in the project area practiced agriculture based activities. About 20% of workforce belongs to the service industry and manufacturing sector.

Vulnerable Groups: About 12.5% of households in the project area belong to vulnerable groups consisting of Single Female Head Households 6.4%, Landless Households 3.5%, No Labor Households 1.4% and Elderly Households 0.9%.

Health: Because most of the villages in the project area are located along national roads, access to a district health centre and provincial hospital is satisfactory. Reported health issues in the past twelve months include malaria, dengue, diarrhea and some cases of HIV/AIDS.

UXO: More than half of the surveyed villages reported that no land within the village boundaries was affected by the UXO. Those villages that did report UXOs were mainly in Saravan and Vapi district of Saravan Province. These villages also reported that land mine clearance teams had completed work in their villages and that over the last five years, few UXO incidents had occurred.

15.1.4 Mitigation Plan for Environmental and Social Impact (EMP)

The screening results based on the scoping items (addressed in Chapter 3.8 Environmental Legislations) are summarized in Tables 15.1-3 and 15.1-4. The results are reflected in developing Environmental Management Plan (EMP) as part of the IEE report. Potential impacts, mitigation and management measures and institutional responsibilities addressed in EMP are shown in Table 15.1-5. The mitigation and management measures addressed in the EMP are applied as monitoring items in the design and construction phases and operation phase. Methods and institutional arrangements are discussed in Section 15.1.4, Monitoring on Environmental and Social Considerations.

Table15.1-3 Results of Screening in Design and Construction Phases

No.	Impact	Rating	Result	Re-Rating
	Social Environment			
1	Resettlement and loss of agricultural lands	B	33 fixed assets (house and other assets) were confirmed on the Transmission Line route (TL route) through IEE site survey. Base on the information, the TL route was re-aligned in order to avoid those assets. Consequently there is no fixed asset loss thus no resettlement occurs. About 2.88ha is to be required for the construction of transmission tower base and it affects on some agricultural land. The potential impact is minor.	B
2	Deterioration of local economy	B	Land acquisition for constructing transmission towers affects some agricultural land. However, the impact is minor. On the other hand, the opportunity for local peoples to be a construction worker is expected to contribute positibe impact on local economy.	B
3	Disturbance to social infrastructures and services	B	During the construction phase, some social infrastructure disturbance is expected due to the tower and substation construction. However, the impact is temporary and minor.	B

4	Interruption to residential activities	B	During the construction phase, some residential activity interruption due to the tower and substation construction is to be expected. However, the impact is temporary and minor.	B
5	Increase the risk of infectious diseases such as HIV/AIDS	C	Few cases of HIV/AIDS were identified through IEE site survey. Awareness activities on infectious diseases by NGO have been implemented in the project area. A temporary influx of migrant labor during the construction period increases the risk of sexual transmitted diseases incidents in the project area. However, the impact is anticipated to be minor.	B
6	Disturbance to water Usage or Water Rights and Rights of Common	B	In case large amount of surface water is used during the construction phase, some impact is to be expected.	B
7	Loss of historical, cultural and archeological properties and heritages	C	There is no historical, cultural and archeological property and heritage on the TL route.	
8	Increase disadvantage of vulnerable people such as ethnic people, single headed female household etc.	C	About 8% of population in the project area belongs to ethnic minority groups; however, the minority groups generally being absorbed into mainstream Lao-speaking society and are treated as Lao citizens within the administration and civic society minus any discrimination. Thus no impact on those people is anticipated. About 12.5% of households in the project are belongs to vulnerable groups. In case those households are affected through land acquisition, some impacts are anticipated.	B
	Natural Environment			
9	Disturbance to wild life and Biodiversity	C	There is no protected area on the TL route. Some parts of the TL route passes 400m to NBCA. Some cumulative impact is anticipated in the area.	B
10	Clearing of forest or bushes	B	About 250ha of forest land is anticipated to be affected for the TL ROW. About 80% of the forest consists of Unstocked Forest where the forest has been already cleared for cultivation. About 50ha of forest land is directly impacted through forest clearing.	B
11	Destruction of landscape	B	A TL is to be constructed along National Road 13 and National Road 15. Thus some impact is expected, however, there is no scenic spot identified on the route so that the expected impact is minor.	B
12	Soil erosion	B	Soil erosion resulting from clearing forest is expected, however, the degree of impact is minor.	B
13	Disturbance to ground water	C	About 92% of population in Savannakhet Province and about 62% of population in Saravan Province relies on ground water. For construction works that require a large amount of ground water, some impact is expected.	B
	Pollution			
14	Air pollution	B	During the construction phase, air pollution such as exhaust fumes from earthmoving equipment as well as construction vehicles associated with the tower and substation construction is anticipated. However, the impact is temporary and minor.	B
15	Water pollution	B	During the construction phase, waste water discharge associated with the tower and substation construction is anticipated. However, the impact is temporary and minor.	B
16	Soil contamination		Uses of materials containing PCB affects soil quality, however, those materials are prohibited in the Lao PDR thus no soil contamination is anticipated.	
17	Waste generation associated with construction and waste generation at workers' camps	C	During the construction phase, generation of materials resulting from construction activities and generation of litter due to the presence of the Project employees and contractors are expected. However, the impact is temporary and minor.	B
18	Disposal of construction debris	C	During the construction phase, vegetation waste resulting from forest clearance is anticipated. However, the impact is temporary and minor.	B
19	Dust emission	B	During the construction phase, dust emissions associated with the tower and substation construction is anticipated. However, the impact is temporary and minor.	B

20	Noise and vibration	B	During the construction phase, noises and vibration associated with the tower and substation construction is anticipated. However, the impact is temporary and minor.	B
21	Injury or sickness of residents or workers	C	During the construction phase, increased risk of accident associated with the tower and substation construction is expected. However, the impact is temporary and minor.	B
22	Disposal of construction debris		Usages of PCB contained materials affects soil quality. However, those materials are prohibited in the Lao PDR thus soil contamination is not anticipated.	
23	Accidents caused by UXO	C	UXO risk is not identified on the TL route in more than 50% of the villages through IEE site survey. Some risk is foreseen in Saravan and Vapi District in Saravan Province. Detailed survey and clearance operation as deemed appropriate is to minimize the impacts.	B

Rating:
A: Serious impact is anticipated
B: Some impact is anticipated
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses)
No Mark: No impact is expected

Table15.1-4 Results of Scoping Items in Operation Phase

No.	Impact	Rating	Result	Re-rating
	Social Environment			
1	Inadequate resettlement and compensation for loss of land	B	No resettlement is expected. Compensation cost for the loss of agricultural land is to be estimated based on the result of DMS and finalized consulting with each affected person. With an appropriate implementation of RAP, impact is to be minimized.	B
	Natural Environment			
2	Disturbance to wild life and biodiversity near NBCA	B	TL route does not pass through NBCA so that direct impact to NBCA is not expected. However, the cumulative impact is anticipated at the area where the boundary of NBCA is 400m close to NBCA. Via appropriate monitoring and mitigation measures, impact is to be minimized.	B
	Pollution			
3	Water and soil contamination	B	Use of herbicide for ROW clearing causes water and soil contamination. With appropriate management plan stipulating prohibition of herbicide use, the impact is to be minimized.	B
4	Noise and vibration	C	Noises and vibration resulting from substations are to be minimized in terms of constructing facilities a safe distance away from residential areas. The proposed substation site locates on agricultural land area and far from residential area thus the anticipated impact is negligible.	B
5	Interference with local residents' communication	C	Communication line interference via an electrostatic induced current is expected. With appropriate monitoring and mitigation measures such as the installation of additional antennas the impact is to be minimized.	B
6	Injury or sickness of local residents	C	With mitigation plans such as the installation of "keep out" boards at each transmission tower, such impacts are to be avoided.	

Rating:
A: Serious impact is anticipated
B: Some impact is anticipated
C: Extent of impact is unknown (Examination is needed. Impacts may become clearer as study progresses)
No Mark: No impact is expected

Table 15.1-5 Potential Impacts, Mitigation and Management Measures and Responsibility

Potential impact area	Project issue / impact	Significance	Mitigation and management measures	Responsibility
DESIGN AND CONSTRUCTION				
Terrestrial Biodiversity	Impact on terrestrial vegetation, terrestrial fauna, forest resources and protected areas	Minor - Moderate	Management clearing of the ROW:	
			Avoid clearance of mixed deciduous forest wherever possible.	EDL Project Management Office
			Minimize the amount of land cleared for the Project.	EDL Project Management Office
			Use of herbicides will be prohibited.	Contractor
			Burning will be prohibited.	Contractor
			Identify sensitive habitats and important NTFP areas close to construction areas and designate these as 'no go' areas.	Contractor
			Maintain forest cover as close as possible to the edge of all Project components.	Contractor
			Only use local, non-invasive plant species in revegetation work.	Contractor
			Carefully monitor land clearance activities throughout the construction phase to ensure that vegetation is not cleared beyond pre-defined project boundaries.	EDL EO/EMUs
			Ensure that ground vegetation and shrubs are not disturbed in the ROW below the required clearance height	Contractor
			Ensure that the alignment of the transmission line is sited as far as possible from NPAs and other designated environmentally sensitive areas.	EDL Project Management Office
			Consider the implementation of measures to minimize impacts on birds and mammals due to electrocution and wire strikes, particularly where the transmission line alignment passes in the vicinity of the NPAs.	EDL Project Management Office
			Prohibit staff and contractors from hunting or trading of wildlife as well as the collection of timber and NTFPs in the vicinity of the NPAs.	Contractor
			Selling of logs by the Contractor and by EDL will be prohibited. Logging and logs selling process will be based on the Forestry Law No.6 (24/Dec/2007) Article 49 and conducted by the Forest and Forestland Management Organizations.	Contractor EDL EMUs
			Forestry Clearing Committee, District Forestry Unit and land owners to list and mark big trees or commercial tree species and cut before ROW clearing.	PEMC District Forestry Unit
Land use	Impact on land use	Moderate	Provide compensation for productive land and residential land lost as a result of the Project.	PEMC EDL EO / EMUs
			Replace or re-install utilities and facilities (such as ground water pumps, fishing ponds, access tracks) disturbed by the Project.	PEMC EDL EO / EMUs
			Construction activities will be timed to avoid disturbance of field crops where possible.	Contractor
			Where crop disturbance is unavoidable, compensation will be paid.	PEMC EDL EO / EMUs
			Access track construction will be minimized. Established roads will be used for construction and maintenance where possible. Where construction of access routes is required, they will be restricted to a single carriage way within the ROW.	Contractor

Potential impact area	Project issue / impact	Significance	Mitigation and management measures	Responsibility
			Temporary concrete batching plants will be located on disturbed sites or areas of low production value (e.g. grass land where possible).	Contractor
			Spoil disposal areas will be identified prior to beginning construction. Productive land areas and areas important for biodiversity will be avoided.	EDL Project Management Office
			Felled trees and other cleared or pruned vegetation will be made available to the owner (individual or village), or will be removed if requested by the owner.	EDL EO / EMUs
			Compensation for removed or pruned trees will be paid at fair market value based on tree type and age.	PEMC/EDL EO/EMUs
Aquatic Biodiversity	Impact on local aquatic flora and fauna	Negligible	Prohibit hunting and fishing, and species introduction by employee of contractor and Project staff	Contractor EDL EO / EMUs
			Control erosion and sedimentation from Project activities. (See below).	Contractor
Erosion and Sediment Transport	Erosion and sediment transport during project construction	Minor	Where possible, schedule construction activities during the dry season (low rainfall).	Contractor
			Towers will be located on flat to gently sloping terrain (i.e. slopes of less than30 Degree).	EDL Project Management Office
			Minimize the area of land cleared for project construction work, and retain vegetation in suitable locations (e.g. riparian) to maximize filtration of sediment from turbid runoff, during and post construction.	Contractor EDL EO / EMUs
			Progressively revegetate disturbed land surfaces at the Project site as soon as practicable, to facilitate long term stabilization.	Contractor
			Compensate villagers for any lost land, assets and livelihood, associated with increased sediment transport rates downstream of project areas.	PEMC EDL EO / EMUs
Water Quality	Increased total suspended solids (TSS) and turbidity downstream of construction areas.	Minor	See above measures for 'Erosion and sediment transport'	EDL EO/ EMUs
	Changes to pH downstream of project areas.	Negligible	Install sedimentation ponds to collect runoff from concrete preparation and construction sites.	Contractor
			Treat (neutralize) runoff from concrete preparation and construction sites, if necessary, prior to offsite discharge.	Contractor
			Prevent washing of excess concrete/ cement from vehicles or equipment adjacent to or in streams.	Contractor
	Accidental release of oil or hydrocarbons	Minor	Store liquid hydrocarbons (fuels, oils and lubricants) in leak-proof containers within suitably designed bunded areas.	Contractor
			Provide temporary shelters to prevent rainfall entering bunded areas.	Contractor
			Store absorbent material in hydrocarbon storage areas.	Contractor
			Store spill response kits at suitable locations, in case of spills outside bunded areas.	Contractor
			Conduct regular maintenance of vehicles and equipment to prevent hydrocarbon leaks.	Contractor
			Conduct vehicle / equipment maintenance in designated areas where contaminated runoff can be contained.	Contractor

Potential impact area	Project issue / impact	Significance	Mitigation and management measures	Responsibility
			Park vehicles and equipment on sealed surfaces where contaminated runoff can be contained.	Contractor
Air quality	Dust emissions	Minor	Disturb only the minimum area necessary. Leave ground vegetation, such as grasses and shrubs, under the line within the ROW	Contractor
			Water roads and / or construction areas to minimize generation of wind-blown dust.	Contractor
	Vehicle exhaust	Negligible	Use low emission trucks and mechanical equipment	Contractor
Noise and Vibration	Nuisance noise and Vibration impacts	Minor	Limit the hours of operation to daylight hours. Local residents will be consulted if some evening work is required.	Contractor
Climate and Energy	Greenhouse gas emissions and energy loss	Minor	Implement measures designed to reduce greenhouse gas emissions and energy loss in transmission systems (including energy efficient transformers, power factor correction and SF6 recycling and elimination strategies)	EDL Project Management Office
General Waste and Hazardous Material	Potential health and safety impacts	Minor	Minimize the production of waste.	Contractor
			Site worker camps at least 1 km from NPAs and other areas of conservation significance, 50 m from surface water bodies and 1 km from villages and sites of cultural significance.	Contractor
			Sewage and solid waste will be stored in septic tanks or treatment ponds.	Contractor
			Maximize waste recycling and reuse.	Contractor
			Waste will be properly disposed and buried on a daily basis.	Contractor
			Clearly label hazardous materials and waste storage sites with appropriate signage in both English and Lao.	Contractor
			Maintain an inventory of all hazardous materials on site and update regularly.	Contractor
Construction Waste	Health, safety and nuisance impacts of improperly disposed waste.	Minor	Vegetation debris from the ROW will be stacked outside the ROW. Burning is not permitted.	Contractor
			Packaging waste will be recycled or disposed of in the local landfill.	Contractor
Archaeology	Loss of physical cultural resources	Minor	Suspend excavation and take appropriate counter-measure according to the instruction or guidance of the Provincial Culture and Tourism Directorate (PCTD) when historical, cultural or archeological property or heritage is discovered or identified at construction site for authorities' inspection.	Contractor
			Compensate for the loss of community's cultural properties such as village cemeteries.	PEMC EDL EO / EMUs
Health and Safety	Increased spread of diseases, including sexually transmitted infections	Minor	Where possible, local labor will be used.	Contractor
			Public health information will be provided to the construction workforce and community before commencement of works – including information on STIs.	EDL Environment Office
			Support existing provincial STD HIV/AIDS awareness and prevention programmes and apply them specifically to the TL construction.	EDL Environment Office
	Sanitation and waste	Minor	Construction contractor to prepare an Occupation Health and Safety Plan and provide related training and instructions to staff and sub contractors during induction.	Contractor
			Construction workforce facilities will include proper sanitation, water and waste facilities.	Contractor
	UXO	Minor	Areas of high likelihood of UXO contamination will be surveyed prior to engaging in construction activities. Surveyed and cleared areas will be marked.	EDL Project Management Office
	Electrocution risk and effects of	Minor	EDL standards for safe clearance to live conductor for a 115 kV transmission line will be adhered to.	EDL Project Management Office

Potential impact area	Project issue / impact	Significance	Mitigation and management measures	Responsibility
	electro-magnetic radiation		Danger and Warning Signs will be erected on every tower as well as on conductors where the line is crossing a road or river.	EDL EMO / EMUs
			Appropriate conductor materials will be used to minimize health and safety risks.	EDL Project Management Office
	Occupational health and safety	Minor	Construction contractor to prepare an Occupation Health and Safety Plan and provide related training and instructions to staff and sub contractors during induction.	Contractor
			Employees will be provided with training and appropriate PPE (personal protection equipment)	Contractor
Roads and Access	Temporary loss of road use and access routes	Minor	Post warning signs to indicate slowing traffic, merging lanes and change of route.	Contractor
			Identify alternative access routes when roads are blocked.	Contractor
OPERATIONS				
Terrestrial Biodiversity	Impact on terrestrial vegetation, terrestrial fauna, forest resources and protected areas	Moderate	Maintenance of the ROW:	
			Maintain forest cover as close as possible to the edge of all Project components.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
			Plantation trees and crops with higher than 3 m will not be allowed.	EDL Branch Office (Saravan and Savanakeht Branch Office)
			ROW checking and maintenance of ROW should be conducted at least once or twice a year.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
			Use of herbicides, burning to clear and control vegetation will be prohibited.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
			The boundary of the NPA will be regularly patrolled to ensure that local residents are not utilizing protected area forests.	EDL Branch Office in cooperation with PAFO
Water Quality	Contamination from leakage of oils from transformers	Minor	Transformers will be constructed within a concrete bunded area to contain any spills or leaks.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
			Transformers will be periodically inspected.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
	Contamination from use of herbicides	Minor	Use of herbicides will not be permitted.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office

Potential impact area	Project issue / impact	Significance	Mitigation and management measures	Responsibility
Health and Safety	Electrocution risk	Minor	EDL standards for safe clearance to live conductor for a 115 kV transmission line will be adhered to.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
			Danger and Warning Signs will be maintained on every tower as well as on conductors where the line is crossing a road or river.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
			An exclusion perimeter around the Nongsano substation of at least 12 meters will be maintained with a fence.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office
	Effects of electro-magnetic field	Minor	25 m ROW will be maintained through period inspection.	EDL Branch Office (Saravan and Savannakhet) EDL Branch Office

(Source: Earth Systems Lao (2009), IEE Report)

15.1.5 Monitoring (Institutional Arrangement and Procedure)

(1) Institutional Arrangement

Environmental monitoring is to be carried out by the following institutions. Table 15.1-6 summarizes the institutional set-up and responsibilities for environmental and social monitoring tasks.

