

**Kingdom of Cambodia  
Ministry of Industry, Mines and Energy**

**Project for Operation and Maintenance  
of the Rural Electrification on Micro-hydropower  
in Mondul Kiri**

**Final Report**

**March 2011**

**Japan International Cooperation Agency**

**Electric Power Development Co.,Ltd. (J-POWER)**

**The Chugoku Electric Power Co.,Inc. (ENERGIA)**

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## Abbreviations

Abbreviation	Description
B/D	Basic Design
CP	Counterpart
DIME	Department of Industry, Mines and Energy
EAC	Electricity Authority of Cambodia
EDC	Electricité du Cambodia
E/N	Exchange of Note
EUMP	Electric Unit of Mondul Kiri Province
F/S	Feasibility Study
GREPTS	General Requirements on Electric Power Technical Standards
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
JICA Project Team	JICA Experts/ Advisory for the Project
kW	Kilo Watt
kWh	Kilo Watt hour
MEF	Ministry of Economy and Finance
MIME	Ministry of Industry, Mines and Energy
M/M	Minutes of Meeting
MOE	Ministry of Environment
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources and Meteorology
NGO	Non-Governmental Organization
NIS	National Institute of Statistics
O&M	Operation and Maintenance
ODA	Official Development Assistance
PPA	Power Purchase Agreement
Pre-FS	Pre-Feasibility Study
The Project	Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower in Mondul Kiri
REE	Rural Electricity Enterprise
SREPTS	Specific Requirements on Electric Power Technical Standards
S/W	Scope of Works



## **Section 1 Overview**

## Section 1 Overview

### 1. Project Summary

#### 1.1 Project Name

Country: The Kingdom of Cambodia

Project Name: Project for Operation and Maintenance of the Rural Electrification  
on Micro-Hydropower in Mondul Kiri

Sector: Natural resources and energy

Type of Cooperation: Technical cooperation project

#### 1.2 Counterpart Organizations

- Ministry of Industry, Mines and Energy (MIME)
- Department of Industry, Mines and Energy of Mondul Kiri Province (DIME of Mondul Kiri)
- Electricity Unit of Mondul Kiri Province (EUMP)  
Note: EDC Mondul Kiri from June 8, 2010
- Electricite du Cambodge (EdC)
- Electricity Authority of Cambodia

The List of counterparts and the outline of electric facilities of EUMP are shown in Appendix.

#### 1.3 Project Duration

First period: from December 3, 2008 through March 26, 2010

Second period: from April 26, 2010 through March 31, 2011

#### 1.4 Project Implementing Company

Joint Venture of Electric Power Development Co., Ltd. and the Chugoku Electric Power Co., Inc.

## 1.5 Component of JICA Advisory Team

The task assignment schedule of JICA Project Team is shown below:

In charge	Task
Team Leader / Management	<ul style="list-style-type: none"> <li>– Superintendence for JICA Project Team</li> <li>– Liaison with MIME, EAC, EDC and other relevant agencies</li> <li>– Technical Guidance for Medium and Long-term strategy and Financial Planning</li> <li>– Preparation of Training Program and Revising O&amp;M Manual regarding Management</li> <li>– Advice for Reasonable Tariff Rate considering financial condition</li> <li>– Advice for organization control of EUMP</li> </ul>
Administration Specialist	<ul style="list-style-type: none"> <li>– Technical Guidance for revising O&amp;M Manual regarding Administration works</li> <li>– Technical Guidance for recording and organizing such data as customer, energy consumption, accounting record and so on.</li> <li>– Technical Guidance for finance and accounting methods</li> <li>– Financial Audit</li> </ul>
Civil Engineer	<ul style="list-style-type: none"> <li>– Technical Guidance for Medium and Long-term Planning of Civil Work structures including Gate and Penstock</li> <li>– Technical Guidance for revising and translation of O&amp;M Manual regarding Civil work structures</li> <li>– Technical Guidance for periodical inspection and maintenance</li> <li>– Technical Guidance for recording and organizing the data</li> </ul>
Electro-mechanical Engineer	<ul style="list-style-type: none"> <li>– Technical Guidance for Medium and Long-term Planning of Hydropower and Diesel Power facilities</li> <li>– Technical Guidance for revising and translation of O&amp;M Manual regarding Generation facilities</li> <li>– Technical Guidance for operation and periodical inspection and maintenance</li> <li>– Technical Guidance for recording and organizing the data</li> </ul>
Transmission and Distribution Engineer	<ul style="list-style-type: none"> <li>– Technical Guidance for Medium and Long-term Planning of Transmission and Distribution facilities</li> <li>– Technical Guidance for revising and translation of O&amp;M Manual regarding transmission and distribution facilities</li> <li>– Technical Guidance for operation and periodical inspection and maintenance</li> <li>– Technical Guidance for recording and organizing the data</li> </ul>
Hydropower Supervisor	<ul style="list-style-type: none"> <li>– Technical Guidance for periodical inspection and maintenance</li> <li>– Assistance for revising O&amp;M Manual</li> </ul>
Diesel Power Supervisor	<ul style="list-style-type: none"> <li>– Technical Guidance for periodical inspection and maintenance</li> <li>– Assistance for revising O&amp;M Manual</li> </ul>

## 1.6 Project Cost

(1) Contract amount ¥ 153,160,000 (Refer to the table below for the breakdown)

**Table 1-1 Breakdown of the Contract Amount**

Unit: Japanese thousands Yens

Breakdown	First period	Second period	Contract amount
I. Direct costs	54,698	33,440	88,138
1. Out-of-pocket expenses	38,080	22,289	60,369
2. Personnel costs	16,609	11,151	27,760
II. Indirect costs	34,545	23,193	57,738
1. Overhead	19,930	13,381	33,311
2. Fee	14,615	9,812	24,427
III. Subtotal (I+II)	89,234	56,633	145,867
IV. Consumption tax and local consumption tax	4,461	2,831	7,292
V. Total (III + IV)	93,695	59,464	153,159

