ELECTRICITY OF VIETNAM
POWER COMPANY No. 1

SYSTEM EFFICIENCY IMPROVEMENT,
EQUITIZATION AND RENEWABLE PROJECT

ENVIRONMENT IMPACT ASSESSMENT

FOR
REHABILITATION OF THAC BAY
HYDROPOWER PLANT

Prepared by:
POWER ENGINEERING CONSULTING COMPANY No 1

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TABLE OF CONTENTS

1. INTRODUCTION
   1.1 General Introduction on the Background of Power Development in the Project Area and Relevant Environment Issues.
   1.2 Relevant Management Organization Structure
   1.3 Purpose of the Report
   1.4 Methodology

2. PROJECT DESCRIPTION
   2.1 Project Description
   2.2 General Layout of Thac Bay Hydropower Plant
   2.3 Resettlement Plan.

3. LEGAL BASIS, POLICIES AND ADMINISTRATIVE MANAGEMENT
   3.1 Requirement from investor to Environment Issues
   3.2 Feasibility Study Report
   3.3 Agreement on Project Site
   3.4 Environmental Management System
   3.5 Laws on Environment.

4. DATA
   4.1 Present Situation of Natural Environment in Na Tau Commune
   4.2 Present Situation of Thac Bay Hydropower Plant
   4.3 Content of Plant Rehabilitation and Upgrade.

5. ENVIRONMENTAL ISSUES
   5.1 Matters Mentioned During Rehabilitating Design Period
   5.2 Environmental Issues Mention During Implementing the Rehabilitation and Upgrade.
6. **MITIGATION MEASURES FOR NEGATIVE ENVIRONMENTAL IMPACT**

7. **EVALUATION OF REPLACING ALTERNATIVES**

8. **ENVIRONMENTAL MANAGEMENT PLAN**
   - 8.1 Mitigation Measures for Negative impacts
   - 8.2 Environmental monitoring
   - 8.3 Action Plan and Cost Estimation

9. **PUBLIC CONSULTATION AND DISCLOSURE**

10. **RESSETLEMENT**

11. **CONCLUSION**

**ANNEXES**
- ANNEX 1: Minutes of Meeting on dam safety for Thac Bay project with Electricity of Lai Chau
- ANNEX 2: Opinion of Lai Chau DOSTE on the EIA
- ANNEX 3: Minutes of Consultation Meeting with local communities on EIA
- Map of the Project
1 INTRODUCTION

1.1 General Introduction on the Background of Power Development in the Project Area and Relevant Environmental Issues

At present, the national grid transverses to Lai Chau in two transmission lines:
- Sa Pa - Phong Tho 35kV Transmission line.
- Son La - Tuan Giao - Dien Bien 110kV Transmission line.

There is one 110/35/22kV - 2,500kVA substation in Dien Bien Phu town. Thac Bay Hydropower Plant (Thac Bay HPP) is operating in connection with this system.

1.2 Relevant Management Organization Structure

The management of Thac Bay Hydropower Plant is belonged to Thac Bay Hydropower Department with 24 people working in a team. Electricity of Lai Chau who is one of the members of Power Company 1, Electricity of Vietnam, directly governs the department.

1.3 Purpose of the Report

The purpose of the report on environmental impact assessment is to clarify the impact from the rehabilitation and upgrade project to the natural environment, the economy and society on Na Tau commune, Dien Bien district, Lai Chau province and the area of Thac Bay Hydropower Plant, and water quality in the downstream of Nam Rom river. Therefore, it is possible to prevent negative impacts and develop advantage factors to improve the project capacity in electric energy supplying.

1.4 Methodology

Many methods of environment impact assessment are being used. For small hydropower plants, which cause little negative impact to the environment, methods of interrelated analysis in combination with direct observation is used to assess the environment impact.
2. PROJECT DESCRIPTION

2.1 Background of the project
Thac Bay Hydropower Plant was built in 1984. The Plant has been repaired and a part of equipment of the plant has been replaced.

Work Items of the Plant are as follows:

1. **Spillway**
   - Type of spillway: Stone masonry with concrete lined.
   - Height: 7.5m.
   - Crest length: 45m.

2. **Diversion Canal**
   - Type of canal: Triangular shape $b \times h = 3m \times 2.7m$.
   - Inclination: $i = 0.1\%$.
   - Length of Canal: 800m.
   - Design Discharge: 7.5m$^3$/s.

3. **Penstock**
   - Type of penstock: 12mm thick steel pipe.
   - Diameter: 2.0m.
   - Length: 72m.

4. **Powerhouse:**
   Open air type with an installed capacity of 2,400kW.

5. **Tailrace Canal:**
   Open air type with trapezium shape, stone masonry built.

**Present status of equipment in the plant are as follows:**

- **Turbine:**
  + Type: Horizontal Francis with metal spiral case.
  + Turbine Capacity: 914kW.
  + Design Head: 42m.
  + Country: Czechlovakia.

- **Generator:**
  + Type: 3 phases, synchronous, horizontal.
  + Nominal Capacity: 1075 kVA.
  + Nominal Voltage: 6.3kV.

- **Transformer:**
  + Capacity: 1600kVA.
  + Voltage: 6.3/35kV.
- **Auxiliary Transformer:**
  + Capacity : 400kVA.
  + Voltage : 6.3/0.4kV.

Since the Plant has been rehabilitated several times, electrical equipment were displaced. Old electrical equipment and backward structure has created irrationality.

Concurrently, there is no communication by telephone from the plant to Electricity of Lai Chau.

General Layout of the Thac Bay hydropower plant is shown in drawing No. 37.01-01TH-01.

This is a rehabilitation and upgrade project. It is not necessary to occupy lands, so no resettlement plan is proposed.

### 3. LEGAL BASIS, POLICIES AND ADMINISTRATIVE MANAGEMENT

#### 3.1 World Bank safeguards policies

The following World Bank's safeguards policies are relevant
- Environmental Assessment (OP 4.01, BP 4.01, GP 4.01),
- Pest Management (OP 4.09),
- Safety of dams (OP 4.37)

Bank Procedures BP 17.50: Public disclosure of Environmental and Social operation documents

- **Environmental Assessment:** This will be addressed in this EIA report
- **Publicity of Information**

During implementing the rehabilitation of the project, all workers shall temporarily change their jobs. This more or less affects their life. When the project completes, living and working condition surely be more improved. These workers have been given this information from their in charged leader (Electricity of Lai Chau)

Information about the rehabilitation and upgrade project, forecast on environmental changing caused by implementing the project, and other relevant information have been informed to Electricity of Lai Chau, who is responsible for supervising of the Thac Bay HPP; Thac Bay Hydropower Department; and People's Committees of Na Tau and Na Nhan communes since August 2001. Such information should be updated regularly and made public, so that relevant people can have opinion on it.