Project Environmental Management Committee (PEMC): PEMC is to be established to decide compensation conditions and monitor the social and environmental aspects for the Project. PEMC is to consist of at least 10 representatives from different concerned agencies from Savannakhet and Saravan Province including Provincial EDL Branches, Provincial WREA, Provincial Energy and Mines Department, Provincial Land Office, Provincial Agriculture and Forestry Department (Provincial Forestry Section), Provincial and District Cabinets and other related officials.

PEMC forms subcommittees to focus on particular aspects of the Project such as Environmental management, Forest Clearing, Grievance management and Compensation.

Environmental Office (EO): EO located within EDL's Headquarters is responsible for environmental and social aspects on the Project in coordination with Provincial EDL Branch Offices.

EO prepares all required documentation concerning the environmental and social aspects following Lao national regulation, and monitors and supervises resettlement implementation by PEMC and provincial Environmental Management Unit (EMU) in order to ensure that the resettlement has complied with the EMP and RAP.

EO is also responsible for conducting internal resettlement monitoring and preparing resettlement progress reports, which will be submitted to DOE, WREA and the financier as appropriate as well as EDL management each quarter during the Project implementation period.

Environmental Management Units (EMUs): EMUs have been established in EDL branch

office in Savennakhet and Saravan. EMU is responsible for the EMP and RAP monitoring and coordination with local authorities and affected persons. At least one EDL official is assigned to EMU.

EMUs also act as the first contact on the ground directly for EO and indirectly for PEMC. In addition, EMU receives all complaints and grievances that arise in the course of the implementation of the RAP.

Environment and Social Management Division (ESD), DOE, MEM: ESD is responsible for the monitoring of the EMP and RAP and consulting with village representatives and Project affected villagers.

Provincial WREA in Savannakhet Province and Saravan Province: Provincial WREA is responsible for the monitoring of EMP and RAP and reviewing the EMP and RAP. It is also responsible for consulting with EMU and PEMC as well as those villagers affected by the Project.

Table 15.1-6 Institutional Set-Up and Responsibilities for Environmental and Social Tasks

Institution/Organisation	Participants	Tasks
Project Environmental Management Committee (PEMC)	EDL Saravan and Savannakhet Provincial Cabinet Office (Saravan and Savannakhet) District Cabinet Office (Saravan and Savannakhet) Provincial Industry & Handicraft Dept. Provincial WREAs, Provincial Agriculture & Forestry Dept Provincial Health Dept Provincial Lands & Asset Dept Provincial Communication Transport Post & Construction (PCTPC)	Project consultation meetings Monitoring, evaluate review environmental plan and implementation work Negotiating compensation unit costs, supervision and authorization of compensation payment
EDL Environment Office (EO)	EDL Environment Office (EO)	Co-ordination of project, the financier and other stake- holders
EDL Environmental Management Unit (EMU)	Saravan and Savannakhet Provincial EDL Branch (EMU)	Implementation of RAP Supervision of environmental activities Co-ordination with local authorities and affected persons, data collection and reporting
Forest Clearing Committee (Sub PEMC)	EDL VTE (EO) and (EMU) Provincial/District Cabinets Provincial Energy and Mines Dept. Provincial WREOs Provincial/District Forestry Officer	Determination of timber value Monitoring of clearing process Provide guidance and authorization of timber sale and or relocation, appoint contractor in timber handling activities
Compensation Committee (Sub PEMC)	EDL VTE (EO) and (EMU) Provincial/District Cabinets Provincial Energy and Mines Dept. Provincial Land Officer	Determination, negotiation of value of land Preparation of compensation guidelines Monitoring of disbursement of compensation payments Participation in Compensation Committee Certification of transfer of land ownership Payment of compensation (with EDL)
Grievance Committee (Sub PEMC)	EDL VTE (EO) and (EMU) Provincial/District Cabinets Provincial Energy and Mines Dept. Village Authority	Settlement of complaints about compensation payments, as well others arise from the Project implementation discrepancies and conflicts

(Source: Earth Systems Lao (2009), IEE Report)

(2) Monitoring Plan

The monitoring includes both internal monitoring activities implemented by EDL and external monitoring carried out by independent third parties. The monitoring of the Project is to be implemented through the following methods.

Monthly Monitoring: EO will send their staff to the Project site once a month to consult with EMU and PEMC, participate in field work and conduct interviews with those villagers affected by the project.

Three Month Monitoring: A joint monitoring and evaluation between EO and ESD will be conducted at the Project site once every three months. The purpose of the monitoring is to work with EMU and PEMC to review the progress of EMP and RAP work, to adjust to the EMP effectiveness and to consult with village representatives as well as those villagers affected by the project.

Six Month Monitoring: A joint monitoring and evaluation mission comprised of Provincial WREA, DOE, and EDL representatives will be conducted once every six months. The purpose of the monitoring is to review all recommendations made by the monthly and three month monitoring and evaluation reports, to consult with EMU and PEMC, to consult with those villagers affected by the Project, to evaluate, review and modify if required the EMP and RAP implementation plan.

External (Independent) Monitoring and Evaluation: An independent institution will be selected by EDL. The main objective of the External (independent) monitoring program is to provide independent monitoring and evaluation of the resettlement implementation program, to determine whether the work carried out by EMU and PEMC and others reflects the intent of the RAP and whether RAP objectives have been achieved.

As recommended in Section 13.4 External Monitoring, Resettlement Technical Guidelines (WREA, 2005), "Regular external monitoring should begin along with implementation activities and continue until the end of the project", it is preferable to conduct periodical external monitoring through the implementation period of RAP. However, under limited budget conditions, it is recommended to conduct external monitoring at least once after the completion of RAP as a means for evaluating the RAP implementation process. In this case, the terms of reference pertaining to monitoring needs to be included; 1) the overall evaluation of the RAP implementation, 2) recommendation for the future improvement of RAP planning, 3) the planning of monitoring programs for operations and maintenance phase and 3) estimation of budget for the monitoring program.[5] In practice, EO will primarily undertake the project's environmental and social responsibilities during the design and construction phases. EDL Branch Office in the Province where the project is located is responsible for environmental management during the operation and maintenance phases.

The Monitoring Plan for the project is shown in Table 15.1-7. Table 15.1-8 is a check-list used by EO for previous transmission line projects.

[5] Normally external monitoring only requires to monitor and evaluate RAP and to review the work of EMU and PEMC. The monitoring plan in EMP for this project includes monitoring plan in operation phase, however it should be treated as provisional and needs to be viewed at the end of the construction phase. The extra task of external monitoring such as re-arranging monitoring plan and its budget were added by EO in order to have this project duly implement the RAP.

Table 15.1-7 Environmental Monitoring Plan

Location	Issue	Parameter	Project Phase	Frequency
ROW	Biodiversity	Ensure that the alingment of transmission line is sited as far as possible from NPAs and other designated environmentally sensitive areas	Design	Once
	Biodiversity	Presence of boundary markings prior to clearance	Pre-Construction	Once
	Biodiversity	Confirm use of manual clearing methods. No use of herbicides or burning	Construction	Monthly
	Biodiversity	Visually confirm that clearance does not extend past the set boundaries.	Construction	Monthly
	Biodiversity	Visually confirm that ground vegetation and shrubs and trees below the clearance distance are allowed to remain in the ROW	Construction	Monthly
	Waste Management	Ensure vegetation debris from the ROW will be stacked outside the ROW	Construction	Monthly
	Erosion control	Presence of erosion control measures; absence of gullies, rivulets, etc.	Construction	Monthly
	Sediment transport	Monitor the turbidity of water downstream of construction activities	Construction	Monthly
	Water Quality	Oil and Turbidity; pH downstream of cement mixing sites	Construction	Monthly
	Biodiversity	Record incidents of bird and mammal death resulting from electrocution or collision with transmission line or towers.	Operation	Monthly
	Health and Safety	Check that no buildings have been constructed in the ROW	Operation	Quarterly
Contractor Camps	Biodiversity	Evidence of wildlife extraction (e.g. fishing and hunting equipment; animal remains; etc.)	Construction	Monthly
	Waste Management	Proper solid waste disposal	Construction	Monthly
	Waste Management	Proper storage and disposal of sewage	Construction	Monthly
	Water Quality	Monitor field parameters (pH, EC, ORP, temperature); Faecal coliforms; turbidity; and presence of oil in surface water downstream of contractor camps	Construction	Monthly
	Health and Safety	Confirm presence of proper latrines	Construction	Monthly
	Hazardous Materials	Check that hazardous materials are properly stored (i.e. bunded area, proper signage, etc.)	Construction	Monthly
	Rehabilitation	Confirm that contractor camps are properly decommissioned	Post-Construction	Once
Affected Villages	Village grievances	Keep a record of reported grievances and any corrective measures undertaken to address these grievances.	Construction	Monthly
	Log selling	Review the process of log selling, and identify who has access to the cuttings and who is selling the cuttings.	Construction	Monthly
	Noise	Keep track of grievances regarding noise. Ensure that project activities - including vehicles on the road - are during daylight hours only.	Construction	Monthly
	Air quality	Keep track of grievances regarding dust. Ensure that dust mitigation measures being fulfilled.	Construction	Monthly
NPA	Extraction of resources from the NPA	Check for evidence of increased extraction of wildlife from NPAs by visually looking for evidence and consulting with local residents	Operation	Monthly (first year of operation)
Substation	Water quality	Oil and turbidity	Construction	Monthly
	Biodiversity	Record incidents of bird and mammal death resulting from electrocution	Operation	Monthly
	Health and Safety	Presence of security fence to maintain12 m buffer	Operation	Annually
	Water quality	Visual observation for oil contamination.	Operation	Monthly

(Source: Earth Systems Lao (2009), IEE Report)

Table 15.1-8 Environmental Check List

Environmental Check List

Project Name:_____
Date of Monitoring: _____/_____/_____

How many staff/workers: _____, Equipments: _____ (the contractor is required to submit lists of their staff/workers and equipments used for performance of construction activities)

	Issues	Comments	Action to be taken
I.	**Forest and bushes clearing along the TL ROW**		
1.	Is tree and bushes debris disposed the areas permitted by the relevant authorities?		
2.	Are herbicides used to control vegetation along the ROW?		
3.	Is there any burning to clear and control vegetation along the ROW?		
4.	Have high commercial tree species been marked and cut before ROW clearing? (This will be undertaken by the Forest Clearing Committee, the District Forestry Unit and land owners who will list and mark big trees or commercial tree species).		
5.	Is vegetation debris from the ROW/Substation clearances stacked on the outside area of the ROW/Substation properly and burnt up?		
II.	**Site worker camps and other facilities**		
6.	Are all site workers accommodated in the provided camps? (No other accommodation of workers will be permitted).		
7.	Are temporary site worker camps located along ROW proposed roads?		
8.	Is there any impact on the watercourse or stream water quality (water pollution) caused by temporary site worker camps located along the ROW proposed roads?		
9.	Are the camp sites and surroundings kept tidy and clean?		
10.	How many rubbish bins are there at the camp sites _____? Is it an adequate number for general liters and rubbish?		
11.	Are workers provided with a portable water supply and/or water tank and secure?		
12.	Is waste/rubbish collection done and taken to a managed waste disposal facility regularly?		
III.	**Construction of Access Road and steel Towers, including transportation of all materials**		
13.	Is construction carried out during the dry (non-farming) season? When was construction of the access road started?		
14.	Is there any disruption to assets and/or production activities caused by construction of access road? Yes or No. (What kind of disruption? How significant?)		
15.	Has the compensation been fairly to affected people?		
16.	Does the contractor provide a proper drainage system in harmony with the natural drain?		
17.	Is sump oil properly disposed of? Yes or No. Is it washed down of oil into water bodies?		
18.	Is transportation of material conducted within the allowable time frame (from 7.00AM to 6.00PM)?		
19.	Does the contractor post warning signs and manage traffic to protect the traveling public and its workers?		
IV.	**Dust emission**		
20.	Does the contractor spray water during dry and windy conditions on local roads where the trucks pass through?	No_____ Yes (_____times per day)	
V.	**Noise (civil works)**		
21.	Daytime working hours (from 7.00AM to 6.00PM), not exceeding the noise limit especially during the nighttime. Nighttime, in principle, means from 9.00PM to 6.00AM. Principally, working will not be allowed during nighttime: Are these standards being meet?		
VI.	**Interference with other infrastructure during the construction and transportation of material**		

Issues	Comments	Action to be taken
22. Does the contractor post warning signs and manage traffic to protect the traveling public and its workers?		
23. In the event that the stringing conductor poses a possible risk to houses, community centers, and to traffic in public roads or rivers, are the bamboo scaffolds constructed across the roads and rivers to protect pedestrians, vehicles, boats (and the conductor itself) from potential injury/damage during conductor stringing?		
24. In the event that the usage of explosives to create access for road and tower foundation construction presents a possible risk to houses, community centers, and to traffic on public roads or rivers, warning signs and warning system are to be posted to protect pedestrians, vehicles, boats (and the conductor itself) from potential injury/damage during conductor stringing?		
25. Are there any weak roads or bridges that need to be temporarily reinforced because they might potentially buckle under if heavy materials are transported over them?	Yes or No, how many? __, Where? _____,	
VII. Health and safety; Injury and sickness of workers and members of the public		
26. Does the Contractor have a health and safety plan prepared?	Yes or No (the contractor is required to submit the plan).	
27. Have the workers had their health screened and been provided with health and safety training sessions?		
28. Are the necessary safety tools such as helmets, working shoes, ear protections, dust filters and etcetera adequately provided for the site workers?		
VIII. Encroachment into farmland, loss of agricultural land and productivities		
29. Are affected farmers/villagers properly compensated for the loss of agricultural land and productivity?		
IX. Encroachment into industrial tree plantation areas, loss of planted trees		
30. Are affected farmers/investors properly compensated for the loss of planted trees?		
X. Historical, cultural and archeological property		
31. Were there any historical, cultural or archeological assets found during excavation? If yes, what action will the contractors take towards informing the proper agency concerned?		
32. Sitting the TL and Tower away from such areas. If unavoidable by way of alignment position, does the contractor site the tower outside i.e. at each end? Yes or No, what procedures does the contractor undergo?		
XI. Encroachment into Temple or village cemetery		
33. Is there any encroachment into the temple or village cemetery? Yes or No. If yes, is compensation paid out to the village?		
XII. Electro–magnetic field		
34. Does the contractor's work meet the Safety Clearance for Live Conductors of 230 kV and 500 kV; minimum clearance distance (meter)? Yes or No, (see annex 1&2 below for reference)		
XIII. Other issues		
35.		
36.		

(Source: EDL EO)

15.1.6 Compensation Estimation and Procedure

(1) Compensation on Land Acquisition and Resettlement

Compensation principles and procedures are stipulated in the "Decree on the Compensation and Resettlement of the Development Project (Oct 2005)". It states that "Project owners must compensate project's affected peoples for their lost rights to use land and for their lost assets

(structures, crops, trees and other fixed assets) in full or in part, at replacement cost". Besides, the Technical Guidelines on Compensation and Resettlement in Development Project (2005 STEA) provides detailed instruction on RAP budgetary planning. As for the estimation of tree compensation, a provided formula in the Regulation on the Development and Promotion of Long Term Plantation (MAF 2000) has been applied as a basis in order to calculate compensation of lost trees for the cases of transmission line construction for the project of EDL. Regarding land acquisition due to developing project, it is stipulated in the Land Law (2004) that land acquisition for a development project needs to be authorized by Land Management Authority.

Although the Decree on the compensation and resettlement of the development project and other legislation provides general provisions pertaining to land acquisition and resettlement, there is no legal framework addressing compensation standards for the transmission line project. At present, the compensation for the transmission line project has been estimated referring to relevant legislations such as the above and international standards. The following are the compensation standards that have been practiced for the transmission line project for EDL project. Based on this standard, the means of compensation is finalized with an agreement between the affected person and provincial line ministries at the province where the project is located.

(a) Compensation Estimation Standards

The following are the compensation estimation standards which have been applied to the past transmission line projects.

Compensation cost for paddy land and dry land rice:

Compensation Cost = Average Annual Yield x Price of 1Kb Husked Rice x Affected Area x Years (depends on the agreement with affected person)

Compensation cost for garden land:

One third of paddy land

Compensation cost for scrubland:

One third of paddy land

Compensation cost for commercial trees:

Compensation Cost = Land Clearing Cost + Cost of Seedling + Maintenance Cost x Year of Maintenance

Compensation cost for fruit trees:

Compensation Cost = Land Clearing Cost + Cost of Seedling + Maintenance Cost x Year of Maintenance + Annual Income from the Tree x Year of Getting Income from the Tree

Compensation cost for buildings:

At the replacement cost or relative compensation.

In addition to the income losses from permanent land acquisition, there will be income losses from temporary land occupation or disturbances during project construction. For such losses, the compensation of lost crops at replacement value and the cost of restoring the land to its original conditions are to be paid. As for the resettlement compensation, the cost of relocation and cost of lost income resulting from resettlement are to be paid.