## 1.7 Man-months

**Table 1-2 Man-months Utilized**

Unit: man-months

Breakdown	First period	Second period	Total
1. In Japan (as contracted)	1.53	1.47	3.00
(as utilized)	1.50	1.47	2.97
2. In Cambodia	19.61	12.90	32.51
(as contracted)			
(as utilized)	19.64	12.90	32.54
3. Total (as contracted) 1+2	21.14	14.37	35.51
(as utilized)	21.14	14.37	35.51

## 1.8 Equipment Provided

The amounts of the equipment provided as enumerated in the table below are included in the out-of-pocket expenses in I.1 of the contract amount in the 1-1 above

**Table 1-3 List of Equipment Provided**

Name	Shop and quantity	Model name and maker	Time of purchase and delivery
Printer (for administration and accounting)	PTC 2 units	Laser printer HP 5550 Hewlett-Packard	2008/12/23 2008/12/23
Printer (for control of power plant and transmission/distribution)	PTC 2 units	Color printer HP K7100 Hewlett-Packard	2008/12/23 2008/12/23
Computer (for administration)	PTC 1 unit	Desktop NEC Power Mate P6000	2008/12/23 2008/12/23
Computer (for administration)	PTC 3 units	Laptop (Toshiba) Portege M800-E367	2008/12/23 2008/12/23
Computer (for control of power plant and transmission/distribution)	PTC 4 units	Laptop (Toshiba) Portege M800-E367	2008/12/23 2008/12/23
Copy machine (including fax)	KIM HENG Computer Center : 1 unit	IR 2022n (Canon)	2008/12/23 2008/12/23
Projector	PTC 1 unit	LCD Projector TLP-X2500A (Toshiba)	2008/12/23 2008/12/23
Cabinet	LEECO Shop 2 kits	Cabinet OS0808+OSW808+base	2008/12/23 2008/12/23
Desk and chair	LEECO Shop 4 kits	Chair: CH 800g Desk: OS1200 + H3	2008/12/23 2008/12/23
Clamp-on Power Meter	Hioki: 1 unit	Hioki Type : 3331and 3169-21	2009/4/10 2009/5/29
Digital Insulation Tester	Yokogawa: 2 units	Yokogawa MY40-01	2009/4/24 2009/6/15
Digital multimeter	Yokogawa: 2 units	Yokogawa Digital multimeter TY720	2009/4/24 2009/6/15
Lineman safety belt, working bag	Fujii 7 sets	Fujii TD-27	2009/4/24 2009/6/15
Earthing tool	Hasegawa: 1 set	Hasegawa Earthing tool set S type	2009/4/24 2009/6/15
Digital Oscilloscope	Hioki: 1 unit	Hioki Analyzer set Type 3197	2009/4/24 2009/6/15
Emergency Power (25kVA)	LY BUN THONG GEN: 1 unit	Model:DCA-25ESI Denyo	2009/4/8 2009/4/8
Water pump set	LY BUN THONG GEN: 1 unit	Model:SCR-80 Kubota	2009/4/8 2009/4/8

## 2. Project Outline

### 2.1 Project Background

Sen Monorom town in Mondul Kiri province, target area of this Project, has a population of about 9,000 and is located in the north –eastern mountain area of Cambodia near the border with Vietnam. This town has been supplied by a private electricity supplier with a small diesel generator. The electricity tariff was as high as 80 to 90 ¢ /kWh and the electricity supply was limited in time and not stable. In order to improve that situation and to eventually raise the level of living conditions of local people, an Exchange of Notes (E/N) was signed between the governments of Cambodia and Japan regarding the grant-aid Project for Rural Electrification on Micro-hydropower in Remote Province of Mondul Kiri in the Kingdom of Cambodia in June 2006 for purposes of inexpensive and stable electricity supply mainly by a small hydropower. Based on that E/N, the construction for the Project was implemented starting in May 2007 and completed in November 2008.

The electric utility of this Project was to be operated by a newly organized Electric Unit of Mondul Kiri Province (EUMP). The management of EUMP consisted of 3 members dispatched from DIME and the staff for administration, operation and maintenance consisted of about 20 employees, all recruited locally. They did not have experiences in power utility, which led to various concerns over management and technical matters. So, it was necessary to provide OJT under the guidance of experts in order for them to acquire practical management and technical skills.

Against the above background, the government of Japan through JICA decided to conduct a technical cooperation project through dispatch of experts for purposes of capacity building for power utility operation of EUMP under the supervision of MIME.

The project was started from December 2008, immediately after the completion of the power plants, considering that EUMP was inexperienced in power supply, and ended in March 2011, with a total duration of 28 months.

In June 2010, before the project completion, EUMP was transferred from MIME to EdC.

## 2.2 Project Strategy

This Project has the following purposes as shown in Figure 1-1 PDM.

① Overall goal

[Sen Monorom town will be provided with stable power supply]

② Project purpose

[EUMP will have such a system and organization as to be able to do appropriate management and operation of civil works, facilities of power generation and transmission/distribution]

In order to attain the above purposes, it was necessary to make EUMP independently operated. So, the JICA Project Team was to support EUMP in terms of management, technical matters and motivation. The sectoral approaches are described below.

The methods for support are basically the following 3 'T' (Tool, Training, Think together)