- **Dam Safety**

Thac Bay HPP is of conveyance work with low dam, creating a daily regulated reservoir (50,000m³ of regulated storage). The dam, also works as spillway, is built of masonry stones with concrete lined. Height of the dam is 7.5m.
The dam was built 15 years ago. During its operation, there has not been any incident. At present, the dam is in normal condition with high stability. According to in-situ investigation, calculation, and evaluations, PECC1 and Electricity of Lai Chau have issued a written confirmation on the long-term stability and safety of the dam (See Minute of meeting in annex part).

- **Pest management:**

The existing equipment is manufactured in 1989 and the transformers do not contain PCBs. The safeguard policy on pest management will therefore be not triggered.

### 3.2 Feasibility Study Report


### 3.3 Agreement on Project Site

This is a rehabilitation and upgrade project; all works related to the project will be carried out inside the under-operating plant, so this kind of agreement is not necessary. Electricity of Vietnam issued a document N°1940 EVN/KH-HDQT dated April 19th 2001 assigning Power Company 1 to be the Investor and PECC1 to prepare Feasibility Study Report on the Rehabilitation and Upgrade project for Thac Bay HPP. Contents of the document are shown in annex part.

### 3.4 Environmental Management System

- Ministry of Science, Technology and Environment (MSTE) is generally responsible for the managing of environmental protection at State level in the whole country, organizing and instructing all environmental protection activities and reviewing reports on environmental impact assessment of large projects.

- Provincial Department of Science, Technology and Environment is responsible to the provincial People’s Committee to carry out the managing of environmental protection at State level in the localities. This project is environmental category II and will therefore be supervised by DOSTE.

- Electricity of Vietnam (EVN) is the project investor responsible for the whole project including resettlement programs. EVN will supervise the establishment of specialized bodies in charge of the preparation and implementation of the project and will have to approve all decisions taken by the Project Management Board (PMB).

- Power Company (PC1): Apart from responsibility to manage the producing and operating of the Thac Bay Hydropower Plant, PC1 is also in charge of Project Management Board to coordinate all activities of the Project, including resettlement planning and implementation. In addition, PC1 is responsible for explaining the scope of the project to People’s Committees at various levels;
providing the budget for the rehabilitation and upgrade project; and reporting on the progress of project implementation to EVN and World Bank.

- Electricity of Lai Chau is responsible for guiding, monitoring and supervising the Environmental Impact Assessment (EIA) planning and implementation of the project; reviewing document on land acquisition and submitting to the Provincial People's Committee of Lai Chau to grant land within the province area; and monitoring, maintaining and repairing the plant periodically. Electricity of Lai Chau is responsible to PCI.

- The PMB, established by Power Company 1, is responsible for managing and supervising during the implementation of the project (the project belongs to Group C) to maintain quality and construction schedule as approved; directly solving arisen matters within its competence or report to PCI for instruction; making easy condition for construction team to fulfill their responsibilities; and regularly making environmental monitoring reports on all activities at the project site to Electricity of Lai Chau, PCI, EVN, the World Bank, and Lai Chau DOSTE.

### 3.5 Laws on Environment

- Law on environmental protection approved on 27th December 1993 by the National Assembly of Socialist Republic of Vietnam in Meeting Session 9th.

- The Government Degree No.175/CP dated October 18th 1994 on Guideline for implementing the Law on Environmental Protection.

- Environmental standards of Vietnam.


- World Bank safeguards policies as described above (3.1).

- Relevant documents to the process of survey, design, construction organization, and management and operation of Thac Bay Hydropower Plant.


- Minutes of meeting on the rehabilitation and upgrade of the Thac Bay HPP between PECC1 and Electricity of Lai Chau dated May 29th 2001.

### 4 DATA

Basis data for assessment of the environmental impact of Thac Bay Hydropower Rehabilitation and Upgrade Project consists of:

- Technical Construction and Design Document and final documents of the plant
4.1 Natural and Socio-economic Condition of Thac Bay Commune in General

Thac Bay is located in Na Nhan Village, Na Tau Commune, Dien Bien District, Lai Chau Province.

Na Tau, a commune of Dien Bien, is located on the northwest of Dien Bien town with a natural area of 15015.82ha, of which agricultural area is 923.74ha. The rest is 11105.66ha of wild lands. The area has a monsoon tropical climate with average temperature of 21.9°C, annual average rainfall of 1900mm, and air humidity of 84%.

According to statistics, in the end of the year 2000, the commune has 1392 households (7002 people) in 14 wards and villages. There are 4 main peoples in the commune: they are Thai, Kho Mu, H’mong and Kinh. They live mainly in agricultural producing.

According to current classification to analyze the socio-economic development in the whole country, Na Tau is belonged to economic region 2 (average economy). Living standard of people in the commune is rather good in comparison with the ones of the whole district. Average income per capita in the year 2000 is 2 million.

Though, operating the reservoir does not inundate cultivation area, it still has negative impacts on the agriculture process of the residents in the upstream of spillway. According to results of the survey carried out in June 2001, in Na Nhan village, right being close to the upstream of spillway, a land area has been filled with deposits of gravel and sand, so it is impossible to cultivate rice in such kind of land. Some other areas, which can cultivate 2 crops a year, now can only cultivate 1crop a year because the areas are inundated in flood seasons. The area is estimated of 2.5ha. Land ownership of such land areas is belonged to several households and co-operatives. The situation has been confirmed by households and leaders in Na Tau commune and Na Nhan village. It is reported that the situation has been informed to the local authorities but it has not been solved yet.

If the reservoir is not dredged in time, the danger of losing agricultural land in Na Tau will increase and this will have negative impact to farmers who are living along the river in the upstream of the project.

4.2 Present situation of project site.
4.2.1 Hydro-engineering Work

4.2.1.1 Reservoir

The reservoir with active design storage of 50,000m$^3$, daily regulated, was first operated in 1991.