Where the Project results in the loss of community infrastructure, community services and other community assets including roads, bridges, schools, electricity, water supply, the affected

community can chose to be compensated for in kind or have these facilities rebuilt to their original status.

Presently, DOE has been developing a guideline on calculating compensation for the transmission line project entitled, "Instruction and Information on Compensation for Power Transmission Line Project". Based on relevant legislations, the aforementioned draft guidelines and successful implementation experience of previous projects, compensation costs were estimated for this Project. Detailed compensation estimation is discussed in Section 16.1.1.

The compensation cost estimation at F/S phase needs to be refined when it is clearly understood what type of compensation package, the affected persons want and what is actually available after implementing the Detailed Measurement Survey.

At this stage, the permanent loss resulting from land acquisition for the transmission tower base (paddy land 1.59 ha, non-rice paddy Land 0.3 ha and 2 cemeteries), the temporal loss of agricultural products (rice, vegetable, fruits etc.), and rehabilitation costs were estimated for the compensation costs of this project. The estimated cost is 53,400 USD. Though substation construction requires 1ha of land, the land is to be given by the Government to EDL, thus no compensation is incurred for the substation site.

(b) Definition of affected person (AP) and entitlement

The PAP is defined in Regulations for implementing Decree No.192 on Compensation and Resettlement of People Affected by Development Project as "All persons, households, a firm or private or public institution who as of the cut-off-date[6] decide in, utilize the land or otherwise derive livelihood from the land within the project impacted area boundaries or those affected by loss of land, structures or other assets, permanently or temporally due to the project, will be considered as Affected Persons (APs) and will be eligible for compensation and other assistance in accordance with the Decree on Compensation and Resettlement and the Technical Guidelines, irrespective of the status of tenure or occupancy right over impacted land or assets." Table 15.1-9 addresses a type of loss and a definition of entitlement.

Table 15.1-9 Types of Loss and Definition of Entitlement

TYPE OF LOSS	APPLICATION	DEFINITION OF ENTITLED PERSON	COMPENSATION POLICY
(a) Arable land	a.1 Less than 20% of total landholding to be acquired (marginal impact on household income and living standards).	a) Legal user of affected land with permanent land rights, and AP's who meet the criteria for permanent land use rights and will therefore be issued with permanent LURC in due time.	Cash compensation for crops and trees at market price, AND Cash compensation for acquired land at 100% of replacement cost.
		b) Legal user of affected land with temporary land rights (illegitimate).	Cash compensation for crops and trees at market price; AND (a) cash compensation for affected land corresponding to 100% of the replacement cost of affected land; OR (b) Cash assistance for lost income from the affected land for the remaining period of the temporary land use right.
		c) Legal user of affected land with lease land rights (illegitimate).	cash compensation for crops and trees at market price; AND Cash assistance for loss income for the remaining lease period.

[6] The commencement of census at DMS is to be served as the cut-off-date for defining entitlements to compensation and other assistance.

Arable land (cont'd)	a.2 More than 20% of total land holding and remaining land is rendered unviable for continued use. (severe impact on household income and living standards)	a) Legal user of affected land with permanent land rights, and AP's who meet the criteria for permanent land use rights and will therefore be issued with permanent LURC in due time.	- Cash compensation for crops and trees at market price; - (a) full title to land of equal productivity at location acceptable to AP's, wherever available; OR - (b) cash compensation for lost land at 100% replacement cost at the informed request of AP's; - Transport allowance to shift to relocation site; - Subsistence allowance for six months; - Rehabilitation package (training for one family member in current or new occupation and training allowance / agricultural extension services, and farm inputs to increase productivity on remaining land, or any other type of suitable assistance)
		b) Legal user of affected land with temporary land rights (illegitimate).	AP's will be entitled to: - Cash compensation for crops and trees at market price; - cash equivalent to 100% of the replacement cost of the affected land; - Transport allowance; - Subsistence Allowance for 6 months, - a rehabilitation package (training for one family member in current or new occupation and training allowance / agricultural extension services, and farm inputs to increase productivity on the farm land, or any other suitable assistance); OR - Cash assistance to provide for lost income from the land for the remaining period of temporary land use right.
		c) Legal user of affected land with lease land rights (illegitimate).	APs will be entitled to: -Cash compensation for loss of crops and trees at market prices; -Land for land compensation of equivalent productive capacity at location acceptable to the APs and on a similar lease basis if available; OR Cash equivalent to provide for lost income from affected land for the remaining lease period; -Transport allowance; -Subsistence allowance for each family member for 6 months; -Rehabilitation package (training for one family member in current or new occupation and training allowance OR agricultural extension services, and farm inputs to increase productivity on the farm land OR any other suitable assistance).
Temporary loss	Loss of use of the land for a period up to a maximum of 1 year.	Legal user of affected agricultural land	Cash compensation for loss of crops at market prices
(b) Residential and/or commercial land (without structures built thereon)	Loss of residential or commercial land due to the project works	Legal land user with permanent rights or temporary rights (but legitimate).	APs will be entitled to cash compensation at 100% of replacement cost of the affected land.
		Legal land user with temporary right (illegitimate).	APs will be entitled to cash assistance equivalent to 30% of replacement cost of the affected land.
(c) Residential and/or commercial land (with structures built thereon)	Loss of residential or commercial land. With remaining legal residential and/or commercial land sufficient to reorganize (at least equal to 100 m2 in rural area)	a) Legal user of affected land with permanent use rights or temporary use rights that will be legalized in due time.	- Cash compensation for land lost at 100% of replacement cost; - Subsistence allowance for 3 months; - Repair cost to re-build the house front if structures partially affected; - APs who are allowed to reorganize will be issued a permanent LURC in case not yet obtained. In exceptional cases, permission may be given to APs to reorganize on their remaining legal land in area less than the standard. APs will be entitled to a special allowance equivalent in value to the difference in land area between the standard plot size and the remaining area on which AP is reorganizing, at the rate of replacement. APs are also entitled to repair costs for partially demolished structures.

(d) Loss of residential or commercial land (with structure)	APs has remaining permanently legal or legitimate residential and/or commercial land less than 100m2	a) Legal APs of the affected land with permanent use rights.	Group Relocation: -Land for land compensation of full title to a standard size plot, on a project sponsored relocation site, (for residential or residential and commercial 100 m2; and for commercial only 14 m2) of land of the same quality (or better) as the affected land and for their remaining legal land (not less than the minimum standard plot size). APs losing an area greater than the plot in RS will receive compensation in cash for the difference; -Sites will be serviced with electricity, water, drainage, access and internal road, and will provide the same access to services (health, education, market) as at the former location, either on site or in the vicinity; OR Self Relocation: At the informed request of the APs they may make their own arrangements for relocation and will be entitled to: -Cash in lieu of land at 100 % replacement cost; Transport allowance; -Subsistence allowance for a period of 6 months; -APs who have their business affected will be entitled to a special income rehabilitation allowance (USD 100 per household) to provide for loss of income during the transition period. -Assistance from local authorities to locate possible plots and to purchase land for resettlement. Re-organization: Only in exceptional cases permission may be given to APs to organize on their remaining legal land in less than standard area. APs will be entitled to a special allowance equivalent in value to the difference in land area between the standard plot size on a RS and the remaining area on which AP is reorganizing, at the rate of RS land. Reorganizing APs will get subsistence allowance for three months.
Residential or commercial land (continued)	less than 100m2 (same as above)	b) Legal APs of the affected land with temporary use rights (but illegitimate).	AP's will be entitled to: Group Relocation: same as for entitled persons category a) ; OR Self Relocation: At the informed request of APs they may make their own arrangements for relocation and will be entitled to: -Cash equivalent to 100% of the replacement cost of their lost land; -Cash compensation to 100% of replacement cost of structures; Subsistence allowance for 6 months; -Transport allowance; APs who had business at their affected location and who must relocate are entitled to a special income rehabilitation allowance of USD 100 to provide for loss of income during the transition period; Assistance from local authorities to locate possible plots and to purchase land for resettlement.
Residential or commercial land (continued)	less than 100m2 (same as above)	c) Illegal APs with no rights to use the affected land and not legitimate.	APs who have no rights to use the land acquired and no legal or legitimate land remaining will be entitled to one of the following options: Group relocation: same as for entitled persons category a); OR Self-Relocation: At the informed request of APs they may make their own arrangements for relocation and will be entitled to: -Cash assistance equivalent to the actual cost of a plot in resettlement site; -Cash compensation at replacement cost for their structures; -Transport allowance to relocation site; -Subsistence allowance; APs who are entitled to relocation and who have business affected will be entitled to a special income rehabilitation allowance of USD100 to provide for loss of income during the transition period; Assistance from local authorities to locate possible plots and to purchase land for resettlement.

(e) Structures	Structures affected by the project	Legal owner of the affected structure.	APs with legal right to build the affected structure will be entitled to compensation at 100% of replacement cost of the affected structure, including material, cash or a combination of the two. No deduction will be made for depreciation or for salvageable materials. Partially affected structures will be compensated for the affected part at replacement cost and additional cash assistance (Repair allowance) will be made to cover the cost of repairing the structure.
		Tenants of leased affected structure	Tenants of structures will be entitled to 3 months rent allowance and assistance in finding alternate rental accommodation
(f) Independent shop owners	Shops located in the project area (with residences at a different location).	a) Legal owner of the shop with permanent rights to use the affected land.	APs will be entitled to one of the following options: Group Relocation: -Land for land compensation of full title to a plot of land on a group resettlement site of the same area and quality as the area lost (minimum 14 m2) on the site suitable for restoring business or at a market place; -Cash compensation for affected structure at replacement cost; Transport allowance; -Subsistence allowance for 6 months; -Special income rehabilitation allowance of US$ 100 to provide for lost income during the transition period; -Suitable rehabilitation assistance; OR Self relocation: At the informed request of APs they may make their own arrangements for relocation and will be entitled to: -Cash compensation at replacement cost for their land lost: -Cash compensation for their structures; -Transport allowance; -Subsistence allowance; -Suitable rehabilitation assistance; Special income rehabilitation allowance of US$ 100 to provide for lost income during the transition period. Assistance from local authorities in identifying individual resettlement sites
Independent shop owners (continued)		b) Illegal owner of the shop with no land use rights	APs will be entitled to one of the following options: Group relocation: -Assistance to relocate to suitable site or at market place; -Cash compensation for affected structure; -Transport assistance; -Special income rehabilitation allowance USD 50 to provide for lost income during the transition period; -Subsistence allowance; -Suitable rehabilitation assistance. OR Self relocation: At the informed request of AP's they may make their own arrangements for relocation and will be entitled to: -Cash assistance at 100% of replacement cost for their structures; -Transport allowance; -Subsistence allowance; -Special income rehabilitation allowance USD 50 to provide for lost income during the transition period; -Suitable rehabilitation assistance; -Assistance from local authorities in identifying individual resettlement sites.
Graves **Private wells**	Graves located in the area acquired. Wells located in area acquired.	Household who owns the graves Household who owns the well.	APs are entitled to cash compensation for all costs of excavation, movement and reburial. Cash compensation at replacement cost or a replacement well if requested by the AP.
Crops	Affected Crops	Owner of affected crops	Compensation in cash at current market prices (farm gate price of crops plus cost of production)
Perennial Trees	Affected Trees	Owner of trees	APs will be entitled to: A lump sum amount for young non-fruit bearing trees to cover for the cost of maintenance and inputs; For fruit bearing trees compensation at 3 years production value at current market prices.

(Source: Technical Guidelines on Compensation and Resettlement of the Development Project (2005), WREA)

(2) Detailed Measurement Survey (DMS)

After finalizing the TL route in D/D, the DMS is to be implemented in order to define APs and their compensation. The objectives of the DMS are as follows:

- Identify land, structures and other assets to be compensated and collect detailed data of all APs concerning the loss of assets and compensation costs in collaboration with APs and with local authorities and,
- Collect socio-economic data of all affected households with a view to identifying any losses of livelihoods and specific needs for livelihoods restoration, especially for vulnerable households.

The information collected at DMS is to serve as basis of compensation estimation.

(3) RAP Approval

"Liner Project" mainly on roads and highway and transmission lines are characterized by a long but relatively narrow corridor of impacts. Because alignments of these corridors often can be shifted to minimize socio-economic impact, and because narrow corridors tend to require only partial acquisition of land and other assets, the resettlement impacts of linear projects often are less severe.[7] In general, RAP is to be developed based on the results through the IEE or EIA conducted in the F/S phase. However, in the case of the transmission line project, because the technical designs remain preliminary in the F/S phase, the project boundaries cannot be finalized. Accordingly, the RAP for the project will not fully cover all the possible impacts of the project, census of affected people, and inventory of losses in this phase thus the RAP remains provisional. Yet this provisional RAP is to be submitted with the IEE to WREA through DOE for obtaining the ECC in the F/S phase. In this case, the provisional RAP should identify the gaps that remain in the RAP. During the D/D phase, the provisional RAP is to be updated fulfilling all requirements. Once updated, reviewed and found acceptable by relevant project authorities and WREA, the RAP will become legally enforceable and the ECC becomes effective. Table 15.1-10 addresses a procedure for developing RAP of transmission line projects in the F/S and D/D phases.

(4) Compensation Appraisal and Payment Procedure

Following an approval of RAP by WREA, the compensation rates for affected assets should be finalized to ensure that they reflect current market rates and compensation for affected assets at their replacement cost. The project authorities should approve the final rates before they are used to determine compensation entitlements to each AP. After the unit price has been validated and approved by the project authorities within the line ministry, the field teams will visit each AP to validate inventory, finalize entitlements and the total amount of compensation and allowances payable to each AP. A Compensation Entitlement Form for each AP will be completed and signed by the APs to indicate their agreement with regards to the affected areas and the assets shown as well as the entitlements and compensation amounts. A copy of the signed copy of the form will be given to the APs for their records. Upon completion of the Compensation Entitlement Form for each AP, public meetings will be arranged in each commune to inform the APs on 1) the schedule for compensation payment, 2) relocation arrangements for those required to relocate and 3) the schedule for the start-up of civil works. All payment of compensation and allowances will be made in designated public places. A coordinated plan for relocation of the APs will be prepared in consultation with the APs, with assistance provided by the project owner, district and commune officials. APs will be provided with sufficient time for relocation prior to handing over the site for civil works. All

[7] Technical Guidelines on Compensation and Resettlement of the Development Project (2005), WREA

compensation and resettlement activities for the project will be completed at least one month prior to the civil works' start-up.[8]

Table 15.1-10: Rap Procedures in F/S and D/D Phase

	Item	Proposed Action	Action at Feasibility Phase	Action Taken by EDL at Detail Design Phase
1	Collect data on land use in project area	Collect information on land tenure in project area	Collect information on land tenure with 250 households as a means of sampling survey	Collect information on land tenure with 100% coverage in project area
2	Hold stakeholders meeting	Disseminate information on the project to central/local government officials and local representatives in project area in order to agree on the RAP approach	Organize stakeholders meeting in co-operate with EDL	
3	Conduct site surrey on Affected Peoples (APs)	Formulate census of APs, inventory of affected land/other assets and socio-economic data through site survey and set up cut-off date in order to establish an eligibility for entitlements of compensation	Conduct a census, inventory of land/other assets and socio-economic data of all APs found to be residing in the project area A census, inventory of land/other assets and socio-economic data for APs such as doing business or cultivating land or having rights over resources in the project area are covered only 250 households as a means of sampling survey	Conduct a census, inventory of land/other assets and socio-economic data of all APs with 100% coverage found to be residing, doing business, cultivating land or having rights over resources in the project are Set up cut-off date in order to establish an eligibility for entitlements of compensation
4	Prepare a entitlement matrix	Analyze date to identify different categories of APs depending upon the degree and scale of impacts of the project components Address the result as a form of entitlement matrix	Prepare draft entitlement matrix	Prepare a finalized entitlement matrix
5	Hold consultation with the key stakeholder to design compensation package	Formulate compensation payment framework (formula for compensation estimation), allowances and rehabilitation assistance through consultation	Formulate draft compensation package (outline only)	Finalize compensation package in holding a stakeholder consultation Compensation package includes: compensation for affected assets, in cash or in kind, allowances (materials transportation allowance, transition subsistence allowance, repair allowance, etc.), rehabilitation assistance
6	Select and design relocation site(s) as appropriate	Select and design relocation site(s) with following principles: -The plots size for house construction should be based on earlier homestead size -APs should be allowed the option to build their own house structure -The replacement residential land must have environmental, social, cultural and economic characteristics similar to the previous site	Design relocation site referring available second source information	Develop options and alternative sites in consulting with APs when APs preferred to choose in kind of compensation in replacing their loss of residential land to relocation site

[8] Technical Guidelines on Compensation and Resettlement of the Development Project (2005), WREA

7	Conduct site survey on host population as appropriate	Obtain and analyze information includes: Settlement patterns and arrangements of location, population density and production capacity of the land, socio-economic and demographic composition, common property resources, territorial claims to land and resources, land utilization patterns, needs for infrastructure development, willingness and acceptability of host population, existing community organizations, cultural sites and networks		Conduct site survey on host population when the AP preferred to relocated to another site
8	Select replacement land for loss of productive assets (agricultural and commercial land) as appropriate	Proceed selection of replacement land with following principles: -Land for land is considered to be the most desirable option for compensating the private and community land acquired for the project -Replacement land should be equivalent productive potential to previous land -Where suitable land at locations acceptable to APs is not available, and at "informed choice" of APs, compensation in cash may be paid -If APs opt for individual or self-relocation, the project should assist them rather than forcing them to accept the site selected by the project for relocation -Where suitable land for reasonable quality for agriculture is not available, skill-up-grading training schemes, income generating schemes and agriculture intensification programs may be suitable option		Prepare replacement land upon the project requirements and AP's preferences
9	Formulate time bound schedule for the implementation of RAP	Provide a resettlement implementation schedule showing specific time-frame and linking resettlement to civil works in RAP	Prepare outline of implementation procedures of RAP	Prepare time bound schedule on the acquisition of assets, compensation payment in full and rehabilitation activities for segment/section or phase (except where long-term rehabilitation measures such as vocational training or other measures recommended)
10	Formulate procedures for grievance readdress	Provide procedures in order to address any complaints and grievances arising out of issues such as determining entitlements to compensation, allowances and other assistance in RAP	Prepare outline on grievance readdress procedures	Prepare detail grievance redress procedure
11	Determine monitoring procedures	Provide monitoring procedures during and post-project period and identify a competent external monitoring agency for external monitoring	Prepare outline on monitoring procedures	Prepare procedures and plan on monitoring
12	Prepare detailed cost estimated for implementation of RAP	Estimate compensation, relocation costs, rehabilitation (or income restoration) costs, administrative costs, preparation costs and technical assistance costs Provide budgetary plan linked to the resettlement timetable Assigned financial responsibility	Prepare outline on cost estimation for implementing RAP	Prepare detailed cost estimates, budgetary plan and institutional arrangement on RAP budget
13	Hold consultations with the key stakeholders on draft RAP	Consult with representatives of APs, local/central authorities in order to finalize RAP		Finalize draft RAP in reflecting the result of stakeholder consultation
14	Submit the RAP report to WREA to be legally enforceable	Submit RAP report to WREA through DOE for approval	Identify the gaps that remain in the RAP prepared at feasibility phase	Fulfill all requirements on RAP and submit RAP report to WREA through DOE for approval

(Source: Technical Guidelines on Compensation and Resettlement of the Development Project (2005), WREA)

15.1.7 Result of Stakeholders Meeting

(1) Project Stakeholders

Key stakeholders in this project are as follows:

- Project Affected Persons (PAPs)

- Affected Villages

- Government Authorities (Central, Provincial, District): Ministry of Energy and Mines, WREA, Ministry of Finance, Ministry of Agriculture and Forestry, National Land Management Authority, Ministry of Health, Ministry of Education, Lao Women's Union and their Provincial and District counterparts.