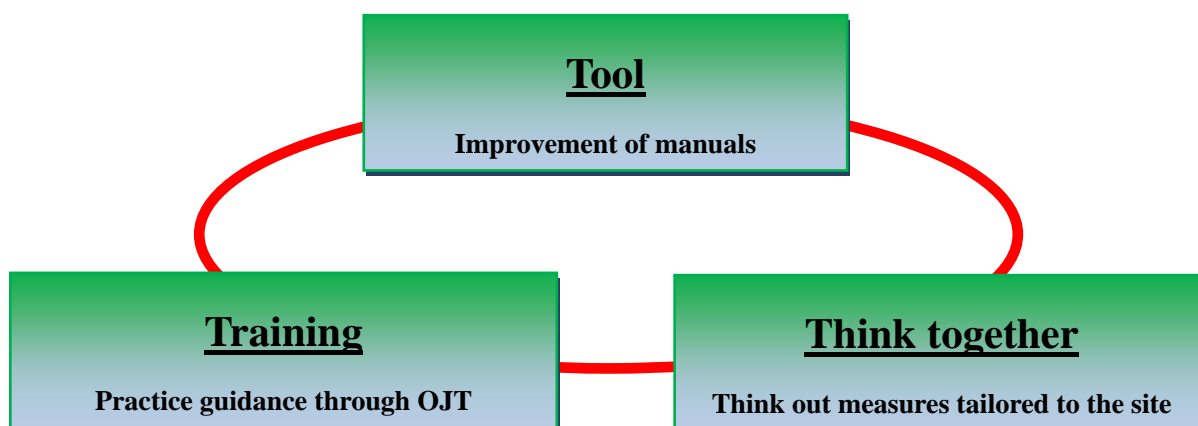
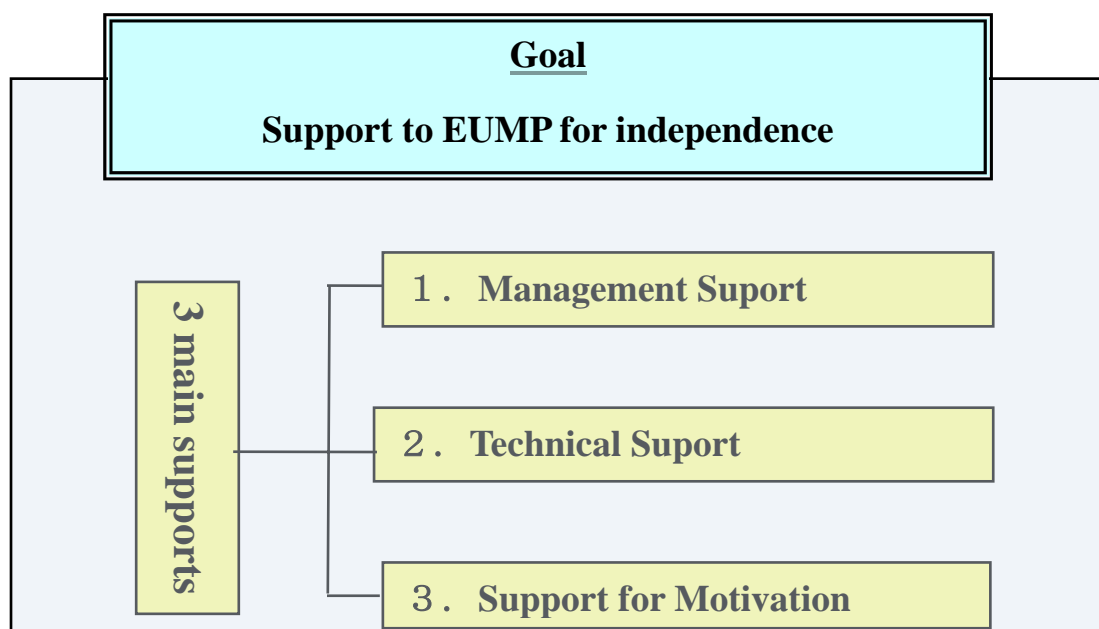


Table 2-1 Project Design Matrix (PDM)

Project title: **Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower in Mondul Kiri**

Target Area: Sen Monorom Town

Target Group: Electricity Unit of Mondul Kiri Province (EUMP)

Duration: **December, 2008– March, 2011**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
<b>Overall Goal</b> <b>To supply stable electric energy to the people in Sen Monorom town</b>	1. Rate of electrified households increased 2. Stable electricity is supplied in Sen Monorom town throughout the year.	1. Statistic data 2. Customers List of EUMP	
<b>Project Purpose</b> To establish the mechanism to properly manage and operate civil work structures, power generation facilities and transmission/distribution facilities within EUMP	1. EUMP can get profit 2. Supplying hours per day increased*1	1. Record of electricity at generation site 2. Accounting report of EUMP	1. The Government of Cambodia provides political and financial support for EUMP to continue its operation. 2. Peoples in Sen Monorom town are willing to pay and use the electricity supplied by EUMP.
<b>Outputs</b> 1. Management and administration system of EUMP is established and functioning well. 2. Technical guidance for maintenance of civil work structures including gate, trash rack & penstock is established and functioning well. 3. Technical guidance for maintenance of power generation facilities is established and functioning well. 4. Technical guidance for maintenance transmission and distribution facilities is established and functioning well.	1. Management and Administration system; 1.1 Collection of electrical bill is appropriately taken in EUMP 1.2 Accounting procedure is appropriately taken in EUMP 2. Regarding civil structures, EUMP has; 2.1 Operation and maintenance manuals which have been revised based on the trial run of the facilities in the 1st and 2nd year of operation. 2.2 Staffs with sufficient knowledge and capacity to operate and maintain civil structures along the above mentioned manuals.*2 3. Regarding power generation activities, EUMP has; 3.1 Operation and maintenance manuals which have been revised based on the trial run of the facilities in the 1st and 2nd year of operation. 3.2 Staffs with sufficient knowledge and capacity to operate and maintain electric generating facilities along the above mentioned manuals.*2 4. Regarding transmission and distribution facilities, EUMP has; 4.1 Operation and maintenance manuals which have been revised based on the trial run of the facilities in the 1st and 2nd year of operation. 4.2 Staffs with sufficient knowledge and capacity to maintain transmission and distribution facilities along the above mentioned manuals.*2 5. Operation hour of each facilities increased	1. Record of bill collection 2. Accounting report of EUMP 3. O&M record at each generation site 4. Maintenance record of transmission and distribution facilities 5. Manuals set as indicators	1. Security at all the facility site are good 2. No natural disaster happened at the project site
<b>Activities</b> <u>1. Management and administration</u> 1.1 To establish the medium and long term business strategy and financial budget's plan 1.2 To establish billing system 1.3 To revise and translate the management and administration manuals from English to Khmer 1.4 To conduct the operation and management of the electric facilities by OJT 1.5 To record and organize the data, such as customer, energy consumption and financial balance etc.. <u>2. Establishment of technical guidance for maintenance of civil work structures</u> 2.1 To establish the medium and long term maintenance plan of civil work structures 2.2 To revise and translate the operation & maintenance manuals regarding civil work structures from English to Khmer 2.3 To conduct periodically inspection and maintenance of civil work structures by OJT 2.4 To record and organize the data, such as operation record, inspection and maintenance record and accident and trouble report etc.. <u>3. Establishment of technical guidance for operation and maintenance of power generation facilities</u> 3.1 To establish the medium and long term maintenance plan of power generation 3.2 To strengthen the operation and maintenance system of hydropower generation facilities 3.2.1 To revise and translate the operation & maintenance manuals regarding hydropower generation from English to Khmer 3.2.2 To conduct periodically inspection and maintenance of hydropower generation facilities by OJT 3.2.3 To record and organize data, such as operation record, inspection and maintenance record and accident and trouble report etc.. 3.3 To strengthen the operation and maintenance system of diesel power generation facilities 3.3.1 To revise and translate the operation & maintenance manuals regarding diesel power generation from English to Khmer 3.3.2 To conduct periodically inspection and maintenance of diesel power generation facilities by OJT 3.3.3 To record and organize the data, such as operation record, inspection and maintenance record and accident and trouble report etc.. <u>4. Establishment of technical guidance for operation and maintenance of transmission and distribution facilities</u> 4.1 To establish the medium and long term plan of transmission and distribution facilities 4.2 To revise and translate the operation & maintenance manuals regarding transmission and distribution facilities from English to Khmer 4.3 To conduct periodically inspection and maintenance of transmission and distribution facilities by OJT 4.4 To record and organize the data, such as operation record, inspection and maintenance record and accident and trouble report etc..	<b>Input to the Project</b> (Cambodian Side) 1. Local Cost Local cost for the implementation of the Project 2. Allocation of necessary counterpart personnel 2.1 Administrative personnel 2.2 Operation and maintenance personnel 3. Preparation of office spaces and facilities (for experts)	(Japanese Side) 1. Dispatch of Experts 1.1 Chief advisor/management and administration 1.2 Civil engineering advisor 1.3 Electrical engineering advisor 1.4 Hydropower equipment specialist 1.5 Diesel power equipment specialist 1.6 Transmission and distribution engineering advisor 2. Provision of Equipment For the necessity of technical cooperation activities 3. Counterpart training in third country and/ or within Cambodia	<b>Precondition</b> 1. EUMP is licensed by EAC 2. Personnel of EUMP devote their every effort to implement the project 3. The technical cooperation project will start without pause to secure smooth operation the