Silts and sand have filled the reservoir to elevation of spill sill: 145m because the reservoir is not dredged every year. At present, the reservoir has no regulated storage and this affects the operation of the station and reduces power capacity. The danger of reservoir sedimentation is losing cultivating land in the upstream (as analyzed in item 4.1 above) and affecting households along the upstream riverbanks.

4.2.1.2 Intakes, Diversion Canal and Surge Tank

- Inlet Valve House has been degraded; and cement mortar layers of both inside and outside walls have been damaged. Windows, doors of the valve house have been degraded and damaged, too. This situation creates difficulty for managing and operating the valve house.

- Diversion Canal: Dimensions of diversion canal is b x h = 3 x 2.7m; its length is L = 800m; and it is built of masonry stones. The cement mortar layer inside the canal has been degraded and it is impossible to prevent water from absorbing out of the canal; and causing instability in many places along the canal as well as losses in capacity, head, etc. This situation has caused the reduction of power generating capacity.

- Surge Tank: The inside cement mortar layer has been degraded, too. This has caused water absorbing and unsafe condition during operating. Therefore, water losses and reduction of power generating capacity occur.

4.2.1.3 Penstock:

- The steel penstock has a diameter of D = 2m; length of 72m. There are supporting anchors and poles arranged along the penstock.

- Steel structure, anchors and supporting poles are still stable; there is no sign of instability (subsidence; slice; etc.).

- Penstock foundation is built of stones, cement mortar connecting stones with each other has been damaged; surface water can absorb through the stone layer, creating erosion inside the foundation. That is in danger and can cause deformation and sliding and unsafe condition for the plant.

4.2.1.4 Infrastructure

- Access Road System:

  Access road system of the station is 400m long, including roads from plant to surge tank, to switchyard, accommodation area, office area and to national highway NO.279 (Dien Bien - Tuan Giao).

  Structures of the road surfaces have been degraded; it is difficult for pedestrians and vehicles to travel along such road. The road is easily eroded in rainy weather.
There are two sections of road are in danger of erosion (one is close to national highway No.279 and one close to the plant).

- Spilling passage through Nam Rom river: it is situated in the access road system to the plant (on the T-junction with national highway No.279) and the spilling passage was swept away by the flood water, so it is impossible for vehicles to transport equipment and construction material to the plant through this passage.

### 4.2.2 Hydro-mechanical Equipment

**Hydro-mechanical equipment system**

The hydro-mechanical equipment system has been degraded. Runners, Guide Vanes have been abraded, cannot maintain technical parameters as designed. They should be replaced with new one.

**Electrical equipment**

The diagram of current situation of equipment is backward now; transportation is complex with low safety and possible to breakdown.

With such instable situation of the headwork and the above-mentioned equipment, the plant can only generate with 70% to 86% of design capacity. Maybe in three or five years later, the plant can work with only 50% capacity; and after 5 years it will be closed.

### 4.3 Contents of Rehabilitate and Upgrade Thac Bay Hydropower Plant.

#### 4.3.1 Hydro-engineering Work

- **Reservoir**
  Dredge the reservoir bed; volume of dredging is 33,830m$^3$.
  Plaster a new cement mortar layer for the whole canal be with a length of 600m.

- **Canal Inlet Valve House and Penstock Inlet Valve House**
  Walls of each Valve House shall be plastered (both inside and outside).
  All doors and windows shall be replaced. Floors shall be paved with granite bricks.

- **Penstock**
  Strengthen penstock foundation with a 10cm concrete layer (D100).

#### 4.3.2 Hydro-mechanical and Hydro-engineering Mechanical Equipment

- Construct and install a new valve control system (electrical operated).
- Replace new control equipment for emergency penstock inlet valve (Diameter is 2000).
- Replace new bearing balls and thrust bearings for turbine and generator.
- Equip new machines and tools for repairing work (one driller, welding machine, one turning lathe, and one grinder)
4.3.3 **Electric Equipment**
- Install completely new 6kV distribution cubicles (including cubicles for breaker, measure, neutral and circuit breaker and fuse).
- Install a new excitation control system of 3 units.
- Install new measuring and protecting systems of generator, transformer, and transmission line.
- Replace the old battery system with a dry battery cubicle in completed set.
- Install new charger and 110V auxiliary cubicle.
- Replace 35kV current transformers and voltage transformers

4.3.4 **35kV Distribution Equipment**
- Replace 35kV current transformers and voltage transformers

4.3.5 **Cables**
- Replace the whole cable system.

4.3.6 **Lighting System and Air Conditioner**
- Install a new Lighting System both inside and outside of the Plant.
- Install Air Conditioning System.

4.3.7 **Earthing System**
- Connect earthing system with new installed equipment.

4.3.8 **Communication System**
- Install a new digital communication system that can be in contact with Electricity of Lai Chau 24/24 hours.

4.3.9 **Infrastructure**
- Upgrade the 400m-long access road. Pave it with a 21cm asphalt macadam layer and a 20cm aggregate foundation.
- Design to renew the road surface with a thickness of 12cm, 6kg/m².
- Embank sloppy roof on the sides of 2 stretches of access road (defined at site) with masonry stone.

Design Spilling passage through Nam Rom river: The passage is designed to face up with flood frequency 10%; width of the passage is 7m and is it concrete structure
## WORK TO BE REHABILITATED AND UPGRADED