- Project Owner (EDL)

- Non-Governmental Organizations (NGOs)

(2) Result of Stakeholders Meetings

Through conducting IEE, three types of stakeholders meetings were held.

Meetings with government officials: The meetings were conducted with relevant government officials for the project at the central, provincial and district level. At the meeting, a brief description of the project was provided, and the IEE process was explained. Participants were given an opportunity to provide comments, advice and information relevant to the project.

Meetings with villagers: The meetings were conducted at a village in the project area during the field survey. During consultation, a brief description of the project was provided, and the IEE process was explained using a project information brochure. Participants were given an opportunity to provide comments, advice and information relevant to the project. Standard survey questionnaires were used to collect information on affected villages, potential negative impact resulting from the project and the market price of assets.

Meetings with all stakeholders: Two open stakeholders meetings (workshops) were held in Savannakhet and Saravan Provinces. The aim of these consultations was to report the findings of the IEE, outline the next steps in the environmental approvals process and to retreive feedback from stakeholders. During the question and answer session, questions regarding compensation estimation and payment procedures were asked. The compensation procedures that finalized the compensation rate would be upon the agreement between EDL and each AP, was confirmed between EDL and stakeholders.

A stakeholder Consultation Information Brochure in English and Lao, List of Stakeholders Consulted, workshop agenda, minutes, photos and list of attendance can be found in Appendix: IEE Report Chapter 15.

15.1.8 Result of IEE

The result of the assessment indicates that any environmental impacts are predicted to be minor. The transmission line route has been selected to minimize impact on environmental and social resources.

The total area of the ROW for the length of the proposed transmission line is 544.3 ha. The ROW travels throughout the land of 903 households within 81 villages. During the IEE, 33 fixed assets were confirmed along the transmission line route. The route, however, was re-aligned in order to avoid these assets. Consequently, resettlement will not be necessary for this project.

The key socio-economic impacts of the transmission line will be the loss of productive land (forests and agricultural land) within the footprint of the substation and the towers and the loss of forests and commercial trees within the ROW.

Other impacts resulting from the Project are likely to include temporary nuisances related to construction activities. These are, however, anticipated to be minor.

With adequate compensation and implementation of management and mitigation measures residual environmental and social impacts are likely to be minor.

15.2 Findings and Recommendations on Environmental and Social Consideration for the Prioritized Project

The issues such as prevention and mitigation measures, monitoring methods, the capability of implementing environmental and social considerations had been discussed with counterpart institutions throughout the Study period. The discussion results were integrated into the IEE reports. In working with the counterpart, the conclusion reached was that the following issues were deemed to be most vital when it came to environmental and social concerns for the project.

15.2.1 Budgetary Planning

Situation: Regardless of the project's financier, the cost concerning environmental and social monitoring has been paid by EDL[9]. Accordingly external monitoring on allocation of the monitoring budget in EDL has been difficult to carry out. Besides, a budgetary plan itself not always been formed taking account of EDL's tight financial situation. Thus appropriate budget allocation for the monitoring of EMP and RAP has been infrequently realized.

Recommendation: A budgetary plan needs to reflect the availability of the EDL fund. In other words, the monitoring plan needs to be developed based on what is available and formed duly excusable by EDL.

15.2.2 Law Enforcement

Situation: There is no specific monitoring legislation or guidelines. Without proper law enforcement such as emission standards, regulation concerning detailed monitoring procedures and instructions great effort is required in allocating staff, budgeting, and setting technical standards for monitoring. Consequently, a lack of domestic legislation forces to default to following international standards that are not always suitable for the Lao PDR's situation.

Recommendation: There is a situation that the setting up of monitoring procedural guidelines has been under way. Until these guidelines are enacted, a monitoring plan needs to be formulated taking into account the uniqueness of the situations that need to be addressed here and developed accordingly.

15.2.3 EU Capacity of Implementing Monitoring

Situation: Monitoring activities in the project area have been carried out by one official as an EU assigned in each EDL branch. Considering the scale of electricity projects in general, the number is not sufficient enough to achieve appropriate implementation of EMP and RAP. Yet unlike all EO officials who possess environmental backgrounds, EU officials do not always

[9] In WB current funded project, external monitoring has been eligible for financing out of WB loan. (Technical Guidelines on Compensation and Resettlement of the Development Project 2005 WREA)

have expertise in this field. As a result, smooth implementation of EMP and RAP has been a far cry, especially during the operation phase of the project of which full responsibility is undertaken from EO to EU. Thus strengthening the EU's monitoring capability is considered to be an urgent matter.

Recommendation: Exchange programs between branch office officials and EO would seem to be useful in urging the EU officials to share knowledge with EO.

Chapter 16
Estimate of the Project Cost

Chapter 16 Estimate of the Project Costs

In this Chapter, the total costs for the Project are estimated on the basis of the ICB prices as of 2009.

16.1 Land and UXO

The basis of the cost estimation on environmental and social considerations and the UXO survey/clearance are discussed in this section.

16.1.1 Compensation for Lands and Right of Way (ROW)

Environmental and social consideration costs are comprised of compensation costs and monitoring and evaluation costs. The following are the basis of the cost estimation and the estimated cost through conducting IEE. Based on the project's implementation schedule, the total number of months for implementing activities for environmental and social consideration is assumed to be 20 months.

(1) Compensation Cost

- The compensation cost includes a Detailed Measurement Survey (DMS), which purposes to define the affected and their lost assets.
- The DMS cost is estimated based on a 40-day field survey with 20 staff and it includes the cost of implementing RAP, which requires a 2-day field work in 81 villages covering the project area with 3 staff. (Table 16.1-1: Budget for implementation of the DMS and RAP)
- The compensation cost also includes;
- Permanent Loss: Cost for the compensation incurred by permanent land acquisition for the construction of a transmission tower base (assumed average footprint of 52.99 m^2 for a 544 transmission tower base), which includes the cost for compensating the rice paddies and non-paddy land losses (Table 16.1-2 Estimation of Compensation Cost for the Rice Paddy Land and Non-Paddy Land losses), compensation cost for losses of trees (Table 16.1-3 Estimation of Compensation Cost for losses of trees), and
- Temporary loss: Cost for the compensation incurred by the temporary occupation for construction activities, which includes costs of rental land, loss of agricultural products and rehabilitation cost (Table 16.1-4 Estimation of Compensation Cost for Temporary loss).
- The community assistance cost, which purposes to compensate the loss of community infrastructure, community services and other community assets such as roads, bridges, schools and water supply, is included in the compensation cost.
- Compensation estimates have been derived from the compensation formula detailed in Chapter 15, the IEE of the previous project (Pakse-Khonphapheng1, Xesset1-Saravanh 115 kV lines and Nabon-Thinthaen 500 kV), information gathered in project area, land use map (Ministry of Agriculture and Forestry) and satellite image.[1]

[1] As described in Chapter 15, there is a limitation in being able to specify the exact number of affected persons and their affected assets at the F/S phase. The actual methodology for calculating compensation estimates needs to be agreed upon and finalized by the EDL in consultation with the concerned local authorities and villagers as well as the project the affected persons.

- The total amount of the compensation is estimated 166,844.51 USD on the basis of above conditions.

(2) Monitoring and Evaluation Cost

- The monitoring and evaluation cost includes the implementation of Monthly Monitoring (1per/60 days), 3 Month Monitoring (2 per/18 days), 6 Month Monitoring (3per/9days), External Monitoring (once/20 days) (Table 16.1-5: Budget for Monitoring and Evaluation)
- The monitoring and evaluation cost also includes the Field Work of Project Environmental Management Committee (PEMC) (Table 16.1-6: Budget Estimation for fieldwork of PEMC)
- The cost of Consultations and Workshops and General Administration cost are also included in the category of Monitoring and Evaluation Cost.
- The total amount of the monitoring and evaluation cost is estimated 43,136.5 USD on the basis of above conditions.

10% of the environmental and social consideration costs are added as a Contingency to the total costs of environmental and social consideration costs. Accordingly, the total costs of environmental and social consideration are estimated 209,981.01 USD. (Table 16.1-7: Summary of Total Budget Estimation)

Table 16.1-1 Budget for Implementation of the DMS and RAP

Item	Unit	Quantity	Day	Unit Cost (USD)	Total Cost (USD)
DMS					
DMS Staff	Pers	20	40	50	40,000
DMS Expenses	Lump sum				20,000
RAP					
RAP Implementation Staff	Per.	3	162	50	24,300
Expenses	Lump sum				10,000
Total					94,300

(Source: Earth Systems Lao (2009) RAP)

Table 16.1-2 Estimation of Compensation Cost for the Rice Paddy Land and Non-Paddy Land Losses

Description	Unit	Quantity	Unit Price (Kip)	Total Compensation Cost (Kip)
Rice paddy land	m2	15,900	400	6,360,000
Non rice paddy land	m2	3,000	150	450,000
Cemeteries	l.s.	2	5,000,000	10,000,000
Total				1,6810,000

(Source: Earth Systems Lao (2009) RAP)

Table 16.1-3 Estimation of Compensation Cost for Losses of Trees

Asset	Unit	Unit price (kip)	Quantity	Compensation cost (Kip)
Mango	tree	100,000	50	5,000,000
Tamarind	tree	75,000	50	3,750,000
Coconut and other	tree	25,000	100	2,500,000
High value timber	tree	100,000	500	50,00,000
Mid value timber	tree	25,000	10,000	250,000,000
Low value timber	tree	6,000	5,000	30,00,000
Total			15,700	341,250,000

(Source: Earth Systems Lao (2009) RAP)

Table 16.1-4 Estimation of Compensation Cost for Temporary Loss

Description	Unit	Quantity	Unit Price (Kip)	Total Comp. Cost (Kip)
1. Rental Land				20,640,000
Paddy	m2	233,000	80	18,640,000
Garden	m2	10,000	60	600,000
Swidden	m2	10,000	50	500,000
Non productive land	m2	30,000	30	900,000
2. Crop Damage				30,000,000
Dry season crop	-	lump sum	-	30,000,000
3. Rehabilitation				45,000,000
Rehabilitation / restoration	-	lump sum	-	45,000,000
TOTAL				95,640,000

(Source: Earth Systems Lao (2009) RAP)

Table 16.1-5 Budget for Monitoring and Evaluation

Budget Estimation for Environmental Monitoring and Evaluation Monitoring	Ps/ Unit	Day	Unit Price (USD)	Total (USD)	Remarks
Monthly				8,700	
EDL Environmental Office	1	60 (20 months x 3 days)	30	1,800	1 monitoring requires 3 days for covering project area
Driver	1	60 (20 months x 3 days)	15	900	
Transportation/Petrol	1	60 (20 months x 3 days)	100	6,000	
3 month				3,150	
EMO & SEU of DOE	2	18 (6 times in 20 months x 3 days)	30	1,080	
Driver	1	18 (6 times in 20 months x 3 days)	15	270	
Transportation	1	18 (6 times in 20 months x 3 days)	100	1,800	
6 month				1,845	
WREA, EDL & DOE	3	9 (3 times in 20months x 3 days)	30	810	1 monitoring requires 3 days for covering project area
Driver	1	9 (3 times in 20months x 3 days)	15	135	
Transportation/Petrol	1	9 (3 times in 20months x 3 days)	100	900	
Independent Monitoring				6,300	
Social Specialist	1	20	200	4,000	
Driver	1	20	15	300	
Transport and others	1	20	100	2,000	
GRAND TOTAL				19,995	

(Source: Earth Systems Lao (2009) RAP)

Table 16.1-6 Budget Estimation for Fieldwork of PEMC

Item	Unit	Quantity	Day	Unit Cost (USD)	Total Cost (USD)
PEMC	Pers.	4 (2 in Saravan and 2 in Savanakhet)	60 (60 days for Saravan and 60 days for Savanakhet)	30	7,200
Driver	Pers.	2	60	15	1,800
Transportation/Petrol		2	60	100	1,200
Miscellaneous (10%)					1,020
Total					11,220

(Source: Earth Systems Lao (2009) RAP)

Table 16.1-7 Summary of Total Budget Estimation

Items	Total Cost (Kip)	Total Cost (USD)
1 Permanent Loss	1,6810,000	1,978
Paddy Rice	22,120,000	
Land Other Than Rice Paddy-	450,000	
Cemeteries	10,000,000	
2 Loss of Trees	341,250,000	40,147.06
3 Temporary Loss	95,640,000	11,251.77
Land Rental	20,640,000	
Crop Damage	30,000,000	
Rehabilitation	45,000,000	
4 DMS		94,300
5 Estimation for Field Work of PEMC		11,220
6 Estimation for Monitoring and Evaluation		19,995
7 Estimation for Community Assistance and HIV/AIDS awareness		4,000
8 Estimation for Consultation & Workshop		3,000
9 General Administration		5,000
Contingency 10%		19,089.18
Grand Total		209,981.01

(Source: Earth Systems Lao (2009) RAP) Exchange rate: 1 USD = 8,500 Kip

16.1.2 Costs for UXO Investigation and Clearance

Since a large quantity of UXO still remains in the country as shown in UXO map (refer to Figure 7.5-20), investigation and clearance works of UXO will be necessary prior to the construction works. For "500 kV Num Teun 2 Transmission Line Project" that has been completed recently, the locally organized consultant for UXO employed by the contractor carried out UXO investigation and clearing works within R.O.W of the 500 kV line. (25 m × 2=50 m). The cost for UXO investigation and clearance for the Project is estimated at the same manner, accordingly.

(1) Particular Areas for UXO Investigation and Clearance

According to the UXO map, UXO scarcely remains on the some areas of the selected transmission line route for the Project. Results of IEE suggests the light remanence of UXO in Saravan District.

a) Pakbo SS - Thaotan SS section
No remanence of UXO

b) Thaotan SS - Saravan SS section
Xeset River ～ Saravan SS: 22.6 km

It was assumed that UXO investigation and clearing works would be carried out within R.O.W. of the line（12.5 m × 2=25 m）constructed in the above areas prior to their excavation work.

(2) Costs for UXO Investigation and Clearance

The unit price of "0.48 USD/m^2 in Light remnant UXO area" is applied with reference to "500 kV Num Teun 2 Transmission Line Project". The cost of UXO investigation and clearance for the Project (22.6 km UXO areas noted above) was roughly estimated at 726,200 USD as below:

22.6 km (Xeset River ～ Saravan SS) × 25 m (R.O.W. of the line) × (0.48 USD/m^2) ≒ 726,200 USD

(1) Particular areas for UXO Investigation and Clearance

According to the UXO map, UXO scarcely remains on the some areas of the selected transmission line route for the Project. Results of IEE suggests the light remanence of UXO in Saravan District.

a) Pakbo SS～Thao Tan SS section
No remanence of UXO

b) Thao Tan SS～Saravan SS section
Xeset River ～ Saravan SS: 22.6 km

It was assumed that UXO investigation and clearing works would be carried out within R.O.W. of the line（12.5 m×2=25 m） constructed in the above areas prior to their excavation work.

(2) Costs for UXO Investigation and Clearance

The unit price of "0.48 USD/m^2 in Light remnant UXO area" is applied with reference to "500 kV Num Teun 2 Transmission Line Project". The cost of UXO investigation and clearance for the Project (22.6 km UXO areas noted above) was roughly estimated at 726,200 USD as below:

22.6 km(Xeset River ～ Saravan SS)×25 m (R.O.W. of the line)×(0.48 USD/$m^{2)}$ ≒271,200 USD

16.2 Construction Cost of Transmission Lines

The construction cost of transmission lines for the Project was estimated under the following assumptions.

a) The construction cost of transmission lines for the Project would be estimated in such a way as the standard unit prices of equipment and civil & erection works multiplied by those quantities calculated in Section 11.2. The standard unit prices have been prepared referring to the recent contract prices of such international competitive bidding projects as "Greater Mekong Power Network Development Project (JICA)". Various ICB price data owned by the Team has also been referred.
b) The costs were estimated in foreign currency (USD) portion (FC) and local currency (USD conversion) portion (LC)[2] based on Table 16.2-1 below.