## 2.3 Brief History of the 1st period Activities

The support services in the 1<sup>st</sup> period comprised 3 works in Japan, which included preparatory works, and 5 field activities in Cambodia.

Power generation facilities, different from mass production of identical products in factories with high quality control, requires adjustments in parallel with actual operation to make the facilities function completely after construction and erection at site. In the case of this power supply project, the necessity of earlier power supply forced the start of operation before trial operation was sufficiently done besides inexperience of the operating staff. EUMP was instructed to make it a rule to record daily operating conditions and to make weekly report to the local coordinator of JICA team. When a trouble occurred, advice was given to the site opportunely by email or telephone.

The workflow of the 1<sup>st</sup> period activities is shown in Figure 2-1.

### Preparatory Works in Japan

Once a contract was concluded with JICA on 3 December 2008, an inception report was prepared for this project of support services examining the results of the grand aid project.

### 1st Field Activities

The 1st field activities started in December 2008. Those activities were conducted in Mondul Kiri by experts in management, administration, civil engineering, electrical engineering and transmission/distribution engineering, all of them are actually engaged in power supply business in Japan. Operation of power facilities requires so delicate techniques that a mistake may cause malfunction of the power facilities constructed with a large amount of money and labor, leading to irreparable damage in the worst case. To that effect, the experts dedicated their efforts to make EUMP staff acquire the minimum operation skills in order to keep power generation and transmission working.

In parallel with OJT at site, JICA team prepared for foundation of JCC as the first step to project framework and convened the 1st meeting of JCC on 22 December 2008. That JCC meeting confirmed the approach and methodology of this project of support services.

On the completion of the 1st meeting of JCC, the experts set about collection and analysis of relevant operation data to draft a long and mid-term plan and power tariff system, in parallel with OJT at site.

And, in March 2009, a draft of the long and mid-term plan and the power tariff system was prepared based on some 3 months data of operation and demand. Thereafter, OJT was provided for about 1 month and the 1st field activities ended in April.

During that time, an inauguration ceremony was held with attendance of Japanese Ambassador, Mr. Shinohara, and Deputy Prime Minister, Mr. Keat Chhon on 23 February.

### 1<sup>st</sup> Works in Japan

An interim report was prepared in Japan and submitted to JICA in March 2009.

### 2<sup>nd</sup> Field Activities

2<sup>nd</sup> field activities were conducted from mid May through early July 2009.

Those activities comprised establishment of a framework for management and administration and technical guidance at site.

As for management and administration, the 2<sup>nd</sup> JCC meeting was held on 15 June 2009, where explanation was made about the draft of the long and mid-term plan and the power tariff system, which was approved by JCC members.

Then, EUMP was going to start with applying the power tariff system suggested by JICA team to EAC, the approval organization.

As for technical guidance at site, inspection engineers for hydropower and diesel power were dispatched, besides JICA team's expert in power generation, and they conducted inspection works as the 1<sup>st</sup> periodical inspection about half a year of operation.

### 3<sup>rd</sup> Field Activities

3<sup>rd</sup> field activities were conducted from September through October 2009. During that period, being in the middle of the rainy season, OJT was provided for operation and maintenance skills specific to rainy season such as operation of civil engineering facilities at the time of flooding, trash rack clearing and drainage works for access path. As for transmission/distribution, OJT was provided taking into account frequent occurrence of troubles caused by thunderstorm and strong wind during the rainy season and necessary troubleshooting.

### 4<sup>th</sup> Field Activities

The 4<sup>th</sup> field activities were conducted from November through December 2009. During that period, the main tasks were editing of O&M manual in English and preparation of the manual in Khmer and, in the administration matter, guidance to prepare workflows of EUMP's administration staff raising awareness of their respective tasks and check of financial situation, and, in the technical matter, the 2<sup>nd</sup> periodical inspection for hydropower and diesel power plants, with all of the 7 experts at the site.