### Table 1

<table>
<thead>
<tr>
<th>N°</th>
<th>Work item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Hydro-engineering</strong></td>
</tr>
<tr>
<td></td>
<td>- Dredging of the reservoir.</td>
</tr>
<tr>
<td></td>
<td>- Removal of the old cement mortar layer and plastering with a new one, and anti-absorbing of the whole 600m long canal.</td>
</tr>
<tr>
<td></td>
<td>- Canal inlet valve house and penstock inlet valve house: removal of the old cement mortar layers and plastering with new ones both inside and outside of the walls; and replacement of doors and windows, paving of floor with granite bricks.</td>
</tr>
<tr>
<td></td>
<td>- Strengthening of penstock foundation with a 10cm layer of D100 concrete.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Hydro-mechanic and engineering mechanic</strong></td>
</tr>
<tr>
<td></td>
<td>- Repairing of hydraulic control equipment for intakes of canal and penstocks</td>
</tr>
<tr>
<td></td>
<td>- Equip a control system for inlet butterfly valve to the plant</td>
</tr>
<tr>
<td></td>
<td>- Repairing of turbine inlet butterfly valves (diameter of 2000mm).</td>
</tr>
<tr>
<td></td>
<td>- Replacement of six bearing balls, three turbine shaft balls.</td>
</tr>
<tr>
<td></td>
<td>- Replacement of 06 balls of 3 generators.</td>
</tr>
<tr>
<td></td>
<td>- Replacement of three sets of runners and three sets of guide vanes</td>
</tr>
<tr>
<td>3</td>
<td><strong>Electrical equipment</strong></td>
</tr>
<tr>
<td></td>
<td>- Rehabilitation of 6kV distribution equipment system according to new diagram.</td>
</tr>
<tr>
<td></td>
<td>- Replacement of static excitation control system of the three units.</td>
</tr>
<tr>
<td></td>
<td>- Replacement of battery, battery chargers, 110V auxiliary cubicle, AVR</td>
</tr>
<tr>
<td></td>
<td>- Replacement of 35kV current transformers and voltage transformers.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td></td>
<td>- Construction of a digital communication system serving 24/24 hours connecting the plant with Electricity of Lai Chau via directory inquiries.</td>
</tr>
<tr>
<td></td>
<td>- Construction of an area with flowers and trees together with a water supplying system.</td>
</tr>
<tr>
<td></td>
<td>- Upgrade of the access road, with a 12cm surface layer of asphalt gravel and a 20cm stone layer of foundation. Embankment of two sections along the access road with masonry stone (defined at site).</td>
</tr>
<tr>
<td></td>
<td>- Designing of spilling passage through Nam Rom river.</td>
</tr>
</tbody>
</table>
MAIN QUANTITY OF THE REHABILITATION AND UPGRADE WORK

Table 2

<table>
<thead>
<tr>
<th>No</th>
<th>Items</th>
<th>Unit</th>
<th>Quantity</th>
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<tr>
<td>1</td>
<td>Excavation, soil</td>
<td>m³</td>
<td>34,642.00</td>
</tr>
<tr>
<td>2</td>
<td>Filling, soil</td>
<td>m³</td>
<td>100.00</td>
</tr>
<tr>
<td>3</td>
<td>Excavation, weathered rock</td>
<td>m³</td>
<td>325.00</td>
</tr>
<tr>
<td>4</td>
<td>Construction, stone</td>
<td>m³</td>
<td>2,848.80</td>
</tr>
<tr>
<td>5</td>
<td>Plastering, cement mortar</td>
<td>m²</td>
<td>8,120.00</td>
</tr>
<tr>
<td>6</td>
<td>Concrete, various type</td>
<td>m³</td>
<td>553.26</td>
</tr>
<tr>
<td>7</td>
<td>Steel</td>
<td>ton</td>
<td>14.80</td>
</tr>
<tr>
<td>8</td>
<td>Doors and windows</td>
<td>m²</td>
<td>217.00</td>
</tr>
<tr>
<td>9</td>
<td>Paving floor, bricks</td>
<td>m²</td>
<td>586.00</td>
</tr>
<tr>
<td>10</td>
<td>Paving roads, macadam</td>
<td>m²</td>
<td>1,400.00</td>
</tr>
<tr>
<td>11</td>
<td>Flower and tree planting</td>
<td>m</td>
<td>400.00</td>
</tr>
</tbody>
</table>

5 ENVIRONMENTAL ISSUES

5.1 Matters mentioned during rehabilitating design period

5.1.1 Land-use issue

The rehabilitation and upgrade project will be completely carried out inside the old plant, so there is no impact to the regional land resource.

Dredging the reservoir will prevent sedimentation overflow to cultivating lands of the local residents in Na Tau commune along Nam Rom river.

5.1.2 Eco-System

The rehabilitation and upgrade project will be implemented in a modest area. No land or natural resources will be occupied for the project (only implemented inside the old plant), so there will be no negative impact on the eco-system. Inside the project area there are no valuable animals living.
5.1.3 **Climate**

The implementation of project doesn’t cause any negative impacts to the local climate.

5.1.4 **Water Supply**

During the project is implemented; water in the downstream will be turbid due to the dredging of the reservoir. However, construction time for dredging is short (1 month), so this matter can be solved quickly.

Substances that can pollute water are: waste water from the staff areas, water used for maintenance and periodical reparation of machines, water from rain and solid wastes such as oil cleaning dusts, rubbish, papers and nylon bags etc...

This quantity of waste is inconsiderable to Thac Bay hydropower plant as it is collected and treated to prevent the pollution of the water.

5.1.5 **Agriculture**

The implement of project doesn’t cause any negative impacts to the agriculture. On the other hand, when the production of electricity is stable the demand on electricity for agriculture will be more ensured.

5.1.6 **Irrigation**

As well as in agriculture, irrigation activities shall be ran more effectively when electricity to be stably supplied.

5.1.7 **Energy**

Energy of the hydropower plant is clean without waste gas and pollution. The purpose of implementing the rehabilitation and upgrade project is to have a plant with stable production capacity of 10 million kWh/year, equivalent to 3000 tons of oil. Using this energy resource can reduce a considerable quantity of waste to the environment in comparison with using coal. This is typical characteristic of hydropower plants. However, stop operating every three month according to design for periodical rehabilitation and upgrade shall loss a certain quantity of energy, therefore it is necessary to reasonably arranged time of stop operating for the plant.

5.1.8 **Minerals, Industry and Small Scale Industry**

Industries always require stable electric supplying. Every electric fault will cause the serious loss. Rehabilitation and upgrade of the plant is an important factor to improve the quality of electric supplying. This project completely does not obstruct to these industries. On the other hand, it is a positive factor for speeding up the regional development.

5.1.9 **Entertainment and Health Care Protection**
Thac Bay is a tourist area in Dien Bien Phu. The rehabilitation and upgrade project of Thac Bay HPP will improve the environmental scenery in Dien Bien Phu.

5.2 Environmental Issues Mentioned During Implementing the Rehabilitation and Upgrade Project

5.2.1 Obstruct the Flow
Carrying out to dredge 33,830 m$^3$ of sediment in the reservoir bed by 1.25 m$^3$ dredger and transporting by trucks to waste area in the upstream will not affect or obstruct the flow.