Table 16.2-1 Share of FC and LC for Each Work Item

	Work item	FC share	LC share
100%	Tower, Conductor, GW, Insulator sets, Accessories, Spare Parts, Tools, etc.		0%
Civil & Erection Works	UXO survey and clearance	0%	100%
	Route survey & design	40%	60%
	Access road construction	30%	70%
	Inland transportation	0%	100%
	Clearing of ROW, Foundation work	20%	80%
	Tower erection work, stringing work	30%	70%
	Others (% to total LTE)	15%	15%

[2] Term "FC" used in this report means expenditures spent abroad for procurement, ocean freight and insurance of the imported equipment and materials of the facilities and other general works for the local installation of the facilities including a part of survey and clearance of UXO Term "LC" means all expenditures spent in the Lao PDR including costs for expatriate persons, procurement of local products, labours, inland transportation, insurance, hiring of heavy equipment, installation of facilities, a part of survey and clearance of UXO, compensation of lands, houses and vegetation and others "LC" does not always mean the amount contributed by the Government of Lao PDR.

Table 16.2-2 shows the construction cost of transmission lines for the Project. Tables 16.2-3 show the details of the estimate.

Table 16.2-2 Construction Cost of Transmission Lines

[1,000 USD]

Sections	Items	FC	LC	Total
Pakbo SS～Thaotan SS (152.2 km)	Plant & Equipment	11,979.4	0	11,979.4
	Civil & Erection	999.0	4,245.8	5,244.8
	Sub-total	12,978.4	4,245.8	17,224.2
Thaotan SS ～ Pakbo SS (66.3 km)	Plant & Equipment	4,839.5	0	4,839.5
	Civil & Erection	417.4	1,765.9	2,183.3
	Sub-total	5,256.9	1,765.9	7,022.8
Total (218.5 km)	Plant & Equipment	16,818.9	0	16,818.9
	Civil & Erection	1,416.4	6,011.7	7,428.1
	Total	18,235.3	6,011.7	24,247.0

Construction cost in the above table was estimated on the bases of results of Team's site investigation for the Pakbo-Thaotan-Saravan section during January - August 2009 and the design of towers and their foundations discussed in Chapter 13.

The site investigation revealed the detailed information and facts for actual conditions for solid soil, flat terrain, less tree clearing in the right-of-way, easy transportation of materials to working sites, easy provision of access roads, almost non-UXO remnant, etc. along the selected transmission line route. The facility design resulted in economical towers and working volumes of their foundations. Further, breakdown of the recent ICB contracts for 115 kV transmission lines in Lao PDR was obtained.

16.3 Construction Cost of Substation Facilities

Construction costs of substation facilities for the Project are estimated based on the design for substations described in Chapter 13.

(1) Standard Unit Prices

The standard unit prices have been decided on by referring to the recent contract prices of such international competitive bidding projects in Lao PDR. Various ICB price data owned by the Study Team have also been a source of reference.

(2) Estimate Conditions

The estimated conditions for the substation facilities are as follows;

a) All substation equipment will be procured from abroad, and the prices will be estimated in US dollars for CIF prices.

b) Costs for procurement of spare parts and tools will be estimated at 5% of the total equipment costs for each substation.

c) The costs of civil and erection works will be estimated in foreign currency (USD) portion (FC), and local currency (USD conversion) portion (LC).

d) Land acquisition for the construction of substations for the Project will be necessary for Pakbo SS and Taothan SS. Since the land for the expansion of Pakbo SS is owned by EDL and the land for new Taothan SS is owned by the Provincial Government, the cost for land acquisition will not be included in the construction costs for substation facilities.

e) The costs for survey and clearance of UXO will not be included in the costs.

(3) Construction Costs of Substation Facilities

Table 16.3-1 summarizes the construction costs of substation facilities for the Project. Table 16.3-2 shows the details.

Table 16.3-1 Construction Cost of Substation Facilities

[1,000 USD]

stations		FC	LC	Total
Pakbo Substation	Plant & Equipment	681.0	65.8	746.8
	Civil & Erection	32.0	315.7	347.7
	subtotal	713.0	381.5	1,094.5
Taothan Substation	Plant & Equipment	4,069.9	427.5	4,497.4
	Civil & Erection	95.0	1,479.9	1,574.9
	subtotal	4,164.9	1,907.4	6,072.3
Saravan Substation	Plant & Equipment	688.6	62.9	751.5
	Civil & Erection	14.0	82.0	96.0
	subtotal	702.6	144.9	847.5
	Total	**5,579.6**	**2,433.8**	**8,013.4**

16.4 Total Project Costs

The conditions for the estimate of the total Project costs are as follows;

a) Compensation cost for the lands and ROW, cost for environmental monitoring and cost for UXO investigation and clearance included in the LC portion of the total costs.

b) Consultant service fee is included in the FC & LC portions and estimated at approximately 8% of the total transmission line and substations' construction cost.

c) Physical contingencies for both the FC and LC portions are estimated at 5% of each portion of the total construction costs.

d) Price contingencies for both then FC and LC portions are estimated at 3% of each portion of the total construction costs.

Table 16.4-1 shows the total costs for the Project.

Table 16.4-1 Total Project Costs

[1,000 USD]

Items	FC	LC	Total
Transmission Lines	18,235.3	6,011.7	24,247.0
Substation Facilities	5,580.5	2,433.8	8,014.3
Sub-total	23,815.8	8,445.5	32,261.3
Compensation		166.8	166.8
Environment monitoring	-	43.1	43.1
UXO suevey & clear	-	271.2	271.2
Consultant fee	2,258.3	192.0	2,450.3
Pysical contingency	1,190.8	422.3	1,613.1
Price contingency	714.5	253.4	967.9
Total	27,979.4	9,794.3	37,773.7

16.5 Disbursement Schedule of the Costs

The Project will be carried out in 36 months as shown in Table 14.6-1 in Chapter 14. Conditions in preparing the disbursement schedule for the project investment are assumed as below;

a) Construction costs for transmission line facilities for the Project will be disbursed in the second and third years equally, after conclusion of the contracts with the contractors.

b) Construction costs for substation facilities for the Project will be disbursed 30% in the second year and 70% in the third year, respectively.

c) Compensation cost for the lands and ROW will be disbursed in the first year.

d) Environmental monitoring cost will be disbursed in second and third years equally.

e) UXO investigation and clearance will be carried out before the excavation work of the foundations for steel towers, and its cost will be disbursed in the second year.

f) Consultant fee will be disbursed 20% in the first year, 40% in the second year and 40% in the third year.

g) Both physical and price contingencies will be disbursed 30% in the second year and 70% in the third year.

Table 16.5-1 shows the disbursement schedule for the Project costs over three years.

Table 16.5-1 Disbursement Schedule

[1,000 USD]

months	items	FC	LC	Total
1～12 months	TL facilities	-	-	-
	SS facilities	-	-	-
(Design Stage)	Compensation	-	166.8	166.8
	Monitoring	-	-	-
	UXO	-	0	0
	Consultant	451.7	38.4	490.1
	Contingency	0	0	0
	subtotal	451.7	205.2	656.9
13～24 months	TL facilities	9,117.7	3,005.8	12,123.5
	SS facilities	1,674.2	730.1	2,404.3
(Construction Stage)	Compensation	-	-	-
	Monitoring	-	21.5	21.5
	UXO	-	271.2	271.2
	Consultant	903.3	76.8	980.1
	Contingency	571.6	202.7	774.3
	subtotal	12,266.7	4,308.3	16,575
25～36 months	TL facilities	9,117.7	3,005.8	12,123.5
	SS facilities	3,906.4	1,703.7	5,610.1
(Construction Stage)	Compensation	-	-	-
	Monitoring	-	21.5	21.5
	UXO	-	-	-
	Consultant	903.3	76.8	980.1
	Contingency	1,333.7	473.0	1,806.7
	subtotal	15,261.0	5,280.9	20,541.9
	Total	**27,979.4**	**9,794.3**	**37,773.7**

Table 16.2-3 Assumpted Estimation for Pakbo-Saravan T/L Construction Cost
"Voltage; 115kV, Conductor; T-Hawk, Single "
for
Laos (Lao People's Democratic Republic)

Assumption:
(1) Foundation Type: 100% of Pad Type Foundations
(2) Soil Conditions: Normal

Category	No.	Items	115kV, 2cct, 217.4km Condutcor : T-Hawk, Single												Remarks
			Pakbo S/S-Tao Than S/S (152.2 km)						Tao Than S/S-Saravan S/S (66.3 km)						
			Unit	Q'ty	Unit Rate (US$)	Amount (US$)	FC (US$)	LC (US$)	Unit	Q'ty	Unit Rate (US$)	Amount (US$)	FC (US$)	LC (US$)	
COST, INSURANCE AND FREIGHT	1	Tower	ton	2,474.3	1,600	3,958,880	3,958,880	0	ton	852.0	1,600	1,363,200	1,363,200	0	FC:100% LC: 0%
	2	Conductor	km	958.9	5,100	4,890,390	4,890,390	0	km	417.7	5,100	2,130,270	2,130,270	0	
	3	OPGW 60mm2	km	159.8	5,900	942,820	942,820	0	km	69.6	5,900	410,640	410,640	0	
	4	OH G.W.	km	159.8	1,200	191,760	191,760	0	km	69.6	1,200	83,520	83,520	0	
	5	Single Suspension Insulator String	set	1,920	400	768,000	768,000	0	set	834	400	333,600	333,600	0	
	6	Single Tension Insulator String	set	504	700	352,800	352,800	0	set	216	700	151,200	151,200	0	
	7	Double Suspension Insulator String	set	108	450	48,600	48,600	0	set	54	450	24,300	24,300	0	
	8	Double Tension Insulator String	set	60	800	48,000	48,000	0	set	24	800	19,200	19,200	0	
	9	Conductor Dumper	unit	4,608	30	138,240	138,240	0	unit	1,992	30	59,760	59,760	0	
	10	OPGW Dumper	unit	768	20	15,360	15,360	0	unit	332	20	6,640	6,640	0	
	11	GW Dumper	unit	768	20	15,360	15,360	0	unit	332	20	6,640	6,640	0	
	12	Conductor Sleeve	unit	480	20	9,600	9,600	0	unit	209	20	4,180	4,180	0	
	13	GW Sleeve	unit	80	15	1,200	1,200	0	unit	33	15	495	495	0	
	14	OPGW Joint Box	unit	29	600	17,400	17,400	0	unit	13	600	7,800	7,800	0	
	15	GW Suspension Unit	unit	338	100	33,800	33,800	0	unit	147	100	14,700	14,700	0	
	16	GW Tenssion Unit	unit	47	200	9,400	9,400	0	unit	20	200	4,000	4,000	0	
	17	OPGW Suspension Unit	unit	338	200	67,600	67,600	0	unit	147	200	29,400	29,400	0	
	18	OPGW Tenssion Unit	unit	47	200	9,400	9,400	0	unit	20	200	4,000	4,000	0	
	19	Others	lot	1	4%	460,744	460,744	0	lot	1	4%	185,982	185,982	0	
		Subtotal				11,979,354	11,979,354	0				4,839,527	4,839,527	0	
COSTOF LABOUR, INLAND TRANSPORTATION AND EXPENSES	1	Survey & S. Investigation	km	152.2	2,000	304,400	121,760	182,640	km	66.3	2,000	132,600	53,040	79,560	FC:40%,
	2	Access Construction	km	304.4	1,000	304,400	91,320	213,080	km	132.6	1,000	132,600	39,780	92,820	FC:30%, LC:70%
	3	Land Clearing	km	152.2	1,000	152,200	30,440	121,760	km	66.3	1,000	66,300	13,260	53,040	FC:20%, LC:80%
	4	Foundation (Volume of Concrete)	m^3	3,063.2	500	1,531,600	306,320	1,225,280	m^3	1,343.0	500	671,500	134,300	537,200	FC:20%, LC:80%
	5	Tower Erection	ton	2,474.3	240	593,832	178,150	415,682	ton	852.0	240	204,480	61,344	143,136	FC:30%,
	6	Stringing	km	152.2	3,000	456,600	136,980	319,620	km	66.3	3,000	198,900	59,670	139,230	FC:30%,
	7	Inland Transportion			CIF*10%	1,197,935	0	1,197,935			CIF*10%	483,953	0	483,953	FC:0%, LC:100%
	8	Miscellaneous	lot	1	5%	227,048	43,248	183,800	lot	1	5%	94,517	18,070	76,447	
	9	General Expenses	lot	1	10%	476,802	90,822	385,980	lot	1	10%	198,485	37,946	160,539	
		Subtotal				5,244,817	999,040	4,245,778				2,183,334	417,410	1,765,924	
		Total				17,224,172	12,978,394	4,245,778				7,022,861	5,256,937	1,765,924	24,247,033

Estimated Condition ; Aluminum base LME 1550US$/ton, Exchange Rate ; 100Yen/US$, 3.0Yen/THB

Total [US$]	24,247,033
(FC)	18,235,331
(LC)	6,011,702

Table 16.3-2 (a): Construction Cost: Pakbo Substation

1. Plant and equipment

	Items	unit	Q'ty	FC (US$) CIF	FC (US$) Total FC	LC (US$) Insurance, inland transportation & installation	LC (US$) Total LC
1.1	**115 kV outdoor switchyard**						
1	Circuit breakers	set	2	50,000.00	100,000.00	4,800.00	9,600.00
2	Disconnectors	set	4	6,900.00	27,600.00	800.00	3,200.00
3	Disconnectors with earthing switches	set	2	8,100.00	16,200.00	900.00	1,800.00
4	Current transformers	pcs	6	7,800.00	46,800.00	600.00	3,600.00
5	Capacitor voltage transformers	pcs	6	9,100.00	54,600.00	500.00	3,000.00
6	Surge arresters	pcs	6	2,000.00	12,000.00	200.00	1,200.00
7	Post insulators	pcs	8	1,100.00	8,800.00	100.00	800.00
8	115 kV busbar with structure	lot	1	8,000.00	8,000.00	1,500.00	1,500.00
9	Power conductors	lot	1	2,500.00	2,500.00	1,000.00	1,000.00
10	Suspension insulator disks	lot	1	3,000.00	3,000.00	1,000.00	1,000.00
11	Steel structures (Gantries), 2 towers & 2 beams	lot	1	36,000.00	36,000.00	3,600.00	3,600.00
12	Accessories, connectors, hardware, etc	lot	1	14,000.00	14,000.00	800.00	800.00
1.2	**Protection & Control Panels**						
1	115 kV Line feeder protection	set	2	78,000.00	156,000.00	3,400.00	6,800.00
2	115 kV TL bay control	set	2	25,000.00	50,000.00	2,800.00	5,600.00
1.3	**Optical Fiber Communication System**						
1	Optical fiber cable (36 cores)	lot	1	3,200.00	3,200.00	2,000.00	2,000.00
2	OPGW joint boxes	lot	1	3,400.00	3,400.00	500.00	500.00
1.4	**Power and Control cables**						
1	1000 V solid dielectric power cables	lot	1	26,400.00	26,400.00	3,120.00	3,120.00
2	PVC insulated control cables	lot	1	48,600.00	48,600.00	7,800.00	7,800.00
1.5	**Earthing, Lightning Protection and Lighting System**						
1	Earthing system (integration in the existing system)	lot	1	25,300.00	25,300.00	7,500.00	7,500.00
2	Lightning protection system	lot	1	1,300.00	1,300.00	800.00	800.00
3	Lighting system	lot	1	3,000.00	3,000.00	600.00	600.00
1.6	**Spare Parts & Special Tools**						
1	5% of Total above	lot	1		32,300.00		
2	Documents	lot	1		2,000.00		
					681,000.00		65,820.00

2. Civil & Other Works

		unit	Q'ty	FC (US$) FC	FC (US$) Total FC	LC (US$) LC	LC (US$) Total LC
2.1	**Preliminary Works**						
1	Site survey	lot	1	2,000.00	2,000.00	2,000.00	2,000.00
2	Sub-soil investigation	lot	1	2,000.00	2,000.00	1,000.00	1,000.00
3	Civil engineering works	lot	1	30,000.00	30,000.00	0.00	0.00
4	Temporary works, site office	lot	1		0.00	36,000.00	36,000.00
2.2	**Site Cleaning & Formation Works**						
1	Cutting and removing trees & shrubs	lot	1		0.00	9,100.00	9,100.00
2	Demolishing existing structure	lot	1		0.00	13,500.00	13,500.00
3	Cutting, filling and compacting earth	lot	1		0.00	42,000.00	42,000.00
4	Earth retaing structure	lot	1		0.00	23,100.00	23,100.00
2.3	**Civil Works**						
1	Cable trenches & ducts	lot	1		0.00	32,000.00	32,000.00
2	Foundations	lot	1		0.00	62,000.00	62,000.00
3	Water supply and drainage	lot	1		0.00	28,000.00	28,000.00
4	Service roads	lot	1		0.00	20,000.00	20,000.00
5	Chainlink fences	lot	1		0.00	19,200.00	19,200.00
6	Gravelling	lot	1		0.00	29,800.00	29,800.00
					32,000.00		315,700.00