The 3<sup>rd</sup> JCC meeting was originally planned during the 4<sup>th</sup> field activities and the first version of O&M manual was going to be explained but postponed to February 2010 during the 5<sup>th</sup> field activities at the request of Cambodian side because of schedule adjustment. The draft of O&M manual prepared in December was sent to each member of JCC for their perusal. That ended the 4<sup>th</sup> field activities.

### 5th Field Activities

The 5th field activities were conducted as the last field activities of the 1st period from 11 February through 28 February 2010. The main tasks included the postponed 3rd meeting of JCC and guidance of management and administration. In the 3rd JCC meeting, O&M manual was explained and annual performance of 2009 reported by CP of EUMP and it was confirmed that EUMP was being well operated. In that meeting an important matter was declared that EUMP would be merged with EdC.

### 2nd Works in Japan

In March 2010, the completion report for the 1st period was prepared compiling the activities so far done.

## **2.4 Brief History of the 2nd period Activities**

### **2.4.1 Modifications to Project Methodology**

Based on the performance of the 1<sup>st</sup> period activities, the project methodology was modified taking into account the following points.

#### (1) General

The 2<sup>nd</sup> period is the final year for the project. The 1<sup>st</sup> period focused on establishing a framework of EUMP and technical transfer of basic skills in a “pulling” way. Meanwhile, the 2<sup>nd</sup> period aimed at self-support of EUMP by repeated training to improve the proficiency and by giving necessary advice on the manual in a side-by-side supporting way

#### (2) Modifications to Activity Plan

The plan for technical transfer at the site was modified mainly considering the following 2 points.

##### ① Check of the proficiency of the counterpart

As mentioned above, in the 1st period most efforts were given to establish a framework for EUMP such as organizational system and task assignments as well as preparation of the manual. In the 2nd period, necessary guidance was given after checking the proficiency and practical ability of all the staff including managers and supervisors.

##### ② As for OJT of distribution lines, the frequency was to be the same as in the 1<sup>st</sup> period. As learned from the operation in the 1<sup>st</sup> period, the maintenance works for transmission/distribution were more troublesome and difficult than expected. This was mainly due to the climate peculiar to Mondul Kiri. Strong winds and dust during dry season and thunderstorms during rainy season cause troubles to the distribution facilities. In the 1<sup>st</sup> period, the first experience was acquired in troubleshooting caused by the above factors. Such an experience, which was only in 1 cycle of season, was not considered to be

sufficient. In the 2<sup>nd</sup> period, it was necessary for EUMPM staff to acquire a higher level of proficiency in skills of operation and maintenance by repeated training of troubleshooting experienced in the 1<sup>st</sup> period in each season.

### (3) Coordination for transfer to EdC

At the 3<sup>rd</sup> JCC meeting held on February 23, 2010, the Cambodian side announced the transfer to EdC of EUMP and it was officially done on June 8, 2010. JICA team considered such a transfer to be desirable from the point of view of maintenance of the donated power facilities after the project completion. At the same time, it was considered to be necessary to minimize negative influence on operation and maintenance as well as employment conditions, so that the following points became necessary to do jointly with EdC.

#### ① Treatment of the Guidelines and Manual on account of the transfer to EdC

Modifications were found necessary to be made to part of the Guidelines and Manual for Operation and Maintenance prepared in the 1<sup>st</sup> period. In the 2<sup>nd</sup> period, consultations and coordination were made with EdC on more concrete matters and necessary training was provided to C/P.

#### ② Transmission plan of EdC

EdC was preparing a plan to supply power to Sen Monorom city by constructing a transmission line to Vietnam. It was necessary to have made opportune consultations with EdC because it was necessary for EdC to make technical verification on connection of the small hydropower with the transmission line from Vietnam before the implementation.

### (4) Study on prospect for revision of power tariff

The current power tariff is of such a system as to vary according to change in fuel price for diesel power. In the case of power import from Vietnam via the said transmission line, the power tariff system would be different, so that a basic revision should be made to the power tariff. Although such a revision will not be made before the project completion, JICA team decided to show some direction for a would-be power tariff by making a tentative calculation considering EdC had few experiences in making such a power tariff incorporating hydropower.

## 2.4.2 Outline of the 2<sup>nd</sup> period Activities

The 2nd year consisted of 3 times of work in Japan and 4 times of field activities from the 6th through 9th.

Guidance were given mainly with a view to stable supply of good-quality power in the 2<sup>nd</sup> period and for EUMP staff to maintain the donated power facilities based on operation and maintenance skills

learned in the 1<sup>st</sup> period.

Learned from the experience in operation in the 1<sup>st</sup> period, EUMP established such a system as to make records of daily operation, which would be reported to the local coordinator of JICA team. When a trouble occurred, they sought direction from JICA team and dealt with the trouble. Those experiences will give EUMP the basic technical foundation necessary for a power utility and for future sustainability. In the absence of JICA team from the site, advice was given on appropriate measures by email or telephone from Japan to the site. The outline of activities was described below.

### 3<sup>rd</sup> Works in Japan

Immediately after signing the contract with JICA on April 26, 2010, the 3<sup>rd</sup> works in Japan was started with reviewing the results of the 1<sup>st</sup> period, based on which the 2<sup>nd</sup> period plan was prepared and submitted to JICA.

### 6<sup>th</sup> Field activities

The 6<sup>th</sup> field activities were performed from the mid-May through late June, 2010.

This was the first field activities in the 2<sup>nd</sup> period, so that the activity plan was explained and agreed in the 4<sup>th</sup> JCC meeting. Coordination and technical examinations were commenced on the condition of the transfer to EdC. The first self-evaluation was made by EUMP staff.

Regarding technical guidance at the site, the 3<sup>rd</sup> periodical inspection of the hydropower plant was conducted one and half a year from the start of operation. As for the diesel power plant, such inspection was postponed till August in rainy season because there was much power demand at that time, giving priority to power supply. The transfer to EdC of EUMP was officially realized on June 8.

### 7<sup>th</sup> Field Activities

The 7<sup>th</sup> field activities were conducted from mid-July through mid-October. This period was in the middle of rainy season and the repeated training was done by OJT as in the 1<sup>st</sup> period.