5.2.2 Water Quality in the Downstream
In the downstream of the project is Lai Chau town. Demand on water in this area is for irrigation purpose. The temporary turbidity of water in 1 month will not affect significantly the water supply for irrigation.

5.2.3 Construction Material and Solid Waste Discharging
Construction material and solid waste are collected to an upstream waste yard on the right bank, 5 km far from the project site. This is a bushing area far from the people resident so it does not affect the local environment.

Dredging waste materials are sands and have no toxic contamination. Disposal options include general land-fill materials for new construction, filling or liner materials for an appropriate site, or as capping materials for a landfill. The place for disposal of the dredging materials will be discussed and agreed upon with the Dien Bien Phu town, or Na Tau commune authorities.

5.2.3 Noise
Since the volume of work, number of machines and equipment is not much, and the capacity is small and in addition the site is far 5 km from the residential area, noise impacts to the regional inhabitants is inconsiderable.

5.2.3 Impact from Worker's camping
Number of worker for the rehabilitation is about 30 - 40 people. In this time plant is temporary closed so plan of the plant shall be used for the camp to reduce the tree cutting down, and the negative impact to the vegetation debris in area.

5.2.4 Labour Safety
In order to ensure the labour safety, all units participating in the project construction should be well prepared in safety condition, with safety working
clothes and tools. Labour safety activities of each worker should be regularly checked. It is necessary to work in conform to the labour safety.

5.2.5 PCBs disposal and management
The existing equipment has been replaced since 1984 and is rather new. The transformers do not contain PCBs and therefore no specific management or disposal plan for PCBs will be required.

5.3 Environmental Impact caused by Resettlement
As mention above, there is no resettlement program for the rehabilitation and upgrade project.
MITIGATION MEASURES FOR NEGATIVE ENVIRONMENTAL IMPACT FROM THE PROJECT

- Construction Schedule should be set so reasonably that the plant can stop operating for rehabilitating and upgrading in dry seasons so that electric energy loss is minimized.

- While the plant stops operating for rehabilitating and upgrading, the loss of electric energy is about 3.5 million kWh, therefore it should be informed in advance to Power Company 2 to prepare electric supplying for daily consumption.

- Arrange replacing jobs for workers during the stop working time to ensure the their life and for their family.

- Arrange camps reasonably to limit the negative impact to the vegetation debris in area.

- Waste discharged from the construction work should be collected to waste yard and treated well to keep environmental hygiene.

- The old replaced equipment should be stored and transported to the specified area.

- Reservoir soil dredged by machine and moved to 5 km of project’s upstream by vans. This place was agreed by local authority. It doesn’t influence the environment. It is necessary to rapidly dredge the reservoir to have normal water flow for the downstream. It is required to reduce to a maximized level the discharging of construction material, waste, and refuse into the Nam Rom river to protect the water resource from polluted.

- Noise: To reduce noise, automatic governing equipment should be replaced and turbine and generator should be upgraded. However, the plant is far from residential area, so it does not affect local residents. Noise reduction is to save health of operating workers.

- Temperature: To save health of operating workers, it is necessary to design a separated central control room equipped with equipment that can reduce temperature in summers and keep warm temperature in winters.
EVALUATION OF THE REPLACING ALTERNATIVES

The purpose of the project is to rehabilitate and upgrade stable electricity together with national grid so that it can supply for regions far from the load center.

The feasibility replacing alternatives in this situation shall be as follows:

- Replace with a diesel power supply
  
  Alternative to replace with a local diesel power supply: this alternative can be quickly but it has some disadvantages: high cost and pollution of the surrounding environment.

- Supplement with electric power generated from the national grid.
  
  Alternative to supplement with electric power generated from the national grid can be implemented since we already have the electric power grid. However, there is still no supplemented power supply since the electricity generated to the nation grid is limited to the increasing load demand. This alternative would not have major environmental impacts. Some very minor impacts could be as tree cutting and construction of tower pads leading to an increased soil erosion.

- Construction some new small hydropower station in the area.
  
  To construct some new small hydropower stations in the area will take long time and may occupy land or may resettle residents in the project area, etc. with high costs.

Hence, it is feasible to carry out the rehabilitation and upgrade project in this period. Contents of the rehabilitation and upgrade alternative have been mentioned in Item 4.3.
8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Mitigation Measures for Negative Impacts

Construction work in the rehabilitation and upgrade includes soil and rock excavation, concrete casting, rock built, brick paving, plastering, roofing, installing and dissembling of equipment; and renewing road surfaces, etc,...

- Soil and rock excavation, plastering, rock built, brick paving, roofing will be carried out by executing.
- Concrete casting is carried out by machine in combination with manual ways.
- Installing and dissembling of electrical and hydro-mechanical equipment is carried out by manual ways in combination with using winch and crane in the plant.
- Dredging sand from reservoir is carried out by using dredgers and transported by van to the waste area. Quantity of work is specified in table 1.

The construction site and local material exploitation area (for sand, stone and gravel) is in Na Nhan village, Na Tau commune, Dien Bien district.

Concrete, steel, timber, etc, are supplied from Dien Bien Phu town, 15km far from the site.

According to Table 1, we can see that quantity of material to be transported is not much: about 350tons of cement, 15tons of steel (various types), and dozens of tons of other materials. Transporting distance is short, only 15km, so it is possible to transport the above-mentioned materials in weekends or in the time transportation density is little. Therefore, it will reduce traffic jam. Negative impacts from the transportation of material from Dien Bien Phu to the construction site are inconsiderable.

Quantity of exploiting material (sand, stone, gravel) is not much: 4600m$^3$ of stones and gravel; other 10,000m$^3$ will be exploited in the site area, so there are no impacts to local environment and eco-system. The transportation of material is carried out in a small area where there are not many residents living in, so it does not affects people's health.

Installation work in the project is: dissembling of needed replacing equipment and installing new equipment.

Material and equipment are easy to dissemble so arranging and collecting such material and equipment is easy, too.

Collecting oil and grease when dissembling equipment, such as governor and turbine, so that it can limit the environmental pollution.