Table 16.3-2 (b): Construction Cost: Taothan Substation

1. Plant and equipment

	Items	unit	Q'ty	FC (US$) CIF	FC (US$) Total FC	LC (US$) Insurance, inland transportation & installation	LC (US$) Total LC
1.1	**Transformers**						
1	3 phase 115/22 kV transformer, 20 MVA	set	1	550,000.00	550,000.00	25,000.00	25,000.00
2	Auxiliary transformer, 22/0.4 kV, 100 kVA	set	1	20,000.00	20,000.00	3,000.00	3,000.00
1.2	**115 kV outdoor switchyard**						
1	Circuit breakers for TR bays & bus-tie	set	2	43,000.00	86,000.00	4,800.00	9,600.00
2	Circuit breakers for TL bays	set	4	50,000.00	200,000.00	4,800.00	19,200.00
3	Disconnectors	set	12	6,900.00	82,800.00	800.00	9,600.00
4	Disconnectors with earthing switches	set	5	8,100.00	40,500.00	900.00	4,500.00
5	Current transformers for TR bay	pcs	3	8,200.00	24,600.00	600.00	1,800.00
6	Current transformers for TL bays	pcs	12	7,800.00	93,600.00	600.00	7,200.00
7	Capacitor voltage transformers	pcs	15	9,100.00	136,500.00	500.00	7,500.00
8	Surge arresters	pcs	15	2,000.00	30,000.00	200.00	3,000.00
9	Post insulators	pcs	61	1,100.00	67,100.00	100.00	6,100.00
10	115 kV busbar with structure	lot	1	28,300.00	28,300.00	6,200.00	6,200.00
11	Power conductors	lot	1	22,800.00	22,800.00	4,800.00	4,800.00
12	Suspension insulator disks	lot	1	16,300.00	16,300.00	5,200.00	5,200.00
13	Steel structures (Gantries), 15 towers & 8 beams	lot	1	154,000.00	154,000.00	21,300.00	21,300.00
14	Accessories, connectors, hardware, etc	lot	1	66,000.00	66,000.00	4,000.00	4,000.00
1.3	**22 kV outdoor switchgear**						
1	Circuit breakers	set	7	15,100.00	105,700.00	1,800.00	12,600.00
2	Disconnectors	set	7	7,100.00	49,700.00	1,400.00	9,800.00
3	Disconnectors with earthing switches	set	5	8,200.00	41,000.00	1,700.00	8,500.00
4	Current transformers for TR bays	pcs	3	1,800.00	5,400.00	500.00	1,500.00
5	Current transformers for feeders	pcs	12	1,800.00	21,600.00	500.00	6,000.00
6	Capacitor voltage transformers	pcs	6	1,400.00	8,400.00	500.00	3,000.00
7	Surge arresters	pcs	15	900.00	13,500.00	400.00	6,000.00
8	Static capacitor bank, 2.5 MVar	set	1	32,500.00	32,500.00	1,600.00	1,600.00
9	Static capacitor bank, 5 MVar	set	1	40,000.00	40,000.00	2,000.00	2,000.00
10	Switch-Fuse Combinations for Aux. TR	set	1	4,100.00	4,100.00	1,900.00	1,900.00
11	22 kV busbar	lot	1	9,500.00	9,500.00	3,500.00	3,500.00
12	Power conductors	lot	1	7,600.00	7,600.00	2,400.00	2,400.00
13	Suspension insulator disks	lot	1	5,400.00	5,400.00	1,800.00	1,800.00
14	Steel structures (Gantries)	lot	1	36,000.00	36,000.00	8,800.00	8,800.00
15	Accessories, connectors, hardware, etc	lot	1	11,700.00	11,700.00	2,800.00	2,800.00
1.4	**Protection & Control Panels**						
1	115/22 kV transformer protection	set	1	82,000.00	82,000.00	4,000.00	4,000.00
2	115 kV Line feeder protection	set	4	78,000.00	312,000.00	3,400.00	13,600.00
3	115 kV busbar protection	set	1	63,000.00	63,000.00	3,100.00	3,100.00
4	115/22 kV transformer control	set	1	32,000.00	32,000.00	3,000.00	3,000.00
5	115 kV TL bay control	set	4	25,000.00	100,000.00	2,800.00	11,200.00
6	115 kV bus-tie control	set	1	16,000.00	16,000.00	2,500.00	2,500.00
7	22 kV feeder protection & control	set	4	47,000.00	188,000.00	2,400.00	9,600.00
8	22 kV static capacitor protection & control	set	1	12,000.00	12,000.00	2,400.00	2,400.00
9	Distributed Control System	lot	1	365,000.00	365,000.00	3,800.00	3,800.00
1.5	**Optical Fiber Communication System**						
1	SDH, MPX & ODB	lot	1	93,800.00	93,800.00	50,000.00	50,000.00
2	Optical fiber cable (36 cores)	lot	1	3,200.00	3,200.00	5,000.00	5,000.00
3	OPGW joint boxes	lot	1	3,400.00	3,400.00	500.00	500.00
4	Digital PABX	lot	1	21,700.00	21,700.00	3,000.00	3,000.00
5	Telephone system	lot	1	15,400.00	15,400.00	2,500.00	2,500.00
6	VHF radio telecommunication system	lot	1	28,800.00	28,800.00	5,300.00	5,300.00
1.6	**Power and Control cables**						

	Items	unit	Q'ty	FC (US$) CIF	FC (US$) Total FC	LC (US$) Insurance, inland transportation & installation	LC (US$) Total LC
1	1000 V solid dielectric power cables	lot	1	52,800.00	52,800.00	14,400.00	14,400.00
2	PVC insulated control cables	lot	1	97,200.00	97,200.00	20,800.00	20,800.00
1.7	**DC installations**						
1	110 V battery banks	set	2	16,400.00	32,800.00	1,400.00	2,800.00
2	48 V battery banks	set	2	14,400.00	28,800.00	1,300.00	2,600.00
3	110 V battery charging system	set	2	11,900.00	23,800.00	1,100.00	2,200.00
4	48 V battery charging system	set	2	8,800.00	17,600.00	800.00	1,600.00
5	110 V DC distribution board	set	1	16,200.00	16,200.00	1,400.00	1,400.00
6	48 V DC distribution board	set	1	16,200.00	16,200.00	1,400.00	1,400.00
1.8	**0.4 kV AC installations**						
1	AC distribution board	set	1	32,800.00	32,800.00	2,900.00	2,900.00
1.9	**Earthing, Lightning Protection and Lighting System**						
1	Earthing system	lot	1	151,500.00	151,500.00	37,500.00	37,500.00
2	Lightning protection system	lot	1	28,000.00	28,000.00	6,400.00	6,400.00
3	Lighting system	lot	1	22,000.00	22,000.00	3,800.00	3,800.00
1.10	**Spare Parts & Special Tools**						
1	5% of Total above	lot	1		193,300.00		
2	Documents	lot	1		10,000.00		
					4,069,900.00		427,500.00

2. Civil & Other Works

		unit	Q'ty	FC (US$) FC	FC (US$) Total FC	LC (US$) LC	LC (US$) Total LC
2.1	**Preliminary Works**						
1	Site survey	lot	1	5,000.00	5,000.00	7,000.00	7,000.00
2	Sub-soil investigation	lot	1	5,000.00	5,000.00	12,000.00	12,000.00
3	Civil engineering works	lot	1	85,000.00	85,000.00	0.00	0.00
4	Temporary works, site office	lot	1		0.00	120,000.00	120,000.00
2.2	**Site Cleaning & Formation Works**						
1	Cutting and removing trees & shrubs	lot	1		0.00	22,600.00	22,600.00
2	Demolishing existing structure	lot	1		0.00	27,000.00	27,000.00
3	Cutting, filling and compacting earth	lot	1		0.00	116,500.00	116,500.00
4	Earth retaing structure	lot	1		0.00	92,400.00	92,400.00
2.3	**Civil Works**						
1	Cable trenches & ducts	lot	1		0.00	168,000.00	168,000.00
2	Foundations	lot	1		0.00	278,000.00	278,000.00
3	Water supply and drainage	lot	1		0.00	84,000.00	84,000.00
4	Service roads	lot	1		0.00	60,000.00	60,000.00
5	Chainlink fences	lot	1		0.00	52,000.00	52,000.00
6	Gravelling	lot	1		0.00	68,000.00	68,000.00
7	Oil pit for TR	lot	1		0.00	18,400.00	18,400.00
2.4	**Building Works**						
1	Control building & guard house	lot	1		0.00	354,000.00	354,000.00
					95,000.00		1,479,900.00

Table 16.3-2 (c): Construction Cost: Saravan Substation

1. Plant and equipment

	Items	unit	Q'ty	FC (US$) CIF	FC (US$) Total FC	LC (US$) Insurance, inland transportation & installation	LC (US$) Total LC
1.1	**115 kV outdoor switchyard**						
1	Circuit breakers	set	2	50,000.00	100,000.00	4,800.00	9,600.00
2	Disconnectors	set	4	8,000.00	32,000.00	800.00	3,200.00
3	Disconnectors with earthing switches	set	2	10,000.00	20,000.00	900.00	1,800.00
4	Current transformers	pcs	6	8,000.00	48,000.00	600.00	3,600.00
5	Capacitor voltage transformers	pcs	6	9,500.00	57,000.00	500.00	3,000.00
6	Surge arresters	pcs	6	2,200.00	13,200.00	200.00	1,200.00
7	Post insulators	pcs	28	900.00	25,200.00	100.00	2,800.00
8	115 kV busbar with structure	lot	1	8,000.00	8,000.00	2,000.00	2,000.00
9	Power conductors	lot	1	2,500.00	2,500.00	1,000.00	1,000.00
10	Suspension insulator disks	lot	1	3,000.00	3,000.00	1,000.00	1,000.00
11	Steel structures (Gantries), 4 towers & 4 beams	lot	1	36,000.00	36,000.00	3,600.00	3,600.00
12	Accessories, connectors, hardware, etc	lot	1	14,000.00	14,000.00	800.00	800.00
1.2	**Protection & Control Panels**						
1	115 kV Line feeder protection	set	2	78,000.00	156,000.00	3,400.00	6,800.00
2	115 kV TL bay control	set	2	25,000.00	50,000.00	2,800.00	5,600.00
1.3	**Optical Fiber Communication System**						
1	Optical fiber cable (36 cores)	lot	1	3,200.00	3,200.00	2,000.00	2,000.00
2	OPGW joint boxes	lot	1	3,400.00	3,400.00	500.00	500.00
1.4	**Power and Control Cables**						
1	1000 V solid dielectric power cables	lot	1	26,400.00	26,400.00	3,120.00	3,120.00
2	PVC insulated control cables	lot	1	48,600.00	48,600.00	7,800.00	7,800.00
1.5	**Earthing, Lightning Protection and Lighting System**						
1	Earthing system (integration in the existing system)	lot	1	2,000.00	2,000.00	2,000.00	2,000.00
2	Lightning protection system	lot	1	2,500.00	2,500.00	1,500.00	1,500.00
1.6	**Spare Parts & Special Tools**						
1	5% of Total above	lot	1		32,600.00		
2	Documents	lot	1		5,000.00		
					688,600.00		62,920.00

2. Civil & Other Works

		unit	Q'ty	FC (US$) FC	FC (US$) Total FC	LC (US$) LC	LC (US$) Total LC
2.1	**Preliminary Works**						
1	Site survey	lot	1	2,000.00	2,000.00	2,000.00	2,000.00
2	Sub-soil investigation	lot	1	2,000.00	2,000.00	1,000.00	1,000.00
3	Civil engineering works	lot	1	10,000.00	10,000.00		
4	Temporary works, site office	lot	1		0.00	25,000.00	25,000.00
2.2	**Civil Works**						
1	Cable trenches & ducts	lot	1		0.00	14,000.00	14,000.00
2	Foundations	lot	1		0.00	40,000.00	40,000.00
					14,000.00		82,000.00

Chapter 17
Project Evaluation

Chapter 17 Project Evaluation

17.1 Evaluation Criteria

This chapter conducts an economic analysis from both a national and a project-operating entity's point of view towards the prioritized transmission project (herein to be referred to as "the Project"). The analyses aim to examine the project's viability.

17.1.1 Criteria for Economic Evaluation

The economic efficiency of the Project would be proved by comparison of the Economic Internal Rate of Return (EIRR) of the Project to the Opportunity Cost of Capital (OCC) for Lao PDR. Like the evaluation for the Optimum Plan in Chapter 10, this study sets the value of the OCC as 12%, as cited from Asian Development's guideline (Guidelines for the economic analysis of projects, February 1997) and from a similar power-related project of Lao PDR[1]. Following are the assumptions for the EIRR calculation.

1) Both costs and benefits are expressed in real term, valued at the 2009 constant price.

2) The evaluation period is set at 30 years taking into account the Project facilities' project life. All costs will be discounted to the beginning of 2009. The evaluation period is from the fiscal year (FY) of 2011 to FY 2043, including detailed designing and the construction period of FY 2011 to FY 2013. Like the analysis of the Optimum Plan, the project expenditure appears at the end of every fiscal year, March. Therefore, the Project is assumed to start in April 2011 and end in March 2014.

3) The economic costs include the following:
   (a) The construction costs of the Project include the consultant's fee, UXO investigation and clearance at tower sites only, and physical contingencies as detailed in Tables 16.5-1 "Disbursement Schedule".
   (b) The annual operation and maintenance (O&M) costs of the Project facilities are estimated to be 1% of the investment costs for the transmission line and 1.5% for substations.
   (c) In a similar manner as applied to the analysis in Section 10.6, a local portion of the Project costs is adjusted into values at economic prices using the SCF (Standard Conversion Factor) of 0.9.
   (d) Depreciation, interest charges, other taxes and duties were excluded.

4) The economic benefits include the following:
   (a) The Project will enable power exchanges between the Central 2 and the South regions. Therefore, the major benefits from the Project are the imported electricity saved from the EGAT system of Thailand. Likewise, the second major benefit is the potential foreign income realized by increased electricity exports to Thailand, which is presently not being realized due to the present limited capacity of the interconnection line between the Southern region and Thailand. For these reasons, the economic benefits to be derived from this Project are twofold: saved electricity imports and increased electricity exports

[1] Asian Development Bank TA No. 4816-LAO Preparing the Greater Mekong Subregion Northern Power Transmision Project, Oct. 2008.

to Thailand.

(b) The existing import/export tariff is employed as an economic value (Table 3.7-3 "Import tariffs" and Table 3.7-4 "Export Tariffs"). The amount of saved imports as well as of increased exports is cited from the figures in Table 8.6-1 "Amount of Different of Power Exchanges in with and without the Project", which is derived as the impact of the Project installation in Section 8.6.

17.1.2 Criteria for Financial Evaluation

Financial evaluation aims to assess project profitability. The financial costs include the capital costs and its relevant O&M costs, while financial values consist of the transmission and substation portion of domestic retail tariffs. Different from economic analysis, the value of the local currency portion can be used without any adjustments, and price contingencies are also taken into account as financial costs.

The financial evaluation assesses the financial viability of the Project by comparing the financial internal rate of return (FIRR) of the Project with the weighted average cost of capital (WACC), or the fee to finance the Project's cost. For this purpose, the WACC is set at 2.7%, which is employed in the latest ADB's electricity s study in Lao PDR[2] because of its interest rate level similarity as well as the financial structure of debt and equity.

The following are the assumptions to estimate FIRR of the Project.

1) Both costs and benefits will be expressed in real terms valued at 2009 constant prices.

2) The evaluation will be carried out for thirty years in the economic terms of the Project facilities. All costs will be discounted to the beginning of 2009. The evaluation period is from the fiscal year (FY) of 2011 to FY 2043 including detailed designing and construction of FY 2011 – FY 2013.

3) The financial costs include:
   (a) The construction costs of transmission lines and substations for the Project are the same as those estimated in Table 16.5-1 "Disbursement Schedule" (including physical as well as price contingency).
   (b) The annual operation and maintenance costs of the Project facilities are estimated to be 1% of the investment costs for transmission lines, 1.5% for substations.
   (c) Depreciation, interest charges, other taxes and duties are excluded.

4) The financial benefits include:
   (a) The financial benefits are defined as the incremental energy sales revenue obtained by the Project. The amount of electricity transmitted over the Project's transmission is estimated to be 530 GWh[3] annually. The benefit is obtained by multiplying this amount of transmitted electricity with the financial value, stated below.
   (b) The current domestic retail tariff (average retail tariff) is employed as the financial value of this evaluation. The rate of the tariff is planned to rise by 5% annually. Further,

[2] Asian Development Bank TA No. 4816-LAO Preparing the Greater Mekong Subregion Northern Power Transmision Project, Oct. 2008. Its proposed interest rate is 1.0%. The breakdown of its financing source is around 90% from long-term loans, and around 10% from the Lao Government/ EdL.

[3] The result of system analysis for year 2020 tells that the power flow at Pakbo terminal is estimated to be 113 MW and 69 MW respectively for the peak time during rainy and dry seasons. Likewise, the power flow for the off-peak times during rainy and dry seasons are calculated at 33 MW and 27 MW respectively. From these results, the annual transmitted amount of electricity is estimated to be 530 GWh.

because the Project covers only transmission and substation facilities, the corresponding portion of the tariff is used as a financial value. According to the latest study by the World Bank, the portion is estimated as 14% of total.

17.2 Results of Evaluation and Sensitivity Analysis

The study team calculated EIRR and FIRR of the Project in accordance with the above premise to obtain the following result:

- EIRR: 27.9%, NPV: 41.9 million USD (at discount rate of 12%)
- FIRR: 17.1%, NPV: 128.0 million USD (at discount rate of 2.7%)

The prioritized Project is concluded to be economically as well as financially viable based on the fact that EIRR exceeds its benchmark of OCC, 12% while FIRR also exceeds its benchmark of WACC, 2.7%.

17.2.1 Sensitivity Analysis of Economic Evaluation

The economic viability is confirmed under the condition set in Section 17.1.1 (Base case, hereafter).

Table 17.2c-1 at the end of this Section 17.2 shows the cash flow of Base case.

Like the analysis on the Optimum Plan in Chapter 10, sensitivity analyses were also undertaken to measure the impact caused by future uncertainty. The following three scenarios are set for this purpose:

1) Capital Cost Increase Scenario

The first scenario assumed that the capital cost would rise by 15% due to events such as global inflation of construction material market and the volatility of currency exchange rate. Because a recent EDL's transmission project has experienced similar situation, the analysis of the impact under this condition is considered useful.