Regarding the connection with Vietnam planned by EdC, technical consultations were made with EdC's technical staff on interconnected operation of hydropower. This plan was made by EdC aiming to materialize in one or two years. JICA team was requested to provide technical guidance and collaboration because of lack of expertise of EdC. In that respect, JICA team obtained a consent from JICA Cambodia in that their experts in generation and transmission/distribution would make consultation and site reconnaissance with EdC in June through August.

The 3<sup>rd</sup> periodical inspection, originally scheduled for the 6<sup>th</sup> field activities, was conducted on the diesel power plant. The 4<sup>th</sup> JCC meeting was held in October 4. Regarding administration matters, in that meeting, JICA team stated to the effect that it would be wise to follow the existing internal

regulations of EdC, so that the administration part of the O&M Manual would fade out.

In parallel with OJT by each expert, collection and analysis of data were started to prepare a basic idea for the mid- and long-term plan and the power tariff.

During the period from September 26 through October 6, when JICA team was developing field activities, JICA conducted a terminal evaluation of the project in Cambodia. Their observations were given at the 4<sup>th</sup> JCC meeting and the minutes of meeting were exchanged between MIME and JICA.

#### 4<sup>th</sup> Works in Japan

In October 2010, the progress report for the 2<sup>nd</sup> period was prepared in Japan and submitted to JICA.

#### 8<sup>th</sup> Field Activities

The 8<sup>th</sup> field activities were conducted from the beginning of November through late December 2009.

As for management matters, an examination was made into a prospect of power tariff after the connection with Vietnam and the result was explained to EAC and EdC. In civil engineering section, inspection patrol and other repeated training were conducted and interviews for self-evaluation were made with CP.

Regarding transmission/distribution section, in addition to guidance on inspection, the electrical standards were explained and vocational safety education was provided by use of video.

In generation part, the final, 4<sup>th</sup> periodical inspection guidance was provided for hydropower and diesel power.

The 4<sup>th</sup> periodical inspection was conducted for the diesel power plant in November. This inspection was the largest overhaul works for the 2 past years of operation, forcing 4-day shutdown of the power plant. It can be highly evaluated that EUMP sent a pre-notice to the customers on the period of inspection works and load restriction and continued to supply power without power outage during those 4 days. For the hydropower plant also, a final periodical inspection was conducted. Those inspections found no irregularities in each equipment and concluded with good results.

A small seminar was held at the site for EUMP on November 24 as review of the things so far learned. The seminar was given by JICA senior volunteer (JSV) and JICA team (generation) on the following theme.

- 1) JSV: electrical theory
- 2) JICA team: literacy of electrical sequence and block diagram

#### 9<sup>th</sup> Field Activities

The 9<sup>th</sup> field activities, the final one of the project, were conducted from mid-February through the

beginning of March 2011.

In order to share the skills of small hydropower learned by EUMP staff, a seminar was held on small hydropower for EdC's staff of the headquarters at JICA Cambodia on February 22.

As for O&M Manual, a revised version of the technical parts of civil structures and facilities for generation and transmission/distribution, including modifications and additions, was prepared in English and translated into Khmer and submitted.

A report on the mid- and long-term plan and the prospect of future power tariff after the connection with Vietnam was prepared and submitted.

The final, 5<sup>th</sup> JCC meeting was held on February 23. After C/P and JICA team made reports, it was confirmed between MIME, EdC and JICA that the project was completed successfully.

#### 5<sup>th</sup> Works in Japan

In March 2011, the completion report was prepared in Japan and submitted to JICA.