Electricity of Lai Chau is responsible to arrange work and support in finance for labour force of the plant while implementing the project. Labour force of the plant is supposed to arrange as follows:

- Participating in the Project management board.
- Participating in some other work of the project.
- Having suitable work in offices of the electricity of Lai Chau.
- Stop working and having allowance (as agreed)

Making a list of the affected households, planning suitable electricity supplying plan to maintain quantity and quality of electricity supplying so as not to affect households who are using electricity supplied by Thac Bay HPP.

Taking seriously the labour safety supervision, especially to workers who are carrying out complicated work so as to reduce working accidents.

Special measures to ensure the dam stability will be applied, based on the available technical design data and additional checking of the technical features.

8.2 Environmental monitoring
- The Environmental monitoring and management should be carried out regularly. The project has a small reservoir and modest site area, affects to the environment is not much, so it is not necessary to have specialized officials to supervise and manage this kind of work. The environmental monitoring and management of the mitigation measures can be carried out regularly by the existing staff of the Plant to improve their experience and to have treatment timely (Such staff should be trained in specialization).
- Contents of the monitoring and supervising work during the rehabilitation and operation are specified in Table 3 and 4 in the annex part.
- Dam safety will be monitored

8.3 Action Plan and Cost Estimation

8.3.1 Rehabilitation and Upgrade Plan

Time for implementing the project is 01 year. Total Cost for the project is VND 13,408,322 thousand (Details are shown in “Feasibility Study Report”).

8.3.1 Environmental Management Plan

As stated above, an engineer who is responsible for operating will be employed to supervise the environment management plan during implementing the project as well as in long term. Details are shown in Table 3 and 4.

Total cost for the whole environmental management plan is MVND 187; details as follows:

1. Cost for training management and operation staff: VND 10,000,000
   2,000,000 VND/person x 5 persons

2. Cost for supervision, checking and implementation for environment protection measures during construction phase*: VND 60,000,000

3. Annual Cost for supervision, checking and implementation for environment protection measures**: VND 100,000,000
   4,000,000 VND/y x 25 years

Subtotal VND 170,000,000
4. Contingency: 10% (1+2+3) VND 17,000,000
   
   Total VND 187,000,000
   
   Total (by USD, Ex.rate: USD1 - 15000 VND) USD 12,467

1. Environment costs during construction consist of:
   
   - Salary of 4 officers in 12 months will be used to pay for supervisors who do extra work (apart from working in their specialized aspects):
     
     \[1,000,000 \times 4 \times 12 = 48,000,000 \text{ VND}\]
   
   - Cost for taking and having water samples analyzed: VND 2,000,000
   
   - Costs for travel, stationary, equipment: VND 10,000,000 (MVND 10)

2. Environment costs during operation:
   
   - Annual monitoring of environment and water measuring and analyzing over 25 years is: VND 50,000,000 (MVND 50).
   
   - Cost for officers of the plant to work as environment supervisors to monitor environmental issues over 25 years is: VND 50,000,000 (MVND 50)

The Environment Impact Assessment Report on the Rehabilitation and Upgrade Project of Thac Bay Hydropower Project in Lai Chau Province has been reviewed by the Department of Science, Technology and Environment of Lai Chau Province. The Review report concluded that the project does not have any negative impacts on the natural environment and local socio-economy, and the project is supported to be implemented (Environmental certification issued by Lai Chau DOSTE is attached in the annex part).
### A - MITIGATING PLAN

<table>
<thead>
<tr>
<th>Phase</th>
<th>Issue</th>
<th>Mitigating Measure</th>
<th>Cost</th>
<th>Institutional Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Installation</td>
<td>Operating</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td><strong>Flow obstruction</strong></td>
<td>Suitable construction plan, included in tender document of construction and installation parts</td>
<td>Included in the cost for construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td><strong>Construction material, waste</strong></td>
<td>Suitable construction plan, tight construction supervision, suitable tanks for waste collecting.</td>
<td>Included in the cost for construction</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td><strong>Noise</strong></td>
<td>No influence, far from residential areas</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td><strong>Tree cutting, affected vegetable cover</strong></td>
<td>Tight monitoring, supplying sufficient wood/timber for construction.</td>
<td>Little</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td><strong>Camps</strong></td>
<td>Suitably arranged with WC area as regulated.</td>
<td>Little</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td><strong>Labour Safety</strong></td>
<td>Instruction about labour safety, supplying sufficient labour safety tools and equipment</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td><strong>Resettlement</strong></td>
<td>No influence because there is no residential inundated area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Deforestation</strong></td>
<td>There are only hills with grass and bushes in the project area. Tight management of tree cutting</td>
<td>Little</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td><strong>Dam safety</strong></td>
<td>Safety measure to ensure the stability of the dam</td>
<td>Included in the construction cost</td>
<td>Constructor</td>
</tr>
<tr>
<td>Phase</td>
<td>Issue</td>
<td>Mitigating Measure</td>
<td>Cost</td>
<td>Institutional Responsibility</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Installation / Operating</td>
<td>Institution / Operating</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Installation / Operating</td>
<td>Institution / Operating</td>
</tr>
<tr>
<td>OPERATION</td>
<td>Flow obstruction</td>
<td>Inconsiderable because the weir is low with a height of 4m.</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Waste (oil, grease) from Construction material</td>
<td>Check, collect and treat timely</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>No influence, far from residential area</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Tree cutting, affected vegetable cover</td>
<td>None</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Camps</td>
<td>None</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Labour Safety</td>
<td>Instruction about labour safety, supply sufficient labour safety tools and equipment</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Resettlement</td>
<td>No influence because there is no residential inundated area</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td></td>
<td>Deforestation</td>
<td>Tight management of tree demolishing and uncontrolled deforestation in the upstream area</td>
<td>Included in costs for the Provincial Forestry</td>
<td>Electricity of Lai Chau &amp; People committee at various levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### B. MONITORING PLAN