2) O&M Cost Increase Scenario

The second scenario assumed that the O&M cost rises by 50%, predicting the rise of maintenance material costs and labor costs. This condition is equivalent to the one that O&M cost including labor costs increases by 5% every year (excluding inflation effect). The effect is based on the net present value of total O&M cost from fiscal year 2011 to 2043.

3) Power Trading Slow Down Scenario

The final scenario assumed that revenue related to power trading decreases by 30% due to possible events such as tariff update, decline in power demand in Thailand, uncollected bills, currency exchang rate fluctuation.

Table 17.2c-2 shows the detailed cash flows of the results, and Table 17.2-1 summarizes the whole results.

Table 17.2-1 Results of Economic Analysis

Scenario	EIRR [%]	NPV2009 [Million USD]	Elasticity	Boundary value
Base Case	27.9	41.9	-	-
1) Capital Cost Increase +15%	25.2	38.5	- 0.63	+190%
2) O&M Cost Increase +50%	27.5	41.0	- 0.02	n.a. (EIRR of 21.1% with 1,000%)
3) Power Trading Slow Down –30%	20.8	21.6	0.85	-60%

Note: NPV stands for Net Present Value, calculated at 12% of discount rate.
Boundary value: the value of key parameter which derives the EIRR value less than 12%, OCC.

As shown in the table, since the value of EIRR exceeds the 12% benchmark for all scnearios, the Study Team concludes that the economic viability of the Project is considered robust.

In addition to the calculation of EIRR, the sensitivity analysis delved into further investigation to measure the uncertainty range in future. The investigation consists of two parts: elasticity test and valid range test. The elasticity test is about the degree of impact on the economic evaluation result by key parameter of each scenario, such as capital cost and power trading amount, to find out the most influential parameter. The test's finding is that the degree of impact via the third scenario turned to be the largest (its elasticity is 0.85), which means that the amount of power trading slow down would reduce the value of EIRR more than the amount of capital investment increase would do. The result of the elasticity test is also shown in Table 17.2-1.

The valid range test is about the boundary condtion by scenario, the condition within which the prioritized Project would remain economically viable. In other words, the value of the Project's EIRR keeps higher than its benchmark, OCC (12%) with the scenario's parameter, whose value keeps lower than its boundary value. The elasticity test revealed that the impact by fluctuation of power trading volume would be larger than any other parameters set in this sentitivy analysis. In this Power Trading Slow Down scenario, the boundary value of the parameter is calculated as minus 60%. This means that if the electricity demand growth rate of Thailand, which is the main importer of electricity produced in Lao PDR, falls and stay under the half of the current figure in long run, EIRR of the Project would decrease to less than 12%. Therefore, the Project might no longer be economically viable if such future is firmly predicted. Likewise, for Capital Cost Increase scenario, whose parameter (capital cost)'s impact turns to be relatively small, its EIRR would be no less than 12% unless the spending on capital cost would become extravagant, like three times larger than original value. Therefore, it can be concluded that the revision of capital budget, such as reduction of capital expenditure and implementation postpone of sub-projects would be unnecessary. Finally, for O&M Cost Increase scenario, its EIRR is led as 21.1% well over 12% of OCC even if the O&M cost increases to ten times as large as its original value. The team concluded that it is less likely that this parameter would make the Project non-economically viable.

Figure 17.2-1 summarizes the above result.

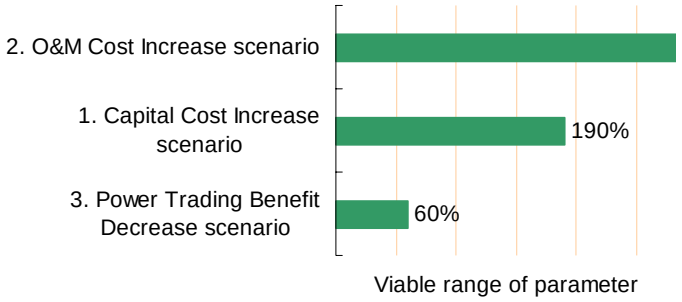


Figure 17.2-1 The Range of Parameters Guaranteeing Economic Viability of the Project

17.2.2 Sensitivity Analysis of Financial Evaluation

The finaiclal viability is confirmed under the condition set in Section 17.1.2 (Base case, hereafter). Table 17.2c-3 at the end of this Section 17.2 shows the cash flow of Base case.

Like the economica evaluation above, sensitivity analyses were also undertaken to measure the impact caused by future uncertainty (Table 17.2c-4 shows the results' cash flow). The analyses examined six scenarios, including a scenario adopting new tariff system propsed in a World Bank's study (Tariff Update, June 2009, IDA). Table 10.6-7 "Proposed electricity tariff (average retail tariff)" shows the proposed new tariff until year 2016.

1) Capital cost increase scenario

The first scenario assumed that future capital investment expands by 15% due to events such as global market fluctuations of construction material and the volatility of currency exchange rate. Because a recent EDL's transmission project has experienced a similar situation, it would be worthwhile to measure its impact for the prioritized Project, too.

2) Benefit unit value decrease scenario

The second scenario assumed that the economic benefits would fall by 10% resulting from events such as tariff reduction and uncollected bills.

3) O&M cost increase scenario

The third scenario assumed that the O&M cost rises by 50%, predicting the increase of maintenance material costs and labor costs. This condition is equivalent to the one that O&M cost including labor costs increases by 5% every year (excluding inflation effect), which is estimated based on the net present value of total O&M cost during the period between fiscal year 2011 and 2043.

4) Demand slow down scenario

The fourth scenario assumed that the electricity demand or the sales volume of electricity per annum would fall by 30% due to events like economic downturn. This condition corresponds to the one that the electricity demand growth rate which averaged the rate of all consumer categories would be 4% for next thirty years, while Base case assumes the rate of 6%.

5) Adoption of proposed new tariff system scenario

The fifth scenario assumed that EDL adopts new tariff system proposed by the World Bank's tariff study (Tariff Update, June 2009).

6) Adoption of alternative new tariff system scenario

Because an alternative tariff system, whose average level is set as half of the level set in the originally proposed new tariff system, is proposed recently in Lao PDR, this final scenario assumed that EDL would adopt this alternative new tariff system. Figure 17.2-2 summarizes the retail tariff rates used in these sensitivity analeses.

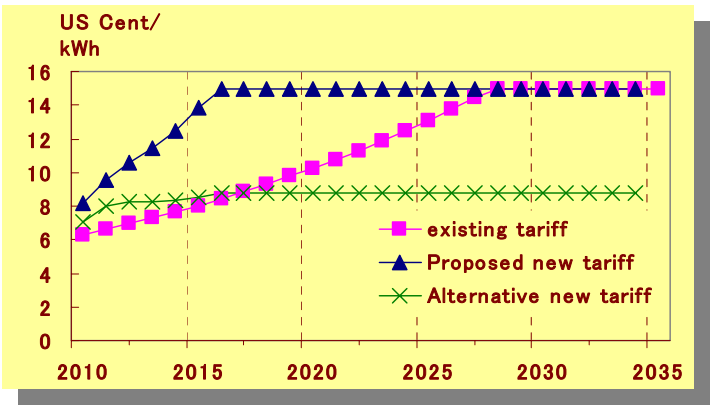


Figure 17.2-2 The Projection of Electricity Tariff Used for This Financial Analysis

Table 17.2c-4 shows the detailed cash flows of these sensitivity analyses, and Table 17.2-2 summarizes the whole results.

Table 17.2-2 Results of Financial Analysis

Scenario	FIRR (%)	NPV2009 [Million USD]	Elasticity	Boundary value
Base Case	17.1	128.0	-	-
1) Capital Cost Increase +15%	15.4	122.4	- 0.67	n.a. (3.5% of FIRR with +300% rise)
2) Benefit Unit Value Decrease –10%	15.6	111.0	0.87	-80%
3) O&M Cost Increase +50%	16.7	124.1	0.05	n.a. (14.6% of FIRR with +300% rise)
4) Demand Slow Down –30%	12.4	76.9	0.91	-80%
5) Adoption of Proposed New Tariff System	24.1	158.9	-	-
6) Adoption of Alternative New Tariff System	14.7	76.9	-	-

Note: NPV stands for Net Present Value at 2.7% of discount rate
Boundary value: the value of key parameter which derives the FIRR value less than 2.7% of WACC.

Because the FIRRs of the all scenarios above exceed their benchmark of 2.7%, the WACC, the Study Team concludes that the financial viability of the Project is considered to be robust. In addition, it is understood that the emerging national grid will have high long term financial benefits by bringing cheaper hydropower to load centers in the Central 2 region and further all over the country.

Like the economic analysis in Section 17.2.1, the Study Team investigated two more analyses, elasticity test and valid range test so that the future uncertainty range can be specified for the prioritized Project.

Firstly, from the elastiticy test, it turned out that the degree of impact resulting from the revision of the tariff system would be the largest among all. Specifically, the FIRR value of scenario 5), the case to adopt the proposed new tariff system by the World Bank's study, records the highest. This result reconfirms that the adoption of the proposed tariff system would enhance EdL's financial robustness. It is also confirmed that the value of FIRR with the sixth scenario to adopt alternative new tariff system surpasses the value of originally-set WACC, 2.7%.

Secondly, for the valid range test, the boundary condtion by scenario, within which the prioritized Project would be financially viable, is evaluated. Its result, the boundary value by scenario, is also shown in Table 17.2-2. For this purpose, Demand Slow Down scenario is selected to be examined first, because the elastiticty test shows that its impact on the financial evaluation result records the highest. According to this range test result, if it is surely predicted that the annual demand, or the amount of electricity transmitted over the Project's transmission line, drops by 80% of the originally-set value in long term, the Project would be condluded as financially non-viable. To put it the other way around, unless the level of the demand becomes less than 20% of its original level, the Project's finaicial viability would be secured. Benefit Unit Value Decrease scenario is also selected to be investigated, because its impact on the financial evaluation result turned to be the second largest. The result tells that the Project would also remain financially viable unless the benefit unit value drops by more than 80%.

Figure 17.2-3 summarizes the result of viable range test.

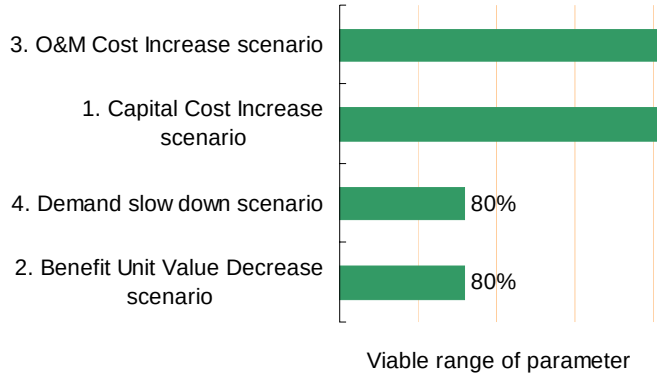


Figure 17.2-3 The Range of Parameters Guaranteeing the Financial Viability of the Project

Table 17.2c-1 EIRR Calculation for the Prioritized Project

Unit: '000 USD.

Fiscal Year	Economic Cost														Gross Benefit			NET
	TL Investment		SS Investment		Consult		Land&ROW	Contingency(Physical portion)		Total Capital		O&M cost		INESTMENT	Energy		Benefit	
	FC	LC	FC	LC	FC	LC	LC	FC	LC	FC	LC	TL FC+LC	SS FC+LC	Total FC+LC	Saved Imp (GWh)	Increased Export(GWh	Total	
FY2011	0	0	0	0	452	35	150	0	0	452	185	0	0	636	0	0	0	−636
FY2012	9,118	2,705	1,674	657	903	69	263	357	114	12,052	3,809	0	0	15,861	0	0	0	−15,861
FY2013	9,118	2,705	3,906	1,533	903	69	19	834	266	14,761	4,593	0	0	19,354	0	0	0	−19,354
FY2014	0	0	0	0	0	0	0	0	0	0	0	236	117	353	244	−100	8,146	7,793
FY2015	0	0	0	0	0	0	0	0	0	0	0	236	117	353	170	92	13,255	12,902
FY2016	0	0	0	0	0	0	0	0	0	0	0	236	117	353	85	82	8,329	7,976
FY2017	0	0	0	0	0	0	0	0	0	0	0	236	117	353	189	21	10,934	10,581
FY2018	0	0	0	0	0	0	0	0	0	0	0	236	117	353	28	238	12,689	12,336
FY2019	0	0	0	0	0	0	0	0	0	0	0	236	117	353	15	228	11,510	11,157
FY2020	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2021	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2022	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2023	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2024	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2025	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2026	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2027	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2028	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2029	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2030	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2031	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2032	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2033	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2034	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2035	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2036	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2037	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2038	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2039	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2040	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2041	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2042	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
FY2043	0	0	0	0	0	0	0	0	0	0	0	236	117	353	29	306	15,967	15,614
Total	18,235	5,411	5,581	2,190	2,258	173	433	1,191	380	27,265	8,587	7,094	3,497	46,442	1,437	7,914	448,062	401,619

Economic IRR for the Project (%) 27.9%
Net Present Value (at 12%) 41,916

OER 250 Kip/THB (Aug. 27, 2009 by Yahoo)
OER 8,515 Kip/USD (Aug. 27, 2009 by Yahoo)
OER 34 thb/usd (Aug. 27, 2009 by Yahoo)
Applied currency and unit: US$ thousand
Base year: Year 2009

Cost side
SCF for Local Currency Portion 0.9
O&M cost: 1% for transmission, 1.5% for substation of capital cost.

Benefit side

EGAT import tariff(peak)*1	1.79 THB/kWh	5.26 USCent/kWh
EGAT export tariff(peak)	1.60 THB/kWh	4.71 USCent/kWh

Table 17.2c-2 EIRR Calculation for the Prioritized Project (Sensitivity Analysis)

SA1) Capital Cost +15% — 15% — Unit: '000 USD.
SA2) O&M +50% — 50%
SA3) Power Trading Amount — -30%

Fiscal Year	SA1 Economic Cost: Investme FC+LC	SA1 Economic Cost: S Investment FC+LC	SA1 Total Capital FC+LC	SA1 O&M cost TL&SS FC+LC	SA1 INESTMENT Total FC+LC	SA1 Net	SA2 Economic Cost INESTMENT: O&M (TL+SS)	SA2 Economic Cost INESTMENT: Total FC+LC	SA2 Net	SA3 Gross Benfit	SA3 Net
FY2011	0	0	636	0	636	-636	0	636	-636	0	-636
FY2012	13,596	2,681	17,984	0	17,984	-17,984	0	15,861	-15,861	0	-15,861
FY2013	13,596	6,256	21,943	0	21,943	-21,943	0	19,354	-19,354	0	-19,354
FY2014	0	0	0	406	406	7,740	530	530	7,617	5,702	5,349
FY2015	0	0	0	406	406	12,849	530	530	12,725	9,278	8,925
FY2016	0	0	0	406	406	7,923	530	530	7,799	5,830	5,477
FY2017	0	0	0	406	406	10,528	530	530	10,404	7,654	7,301
FY2018	0	0	0	406	406	12,283	530	530	12,159	8,882	8,529
FY2019	0	0	0	406	406	11,104	530	530	10,980	8,057	7,704
FY2020	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2021	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2022	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2023	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2024	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2025	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2026	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2027	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2028	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2029	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2030	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2031	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2032	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2033	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2034	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2035	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2036	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2037	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2038	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2039	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2040	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2041	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2042	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
FY2043	0	0	0	406	406	15,561	530	530	15,437	11,177	10,824
Total	27,193	8,937	40,564	12,179	52,743	395,318	15,886	51,738	396,324	313,643	267,201
Economic IRR for the Project (%)						25.2%			27.5%		20.8%
Net Present Value (at 12%)						38,489			41,013		21,570

Table 17.2c-3 FIRR Calculation for the Prioritized Project

Unit: '000 USD

Fiscal Year	Financial Cost															Incremental Energy & Revenues			NET
	TL Investment		SS Investment		Consult		Land&ROW	Contingency		Total Capital		O&M cost							
	FC	LC	FC	LC	FC	LC	LC	FC	LC	FC	LC	TL FC+LC	SS FC+LC	Total FC+LC		Energy (MWh)	Tariff ($/MWh)	Total Revenue	
FY2011	0	0	0	0	452	38	167	0	0	452	205	0	0	657		0	9	0	-657
FY2012	9,118	3,006	1,674	730	903	77	293	572	203	12,267	4,308	0	0	16,575		0	10	0	-16,575
FY2013	9,118	3,006	3,906	1,704	903	77	22	1,334	473	15,261	5,281	0	0	20,542		0	10	0	-20,542
FY2014	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	11	5,680	5,253
FY2015	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	11	5,964	5,537
FY2016	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	12	6,262	5,835
FY2017	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	12	6,575	6,148
FY2018	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	13	6,904	6,477
FY2019	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	14	7,249	6,822
FY2020	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	14	7,611	7,185
FY2021	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	15	7,992	7,565
FY2022	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	16	8,392	7,965
FY2023	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	17	8,811	8,384
FY2024	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	17	9,252	8,825
FY2025	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	18	9,714	9,288
FY2026	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	19	10,200	9,773
FY2027	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	20	10,710	10,283
FY2028	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2029	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2030	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2031	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2032	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2033	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2034	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2035	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2036	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2037	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2038	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2039	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2040	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2041	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2042	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
FY2043	0	0	0	0	0	0	0	0	0	0	0	280	147	427		530,000	21	11,245	10,819
Total	18,235	6,012	5,581	2,434	2,258	192	481	1,905	676	27,979	9,794	8,394	4,407	50,575		15,900,000	0	291,243	240,668
															Financial IRR for the Project (%)				17.1%
	1,000 USD														Net Present value with discount rate of		2.7%		127,974

OER 250 Kip/THB (Aug. 27,2009 by Yahoo)
OER 8,515 Kip/USD (Aug. 27,2009 by Yahoo)
Applied currency and unit: US$ thousand
Base year: Year 2009