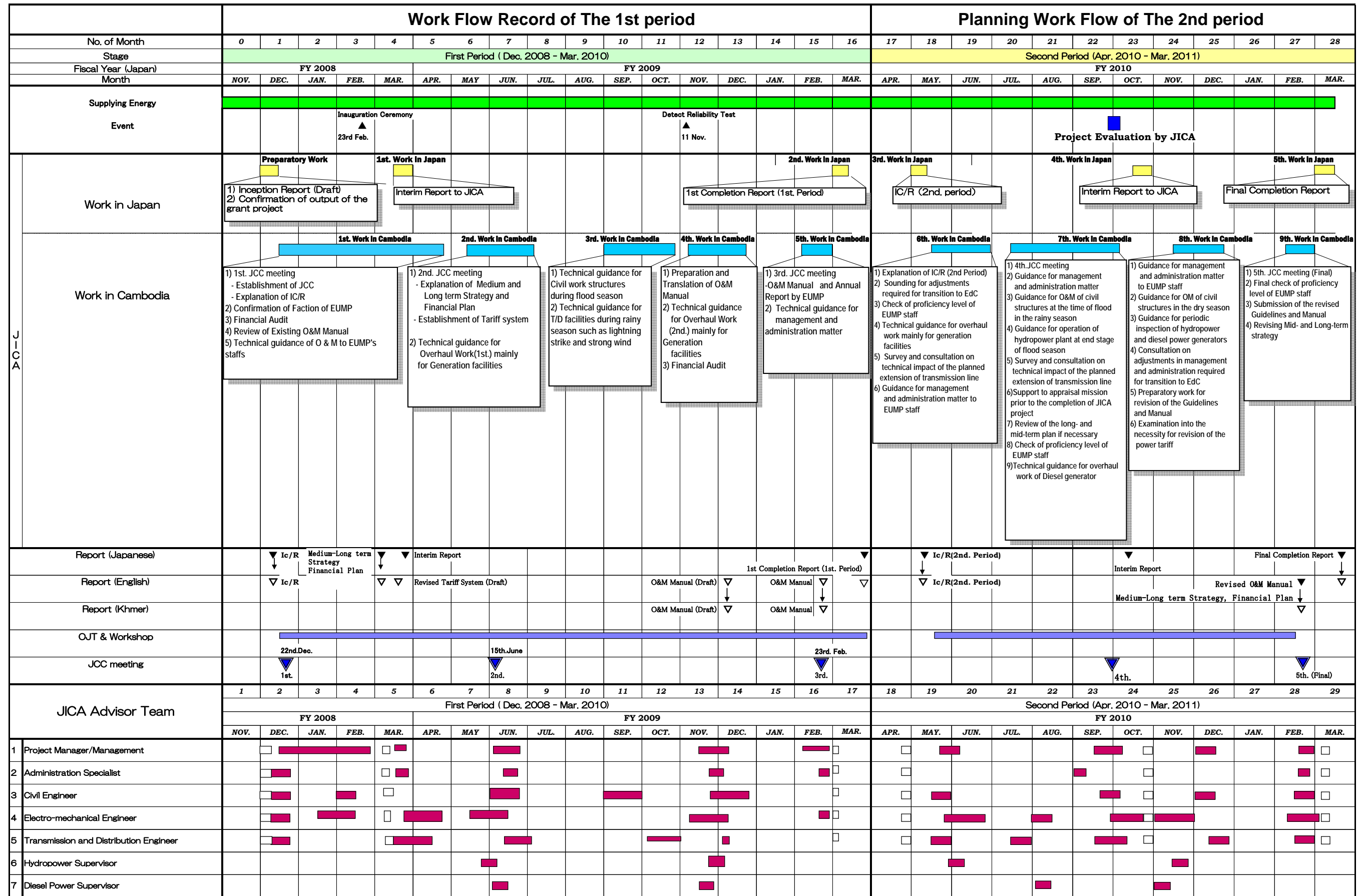


Figure 2-1 Work Flow Record of the 1st. Period and Schedule of 2nd. Period



Month	2008			2009												2010												2011		
	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3		
<b>Project Schedule</b>																														
1	First period for O&M Training																								Completion of OJT at site					
2	Second period for O&M Training																													
3	1st Site Survey			2nd Site Survey			3rd Site Survey			4th Site Survey			5th Site Survey			6th Site Survey			7th Site Survey			8th Site Survey			9th Site Survey					
Site Visiting	—		—		—		—		—		—		—		—		—		—		—		—		—		—			
4	▼	1st					▼	2nd						▼	3rd									▼	4th			▼	5th	
5																			▼	1st		▼	2nd					▼	3rd	
6																			▼	1st		▼	2nd	▼	3rd		▼	4th		
<b>Guidance for Project Operation</b>																														
1	—		—		—		—		—		—		—		—		—		—		—		—		—		—			
1	JCC meeting	▼				▼					▼			▼				▼					▼				▼			
2	JCC meeting	▼				▼					▼			▼				▼					▼				▼			
3	JCC meeting	▼				▼					▼			▼				▼					▼				▼			
4	▼					▼					▼			▼				▼					▼				▼			
<b>Guidance for Office Management</b>																														
1	—			—		—					—			—				—				—				—				
1	▼			▼		▼					▼			▼				▼				▼				▼				
2	▼			▼		▼					▼			▼				▼				▼				▼				
3	▼			▼		▼					▼			▼				▼				▼				▼				
4	▼			▼		▼					▼			▼				▼				▼				▼				
5	▼			▼		▼					▼			▼				▼				▼				▼				
<b>Guidance for Maintenance of Civil Work Structures</b>																														
1	—	—				—				—				—				—				—				—				
1	▼		▼			▼				▼				▼				▼				▼				▼				
2	▼		▼			▼				▼				▼				▼				▼				▼				
3	▼		▼			▼				▼				▼				▼				▼				▼				
4	▼		▼			▼				▼				▼				▼				▼				▼				
5	▼		▼			▼				▼				▼				▼				▼				▼				
<b>Guidance for Maintenance &amp; Operation of Electrical Facilities</b>																														
<b>1) Hydropower generating facility</b>																														
1							▼					▼							▼						▼					
2	▼		▼			▼					▼			▼				▼				▼			▼					
3	▼		▼			▼					▼			▼				▼				▼			▼					
4	▼		▼			▼					▼			▼				▼				▼			▼					
5							—				—							—				—			—					
<b>2) Diesel generating facility</b>																														
1							▼					▼							▼					▼						
2	▼		▼			▼					▼			▼				▼				▼			▼					
3	▼		▼			▼					▼			▼				▼				▼			▼					
4	▼		▼			▼					▼			▼				▼				▼			▼					
5							—				—							—				—			—					
<b>Guidance for Maintenance &amp; Operation of Transmission and Distribution Facilities</b>																														
1	—			—		—					—			—				—				—			—					
1	▼			▼		▼					▼			▼				▼				▼			▼					
3	▼		▼			▼					▼			▼				▼				▼			▼					
4	▼		▼			▼					▼			▼				▼				▼			▼					
Regent: — Site allocated M/M and visiting ▼ Activities by the Advisors																														

Figure 2-2 Technical Transfer Knowledge (OJT) Schedule for The Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower in Mondul Kiri

### **3. Project Outputs**

#### **3.1 Project Outputs**

EUMP has been carrying out sound management in line with the mid- and long-term plan approved in the 1<sup>st</sup> JCC meeting, achieving a profit of 14% in 2009. In 2010, the severest drought in the past 20 years was recorded, bringing far less quantity of rainfall than usual years, which was a prevailing situation in the entire basin of Mekong river. That climatic condition forced EUMP to operate the diesel power plant more than expected, oppressing its financial situation. However, EUMP was able to gain a profit of 5% by making use of the previous profit and part of the drought reserves.

Meanwhile, power supply hours were much improved in that the service area was being supplied for 24 hours for 365 days after the commencement of the project although only for some hours a day before its commencement.

#### **3.2 Sectoral Achievements**

(1) Management

The power tariff was set through public hearings of local residents and consultations with EAC, approving body for power tariff, resulting in such fair tariff as to consider operation and maintenance of the power facilities. The collection rate of power tariff was 97% on the average, showing the adequate system establishment and efficient operation.

Regarding capacity building related with the billing system, basic abilities were gained through monthly metering, billing, tariff collection and summarizing works. As for accounting works, monthly financial statements and year-end financial reports were appropriately prepared.

(2) Operation and maintenance of civil structures

This part of the Operation and Maintenance Manual was prepared in English and Khmer considering the abilities and performance of EUMP and approved in the 2<sup>nd</sup> JCC meeting. As for capacity building, good progress was made to the extent that gate operation, clearing works and water-level measurement were conducted without problems. There were some staff members who did not understand part of the procedure for flow measurement and systematic patrol and inspection by use of check sheet. These issues were solved by joint works of each member teaching mutually.