<table>
<thead>
<tr>
<th>Phase</th>
<th>What parameter is to be monitored?</th>
<th>Where is the parameter to be monitored?</th>
<th>How is the parameter to be monitored/type of monitoring equipment?</th>
<th>When is the parameter to be monitored - frequency of measurement of continuous?</th>
<th>Why is the parameter to be monitored (operated)?</th>
<th>Cost</th>
<th>Institutional Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality</td>
<td>Downstream of Powerhouse</td>
<td>Taking sample and analyzing of 12 chemical factors</td>
<td>Completion of the Project</td>
<td>To see if water quality affects the downstream</td>
<td>VND 10,000,000</td>
<td></td>
<td>Electricity of Lai Chau and DOSTE</td>
</tr>
<tr>
<td>Waste, Oil and grease</td>
<td>Machinery Hall, Transformer Housing</td>
<td>Check to see if there is any leakage of oil and grease. If yes, does the oil and grease flow to the collecting tank or not? Is other kind of waste collected to a proper place or not?</td>
<td>During Construction</td>
<td>To see if there is environmental pollution due to waste.</td>
<td>Little</td>
<td></td>
<td>Contractor for Construction and Installation</td>
</tr>
<tr>
<td>Noise</td>
<td>Power House</td>
<td>By listening. Normal</td>
<td>Regularly</td>
<td>If it is more than usual level, hire equipment to measure.</td>
<td>Little</td>
<td></td>
<td>Contractor for Construction and Installation</td>
</tr>
<tr>
<td>Dust</td>
<td>Project Site</td>
<td>By observing</td>
<td>During Construction</td>
<td>If there is too much dust, eject water</td>
<td>Little</td>
<td></td>
<td>Contractor for Construction and Installation</td>
</tr>
<tr>
<td>Dam stability</td>
<td>Dam</td>
<td>Checking of technical features</td>
<td>During construction</td>
<td>To ensure the safety of the dam</td>
<td>Supervision</td>
<td></td>
<td>Supervision constructor</td>
</tr>
<tr>
<td>Environmental supervising</td>
<td></td>
<td>Salary for environmental supervising during construction</td>
<td></td>
<td>VND 48,000,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase</td>
<td>What parameter is to be monitored?</td>
<td>Where is the parameter to be monitored?</td>
<td>How is the parameter to be monitored/type of monitoring equipment</td>
<td>When is the parameter to be monitored - frequency of measurement of continuous?</td>
<td>Why is the parameter to be monitored (operated)?</td>
<td>Cost</td>
<td>Institutional Responsibility</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------</td>
<td>------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>--------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Water quality</td>
<td>Downstream of Powerhouse</td>
<td>Taking sample and analyzing of 12 chemical factors</td>
<td>December, annually</td>
<td>To see if water quality affects the downstream</td>
<td>VND 50,000,000</td>
<td></td>
<td>Electricity of Lai Chau and DOSTE</td>
</tr>
<tr>
<td>Waste, Oil and grease</td>
<td>Machinery Hall, Transformer Housing</td>
<td>Check to see if there is any leakage of oil and grease. If yes, does the oil and grease flow to the collecting tank or not? Is other kind of waste collected to a proper place or not?</td>
<td>Every 6 month, during operation</td>
<td>To see if there is environmental pollution due to waste.</td>
<td>Little</td>
<td>Little</td>
<td>Electricity of Lai Chau and DOSTE</td>
</tr>
<tr>
<td>Noise</td>
<td>Power House</td>
<td>By listening. Normal</td>
<td>Regularly</td>
<td>It is more than usual level.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>Project Site</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water flow</td>
<td>Downstream</td>
<td>Water level and water flow</td>
<td>Dry and rainy seasons</td>
<td>Change in the hydrological regime and the impacts on downstream fishery and agriculture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental supervising</td>
<td>Salary for environmental supervising during operation</td>
<td></td>
<td></td>
<td></td>
<td>VND 50,000,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9  PUBLIC CONSULTATION AND DISCLOSURE

During implementation the rehabilitation and upgrade project, all the workers working in the plant have to stop or change their work, and their life maybe more or less affected. When the project is completed, their living and working condition will be improved. Such workers have been informed about the project by Electricity of Lai Chau (their management board).

The implementation of the project was informed to and asked for opinion from engineers and workers in Thac Bay Department and local authorities (people’s committees of Na Tau commune and Dien Bien district) in June 2001. Records of these meetings are provided in Annex 2. Information about the project and the summary of the environmental assessment was sent in January 2002 to Cultural Center of Na Tau commune to be displayed and broadcasted for the public information and comments. Local NGOs such as the Women Union, the Youth Union, the Farmer Union and the Fatherland Front were invited to provide comments. This public consultation process took place in the end of February 2002. Records of these meetings are provided in Annex 3.

Copies of the EA summary and the Environmental Management Plan (EMP) have been displayed at a public place such as DOSTE and the Na Tau commune people’s committee from January 8, 2002 for four months for public comments.

In general, no major environmental issues have been raised and the mitigation and monitoring plans for the project have been agreed in principle and highly supported by the above-mentioned people and offices.

Electricity of Lai Chau has got an agreement on the arrangement of suitable work for workers of Thac Bay HPP during the implementation of the project so as not to have negative impacts to living condition of the workers as well as their families (the agreement is enclosed in annex part).

10. RESETTLEMENT

Thac Bay HPP has been operating since 1991. The Resettlement Plan had been completed before the plant came into operation. Resettled households are having stable life with local community. The rehabilitation and upgrade project will be carried out completely inside the existing plant. Other areas such as material area, workers’ camping for the construction work, and waste area, etc, are all inside the existing plant, too. There are no more land area or residential area to be occupied for the project, so it does not affect local residents. Therefore, there is no resettlement plan in this project.
11. CONCLUSION

Carrying out the rehabilitation and upgrade of the Thac Bay HPP in this period is necessary. Dien Bien Phu town is far from the large national electricity grid. Supplying electricity for this area is only come from Hoa Binh 110kV transmission line, so the probability of stopping supplying electricity is high. To maintain the local electricity source is very essential and has a special significant for the development of the economic and social of the Dien Bien Phu in particular, as well as to Lai Chau province in general. Negative impacts from the project are inconsiderable. Other small ones can be solved easily with little costs. There is no resettlement area in the project is also an advantage for the implementing of the project. It is suggested to carry out the project as soon as possible.
ANNEX
ANNEX 1
THE SOCIALIST REPUBLIC OF VIETNAM
Independence - Freedom - Happiness

MINUTES OF MEETING
IDENTIFYING THE DAM SAFETY OF
THAC BAY HYDROPOWER PROJECT IN LAI CHAU PROVINCE

I. PARTICIPANTS

   - Mr. Le Hao: Project Manager.