Cost side
WACC 2.7%

Benefit side
TL&SS portion of tariff 14% (Source: WB Tariff update study, Aug.20,2009)

Table 17.2c-4 FIRR Calculation for the Prioritized Project (Sensitivity Analysis)

	SA1) Investment Costs +15%						SA2) Benefits (reduced tariff)		SA3) O&M +50%		
	15%						-10%		50%		
	Financial Cost					NET		NET	Financial Cost		NET
Fiscal Year	TL	SS	Total Capital	O&M cost TL&SS	Investment		Gross Revenue		O&M (TL+SS)	Investment	
	FC+LC	FC+LC	FC+LC	FC+LC	FC+LC					FC+LC	
FY2011	0	0	657	0	657	-657	0	-657	0	657	-657
FY2012	13,942	2,765	18,754	0	18,754	-18,754	0	-16,575	0	16,575	-16,575
FY2013	13,942	6,452	23,202	0	23,202	-23,202	0	-20,542	0	20,542	-20,542
FY2014	0	0	0	491	491	5,189	5,112	4,685	640	640	5,040
FY2015	0	0	0	491	491	5,473	5,367	4,941	640	640	5,324
FY2016	0	0	0	491	491	5,771	5,636	5,209	640	640	5,622
FY2017	0	0	0	491	491	6,084	5,918	5,491	640	640	5,935
FY2018	0	0	0	491	491	6,413	6,213	5,787	640	640	6,264
FY2019	0	0	0	491	491	6,758	6,524	6,097	640	640	6,609
FY2020	0	0	0	491	491	7,121	6,850	6,424	640	640	6,971
FY2021	0	0	0	491	491	7,501	7,193	6,766	640	640	7,352
FY2022	0	0	0	491	491	7,901	7,552	7,126	640	640	7,751
FY2023	0	0	0	491	491	8,320	7,930	7,503	640	640	8,171
FY2024	0	0	0	491	491	8,761	8,327	7,900	640	640	8,612
FY2025	0	0	0	491	491	9,224	8,743	8,316	640	640	9,074
FY2026	0	0	0	491	491	9,709	9,180	8,753	640	640	9,560
FY2027	0	0	0	491	491	10,219	9,639	9,212	640	640	10,070
FY2028	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2029	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2030	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2031	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2032	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2033	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2034	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2035	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2036	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2037	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2038	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2039	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2040	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2041	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2042	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
FY2043	0	0	0	491	491	10,755	10,121	9,694	640	640	10,605
Total	27,884	9,216	42,613	14,721	57,334	233,908	262,118	211,543	19,202	56,976	234,267
				Financial IRR for the Project		15.4%		15.6%			16.7%
				Net Present Value at	2.7%	122,398	2.7%	110,956		2.7%	124,065

SA4) Demand -30%			SA5) New tariff system				SA6) Alternative Traiff			
-30%										
Gross Benefit		NET	Gross Benefit			NET	Gross Benefit			NET
Energy (MWh)	Revenue		New Tariff (Kip/kWh)	$equivalen ($/MWh)	Revenue		New Tariff (Kip/kWh)	$equivalent ($/MWh)	Revenue	
0	0	-657	114	13	0	-657	95	11	0	-657
0	0	-16,575	127	15	0	-16,575	99	12	0	-16,575
0	0	-20,542	136	16	0	-20,542	99	12	0	-20,542
371,000	3,976	3,549	149	17	9,272	8,845	100	12	6,204	5,778
371,000	4,175	3,748	165	19	10,248	9,821	102	12	6,318	5,891
371,000	4,383	3,957	178	21	11,102	10,675	105	12	6,527	6,100
371,000	4,603	4,176	178	21	11,102	10,675	105	12	6,527	6,100
371,000	4,833	4,406	178	21	11,102	10,675	105	12	6,527	6,100
371,000	5,074	4,648	178	21	11,102	10,675	105	12	6,527	6,100
371,000	5,328	4,901	178	21	11,102	10,675	105	12	6,527	6,100
371,000	5,594	5,168	178	21	11,102	10,675	105	12	6,527	6,100
371,000	5,874	5,447	178	21	11,102	10,675	105	12	6,527	6,100
371,000	6,168	5,741	178	21	11,102	10,675	105	12	6,527	6,100
371,000	6,476	6,049	178	21	11,102	10,675	105	12	6,527	6,100
371,000	6,800	6,373	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,140	6,713	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,497	7,070	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
371,000	7,872	7,445	178	21	11,102	10,675	105	12	6,527	6,100
11,130,000	203,870	153,295			330,366	279,792			195,273	144,698
		12.4%				24.1%	Financial IRR for the Project			14.7%
	2.7%	76,919			2.7%	158,872	Net Present Value at		2.7%	76,918

17.3 Financing Plan of the Prioritized Project

The financing plan of the electricity business needs to assure stable and inexpensive arrangements of a large amount of financing, because the arrangement could affect not only the electricity business itself but also its stable power supply with low rates, which is the electricity industry's mission.

17.3.1 Glance at Japanese Assistance to Lao PDR

Since the 1970s, the Japanese Government has provided loans and grants to numerous Lao PDR electricity projects, including Nam Ngum 1 hydropower project (155 MW, 1971) to achieve stable power supply to the country's Vientian metropolitan area. Currently, power system loan assistance is underway, which aims to develop the 115 kV transmission lines from Paxan to Pakbo (around 300 km long) by bridging Central 1 region and Central 2 region. Recently, the Japanese Government dispatched electricity policy advisors and provides electricity technical standard projects. The major loan assistances are shown below.

- 1974 Nam Ngum 1 hydropower project (3.2 billion Japanese Yen or JPY)
- 1976 Nam Ngum 1 hydropower project (2.1 billion JPY)
- 1996 Nam Leuk hydropower project (3.9 billion JPY)
- 2004 Greater Mekong Power Network Development Project (3.3 billion JPY)

(Source. ODA Data-book by country 2006 [11] Lao PDR)

One of the goals stated in the Japanese assistance plan to Lao PDR (September 2006) is to assist the Lao PDR in developing an infrastructure leading to the country's economic prosperity, which would be a great driver for self-sustaining growth. Among them, the plan highlights the effective use of the existing infrastructure and the development of the social economic infrastructure. JICA's project execution plan (February 2007) is to adhere to this idea. Its overall policy is to assist the targets of Lao's electricity sector: 1) to increase the electrification ratio nationwide achieving a secure, stable, and sustainable energy supply at the same time, 2) to earn foreign income by means of electricity exports. The fundamental approach is to mix loan assistance and technology cooperation, such as 1) policy making assistance in the electricity sector, 2) assistance in developing a long-term master plan, 3) assistance in expanding the electricity system, and the 4) capacity enhancement of executing electricity technical standards.

This prioritized project is defined as one of the electricity infrastructure development programs, which aims to enhance the capability of the Government as well as of EdL in power development and network expansion planning efficiently. Such enhancements will bring stable power supply to major cities and will promote electrification in rural areas, finally leading to life quality improvement as well as poverty reduction of Lao PDR.

17.3.2 Trend of Other Official Development Assistance Resources

Regarding the official development assistance (ODA) in developing 115 kV transmission lines in Lao PDR, the World Bank (the Bank, hereafter) mainly assists related projects in the country's southern region, while the Asian Development Bank (ADB, hereafter) assists those in the northern region. Considering that the Japanese Government mainly assists in projects in the central region and backbone transmission line projects, the development of the 115 kV network has been conducted efficiently in Lao PDR. With the completion of the nationwide dispatching system funded by the Bank, this prioritized Project is expected to bring about a synergy effect to

Lao's electricity sector. The following shows the major assistance records in the electricity sector by donor:

The World Bank
- 115 kV transmission line between Ban Hat substation (SS) and Cambodian border
- 115 kV transmission line between Xeset 1 HHP and Saravan SS
- Central dispatching center
- Assistance in information management system of substations

The Asian Development Bank
- 115 kV transmission line in the northern region

JICA (former JBIC)
- 115 kV transmission line linking the Central 1 area and Central 2 area

(Ref.: Preliminary study on Power Network System Plan in Lao PDR)

17.3.3 Financing Options

(1) The Analysis of Various Financing Options

This subsection analyzes the appropriate financing option for the prirotitized Project. The candidates are shown in Table 17.3-1 (re-displayed of Table 3.9-1 "Major financing schemes"). Table 17.3-2 shows the anticipated risk related to some of the options.

Table 17.3-1 Major Financing Schemes

1) Internal financing	a. Retained earning	Cost of Equity	
	b. Depreciation etc.	Weighted Average Cost of Capital	
2) External financing	a. Equity finance	Cost of Equity	Direct: capital increase (share issue)
	b. Debt finance	Cost of Debt	Direct: corporate bond, commercial paper
			Indirect: Borrowing
	c. Asset finance		

Note: Besides the above options, there are other financing schemes such as project finance and public private partnership, which utilizes private participation. These options are, however, not considered in this study because Lao PDR's Law on Electricity prohibits private ownership of transmission lines except the one by EdL. Although public investment via a national budget could be another option, the review in Chapter 2 concluded that this option is not feasible in today's circumstance in Lao PDR.

(Source: Accounting for the electricity business ("Denkijigyo no keiri"))

Table 17.3-2 Possible Risk and Financing Options

Financing option	Risk
Retained earning	Insufficient amount to cover total investment
Borrowing from commercial banks	Worsening of financial figures in long run.
Borrowing from international assistance organizations	Long appraisal period
Issuing corporate/ project bond	Subject to the condition of financial market.
Listing on the stock market	Subject to the condition of financial market.

(2) The Optimal Financing Scheme Considering Present Situation Surrounding EDL

As identified in Section 3.9, it is essential for EdL to develop its power system efficiently in the short term in order to satisfy fast-paced electricity demand growing at a rate of over 11% per year. The story is also same for financal arrangements. The examination of financing options

reveals that most options turned to be not feasible in Lao PDR. Firstly, the current Government's budget cannot afford capital investment including power facilities. Secondly, Lao's domestic financial market is not mature enough for EdL to procure a sufficient amount of funds through bond issuance or borrowing from commercial banks. Although the establishment of Lao's first securities exchange is scheduled for October 2010, its outline including a possible company listing is not yet fixed. Therefore, this option is also regarded as non- suitable. The exception could be cross-border infrastructure bond issuance by the Lao government in Thailand, which is supported by ADB. According to the Bangkok Post dated May 23rd, under the proposed structure, the bonds are planning to be issued in Thailand currency to raise around 40 billion Japanese yen equivalent backed by royalties from two IPPs, THPC (Theun-Hinboun Power Company Limited) and the HHPC (Houay Ho Power Company Limited). The bond is likely to be 5 to 15-year notes, and proceeds from the bonds would be used to buy a stake in a hydropower project to provide electricity to Thailand. The possibility to use this bond to finance the Project is, however, small, because the bond basically aims to promote power generation development.

For these reasons, the suitable financing option for the Project is limited to loans from overseas assistance agencies the same as before. Attention is also to be paid towards the "employing loan scheme" and whether or not it will harm EdL's financial status as shown in Table 17.3-2, by verifying the details of its loan policy.

17.3.4 Financing Plan

The Study Team concludes based on the above discussion that an appropriate financing scheme for the Project is to receive loans from overseas development agencies. Further, because the EDL appreciates Japanese Yen loans for this purpose, expected conditions would be similar to that applied to the existing Greater Mekong Power Network Development Project. The following shows the expected conditions:

Currency:	Japanese Yen
Interest Rate:	1%
Repayment Period:	30 years
Grace Period:	10 years
Total Investment amount:	37.8 Million USD (project cost)
Financing amount:	More than 90% of total investment amount
Disbursement plan:	3 years (from April 2011 to March 2014)

The financial analysis result undertaken in Section 17.2 shows that the FIRR of the Project exceeds its WACC benchmark of 2.7%. The analysis result of EdL's financial status in Section 3.9 has also confirmed that EdL is qualified with further loans as it satisfies the conditions set in its loan policy, e.g. equity ratio has been steady at around 60% for over the past five years. As for the prospect of EDL's financial status, the status is expected to improve strongly if the new tariff system proposed by the aforementioned World Bank's Tariff Update Study as the new system provides enough rates for EDL to recover its supply cost of electricity.For these reasons, the Study Team concludes that the proposed financing plan is viable.

Chapter 18
Conclusion and Recommendation

Chapter 18 Conclusion and Recommendation

The main purpose of this study was to create an optimum power system plan up to 2030 and to select the highest prioritized project to be designed around its required facilities. The optimum power system plan has been created in accordance with governmental policy for the power sector of Lao PDR aimed at maintaining and expanding stable and sustainable domestic power supply.

We hope that the results of this study will be taken into consideration for formulating the power sector policy and the power development program in Lao PDR.

18.1 The Highest Prioritized Project

The transmission line from the Pakbo substation to the Saravan substation has been selected as the highest prioritized project among the aforementioned power system plans for contributing to the reduction of power imports by utilizing surplus power in the south by connecting the central to the south in accordance with the policy of the power sector in Laos that states the expansion and the support to the stable and sustainable domestic power supply.

The project to be operated until 2014, according to the discussion with the EDL Managing Director about the coordination with the commissioning year of Houaylamphan hydropower station, is outlined as follows.

- The construction of the 115 kV transmission line from the Pakbo substation to the Saravan substation is as follows:
  - The interval of the transmission line: Pakbo – Taothan and Taothan – Saravan
  - The voltage: 115 kV
  - The length of the transmission line: 220 km
  - The number of circuits: two (2)
  - The type of conductor: TACSR 240 mm^2
- The expansion and the related works of the substations
  - Pakbo substation: adding two (2) bays and modifying the related facilities
  - Saravan substation: adding four (4) bays
  - Taothan substation: installing four (4) bays and 20 MVA transformer x 1

Carrying out the IEE of this project has been supported in this study. It has been concluded that the project will pay attention to the social and environmental considerations such as avoiding the routes passing through protected or residential areas to be able to minimize the natural environmental and regional social impacts.

The section 11.4.2 in Chapter 11 shows the additional study required before its construction such as the detailed design of the facilities, the additional environmental examination if required, the land acquisitions and the preparation of the bidding documents. It is recommended that EDL begin the necessary arrangements for obtaining the WREA Environment Certificate and start urgently preparing for the project's financial arrangements.

The following table shows the total project's estimated budget based on its design results. The total amount of the budget reaches around 37.8 million USD.

Table 18.4-1 Total Project Costs

[1,000 USD]

Items	FC	LC	Total
Transmission Lines	18,235.3	6,011.7	24,247.0
Substation Facilities	5,580.5	2,433.8	8,014.3
Sub-total	23,815.8	8,445.5	32,261.3
Compensation		166.8	166.8
Environment monitoring	-	43.1	43.1
UXO survey & clear	-	271.2	271.2
Consultant fee	2,258.3	192.0	2,450.3
Physical contingency	1,190.8	422.3	1,613.1
Price contingency	714.5	253.4	967.9
Total	**27,979.4**	**9,794.3**	**37,773.7**

The completion of this project will realize power transmission capability from the south, where the surplus power is to be expected, to the Central 2, where the shortage of the power supply is to be expected in response to the future increase in power demand. It can also contribute to the decrease of power imports from Thailand and the promotion of the regional electrification.

It can be concluded from the results of the economic and financial evaluation of the project shown in Chapter 17 that the implementation of the project will be economically and financially feasible because the Economic Internal Rate of Return and the Financial Internal Rate of Return of the project exceed the Opportunity Cost of Capital (OCC) and the Weighted Average Cost of Capital (WACC) respectively. These are the criteria for their evaluation.

18.2 Power Network System Plan

Tables 10.1-1 to 10.1-3 in Chapter 10 show the subprojects of transmission lines and Tables 10.2-1 to 10.2-3 show the subprojects of substations respectively as the power system plans made in this study. The subprojects shown in those tables comprise the basic plan of the power network system for power transmission from power generation sources outlined in the DOE/EDL Power Development Plan and the large scale thermal power station proposed around 2030 in this study to the substations and the identified special power consumers in the whole of Laos, and the power system of Thailand.

It is recommended that EDL conduct, with the technical skills obtained through this plan, a power system analysis for confirming yearly situations, make an effort to update the basic power system plan based on this plan and utilize the plan for the study of the implementation plan at the feasibility study stage of the individual projects of power generation and transmission lines and substations reflecting the latest information about the updated power demand forecast due to the change in the actual power demand, the change in the economic trends and the revision of the power generation development program.

18.3 Power System Operation

The Central Load Dispatching Center has been scheduled in accordance with the construction progress of the regional interconnections and the expansion of the Laos power system as shown in Section 7.6 in Chapter 7 where its functions were proposed. EDL will need to study the functions of the Central Load Dispatching Center and the organization of the power system operations.

The number of the staff engaged in the operation and maintenance of the facilities should be increased because the power system facilities will double in the near future. Staff that will be

engaged in the operations and maintenance of power system facilities must possess a thorough knowledge of the Technical Standards of the electric facilities already being enforced in Laos. Staff training and the arrangement of operations and maintenance manuals should be further strengthened.

It is expected that the information collection for the power system operation and the management of electric power quality such as regarding the power system reliability and the voltage will become more difficult because of the increase in the number of the IPPs and the large number of customers connected to the EDL power system. Thus, the establishment of a common rule (Grid Code) determining the technical requirements of connecting the EDL power system and the types of the information provided with the power system operator applicable to all power system users is urgently required.

18.4 Power Generation Plan

Based on DOE/EDL's power development plan, an highly reliable power supply can be ensured until around 2020 via the installation of power plants for domestic power.

However, the increase in the Laos's power demand will require additional power generation of several hundred MW by around 2030. Countermeasures will be needed during times of insufficient energy especially during the dry seasons due to the decrease of hydropower outputs. Thermal Power Plant development in Laos should be considered because hydropower potential is expected to become short of its provisions during that time and a certain amount of buried coal is estimated to be in the north and the south.

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