2. Electricity of Lai Chau: The Management Board.
   - Mr. Nguyen Van Tao: Director
   - Mr. Cao Ngoc Lac: Vice General Director.
   - Mr. Pham Minh Cuong: Head of Construction Management Department.
   - Mr. Tran The Luy: Deputy Head of Construction Management Department.
   - Mr. Nguyen Quang Ket: Deputy Head of Technical Department.

II. CONTENTS

1. Salient Features of the Dam:
   - Dam Structure: Rock built dam with reinforced concrete lined (is of small type).
   - Max. Height: H = 7.5m.
   - Crest Length: L = 45m.
   - Design Flow 1%: Q = 747 m³/s.
   - Dam Foundation: Situated on a primitive basalt rock layer.

2. Identify the Dam Safety
   Based on the field investigation and a process of observing and evaluating the dam operation, a conclusion has been made: The Dam of Thac Bay Hydropower Project has a high stability that is completely safe for the operation of the plant in long-term.

Lai Chau, 2001

Electricity of Lai Chau

(signed)

Power Engineering Consulting Company 1

(signed)

NGUYEN VAN TAO

LE HAO
ANNEX 2
THE SOCIALIST REPUBLIC OF VIETNAM
Independence - Freedom - Happiness

REVIEW OF
REPORT ON THE ENVIRONMENTAL IMPACT ASSESSMENT
AND RESETTLEMENT ACTION PLAN
REHABILITATION AND UPGRADE OF THAC BAY HYDROPOWER PLANT
LAI CHAU PROVINCE
(Feasibility Study Stage)

I. 1. Comment

1. The Report on Environmental Impact Assessment and Resettlement Action Plan of the Rehabilitation and Upgrade Project for Thac Bay Hydropower Plant prepared by Power Engineering Consulting Company 1 (PECC1) has completely described and evaluated all the impacts of the Project to the regional environment and socio-economy where the project will be implemented.

2. The Rehabilitation and Upgrade Project for Thac Bay Hydropower Plant (Thac Bay HPP) will be implemented right in the old plant area. Thac Bay HPP was first commissioned in 1991. Work volume of the Project is small. The rehabilitation and upgrade mainly concentrate on replacing hydro-mechanical and electrical equipment.

Therefore,

- The Project has no negative impact on the regional environment and socio-economy. Vice versa, it has many positive impacts, such as creating a stable electricity and socio-economy development as well as developing traditional jobs in the locality.

- The Project has no resettlement plan.

3. Mitigation Measures for Environment

- While implementing the Rehabilitation and Upgrade Project, the plan has to stop generating, so time for implementing the project in 1 year is reasonable. However, it is necessary to have another source to supply electricity for the local production and living (electricity may be supplied from the National Grid).

- The Electricity of Lai Chau should have a plan to arrange works for the plant staff while the project is implemented, so that it cannot affect to income of workers.

4. Environmental Management Plan

- The Mitigation and management Plan mentioned in the Report is reasonable.

II. II. Conclusion

- The Rehabilitation and Upgrade Project for Thac Bay Hydropower Plant has no negative impact on the natural environment and the regional socio-economy.

- The project has no resettlement plan.

- Local population all agreed to implement the Project.

Lai Chau, 2001 -
Science, Technology and Environment Department
of Lai Chau Province
(signed)
MINUTES
(COMUNITY CONSULTANCY ON IMPACTS OF REHABILITATION WORKS OF THAC BAY HYDROPOWER STATION)

The meeting opened at 1.30p.m on November 20th 2001.
Place: Na Tau commune, Dien Bien district, Lai Chau province.
Subject: Consulting local community on the rehabilitation and refurbishment of Thac Bay hydropower station.

I. Attendants:
I. Representatives from Lai Chau Electricity Service (Management organ) including:
   i. Nguyen Van Tao Director, and;
   ii. Tran The Luy Vice Head of Construction Management, and;
   iii. Mr. Nguyen Quang Ket Vice Head of Technical Department.
I. Representatives from Na Tau commune authorities including:
   iv. Mr. Lo Van Phuong Chairman of People’s Committee, and;
   v. Mr. Quang Van Tien Chairman of Veterans’ Organization, and;
   vi. Mrs. Lo Thi Khia Chairperson of Women’s Organization, and;
   vii. Mr. Lo Van Binh Chairman of Peasant’s Organization, and;
   viii. local residents.

II. Contents and Comments
The Director of Lai Chau electricity Service presented scale of rehabilitation work at Thac Bay hydropower station, which including:
- Rehabilitation and refurbishment of electric equipment, hydro-mechanical equipment and hydraulics equipment;
- Rehabilitation and refurbishment of civil works including that of headrace, powerhouse structures and management building, access road and a road over Nam Rom river.
- The Rehabilitation and refurbishment works were proposed to be carried out in 1 years.

All attendants agreed with the following conclusions:

- Rehabilitation and refurbishment of Thac Bay hydropower station is necessary and reasonable.

- The refurbishment works will create a good chance for the local economy and raise up the power supply ability of the station to the local grid and the National Grid as well.

- The rehabilitation and refurbishment works creates no impacts on natural environment and social-economic situation.

- No compensation and resettlement are required as a results of the works.

- All attendants agreed and supported the rehabilitation and refurbishment of Thac bay hydropower station.

It was proposed that the project would be approved by authorities in order to put it in to exercise.

\[\text{NA TAU COMMUNE AUTHORITIES}\]

Veterans' Organization

Women's Organization

Peasant's Organization

Chairman of People's Committee

Technical Department

\[\text{LAÏ CHAU ELECTRICITY}\]

Director

(signed)

(signed)

(signed)

(signed)

(signed)
GENERAL LAYOUT

Scale: A

Improving reservoir

Improving access road

Improving 36kV Substation

Improving canal

LEGEND:

1. Powerhouse
2. Penstock
3. Basin
4. Outlet
5. Chute
6. 35kV Substation
7. Canal
8. Surface water drain
9. Spillway
10. Intake
11. Masonry dam
12. Reservoir

NOTE:

1. This drawing is established based on construction drawing of Thac Bay hydropower and from factual situation.
2. Dimensions are in m, elevations are in m.

ELECTRICITY OF VIETNAM POWER ENGINEERING CONSULTING COMPANY LTD.

IMPROVEMENT

THACBAY HYDROPOWER STATION

GENERAL LAYOUT

Drawn by...

Reviewed by...

Checked by...

Designed by...
Thacbay Hydropower plan