(3) Operation and maintenance of power generation facilities

This part of the Operation and Maintenance Manual was prepared in English and Khmer considering the abilities and performance of EUMP and approved in the 2<sup>nd</sup> JCC meeting. As for capacity building, good progress was made to the extent that the operation of the power generation

facilities and the preparation of the operation records were learned through OJT. The curves of discharge into the headrace and power generation were prepared based on the operation records, which enabled operation control of power generation conforming to actual measurements. EUMP's staff have come to be able to conduct regular periodical inspection by themselves.

(4) Operation and maintenance of facilities of transmission/distribution

This part of the Operation and Maintenance Manual was prepared in English and Khmer considering the abilities and performance of EUMP and approved in the 2<sup>nd</sup> JCC meeting. As for capacity building, basic abilities for regular inspection and maintenance works as well as trouble shootings were learned through OJT. Calculation for distribution loss was also learned in line with the Manual, producing accurate data. Moreover, it was learned to consolidate the record of distribution troubles.

As described above, the targets were achieved in the 4 sectors of management, civil structures and facilities of power generation and transmission/distribution.

**Table 3-1 Summary Achievements as of the Time of Completion of the Support Services, March 2011**

Target Area: **Sen Monorom Town**

Target Group: **Electricity Unit of Mondul Kiri Province (EUMP)**

Duration: **December, 2008- March, 2011**

Narrative Summary	Objectively Verifiable Indicators	Achievements	Outcome
<p><b>Overall Goal</b> To provide stable supply of electricity to the people in Sen Monorom town</p>	<p>1. Increase the coefficient of electrification of Sen Monorom town</p>	<p>1. Sen Monorom town saw a drastic increase in coefficient of household electrification with the start of power supply by EUMP and continues to increase gradually.                      •450 customers/1,560households=30% before power supply by EUMP in October 2008                      •1,304 customers/1,740 households=75% ※1                      2year and 1 month of power supply by EUMP in 20 December 2010                      2. The number of customers and power consumption of EUMP has been gradually increasing.                      •As of 21 October 2008, at the start of power supply by EUMP:                      465 customers, 60kW of maximum daily power demand, 773kWh of daily power consumption                      •As of the end of December 2010, 2 year and 1 month later:                      1304 customers, 490kW of maximum daily power demand, 5,664kWh of daily power consumption (21st November, 2011)</p>	
<p><b>Project Purpose</b> Establish in EUMP such an organization and system as to enable appropriate management and operation of civil structures, power generation facilities and transmission/distribution network</p>	<p>1. EUMP makes profit 2. Power supply hours increase on a daily basis</p>	<p>1. 14% of profit rate achieved in 2009, 5% of profit rate achieved in 2010 that was drought year 2. Several hours before power supply by EUMP, while 24 hours continuously (99.1%) except for power outage due to trouble December 2008 to January 2010: 99.1% January 2010 to December 2010:99.8%</p>	
<p><b>Output</b> 1.Establish management and administration system in EUMP and make it function  2. Technical guidance for maintenance of civil work structures including gate, trash rack &amp; penstock is established and well functioning  3. Technical guidance for maintenance of power generation facilities is established and well functioning</p>	<p>1. Management and administration system 1.1Improve collection rate of electricity bills 1.2Take appropriate accounting procedures  2.EUMP has the operation and maintenance manuals on civil structures which have been revised based on the trial run of the facilities in the 1st and 2nd year of operation. 2.2 Bring up such personnel as can understand the manual to a certain level and do maintenance works of civil structures  3.Generation facilities 3.1 EUMP has the operation and maintenance manuals on power generation facilities which have been revised based on the trial run of the facilities in the 1st and 2nd year of operation. 3.2 Bring up such personnel as can understand the manual to a certain level and do maintenance works of generation facilities</p>	<p>1.1Guidance has been provided from the onset for establishment of billing system and its application, resulting in 97%(95-99%) of average collection rate. 1.2Monthly income statements is prepared and annual financial report to MIME is prepared at the end of year.  2.1The first version of manual in English and Khmer was prepared for civil structures considering operation records obtained through OJT. Second version considering the performance of OJT was submitted on February 2011. 2.2Hands-on experience was acquired regarding flow measurement, trash clearing at the intake, repair of drainage of road and the like. Almost all staff reached the level that they can conduct periodical patrol by themselves according to the evaluation.  3.1The first version of manual in English and Khmer was prepared for generation facilities considering operation records obtained through OJT. Second version of Manual considering the performance was submitted on February 2011. 3.2 Hands-on experience was acquired regarding normal operation method and preparation of operation record. Semi-annual periodical inspection was made four times, whereby understanding was deepened about the function and characteristics of the facilities.</p>	<p>1. Billing book 2. Annual financial report of EUMP  1. Flow measurements 2. Hourly recording in operation record 3. Repair record of hydropower plants 4. O&amp;M manual (revised) 5. Result sheet of self-evaluation  1. Operation and maintenance records of hydropower plants and diesel power plants 2. Inspection and repair works of hydropower plants and diesel power plants 3. O&amp;M manual (revised) 4. Periodical inspection report (1st - 4th)</p>

Activities	Achievements	Outcome
<p><u>1. Establish management and administration system and make it function</u>                      1.1 Prepare long and mid-term plan and financial plan                      1.2 Establish billing system                      1.3 Revise the manual for management and administration system where necessary and translate it from English to Khmer.                      1.4 Control operation of electrical facilities through OJT.                      1.5 Record and compile relevant data (customer data, sales of electricity, revenues and expenditures, and the like)</p>	<p>1.1 Long and mid-term plan and financial plan were prepared in March 2009 and confirmed by the 2nd JCC meeting in June 2009. Long and mid-term plan for after-project was submitted by final JCC meeting on February 2011.                      1.2 Billing system was prepared in March 2009 and started for application. Power tariff was confirmed as reasonable by the 2nd JCC meeting in June 2009 and established as such.                      1.3 1.3 Manual for management and administration including EUMP's internal regulations was prepared and translated into Khmer.                      1.4 OJT was provided for work procedure of personnel and procurement in the administrative section for smooth operation of power facilities                      1.5 Data control was done through compilation and analysis of data on customers, power sales, and revenues and expenditures.</p>	<ul style="list-style-type: none"> <li>• Long and mid-term plan (submitted in September 2009)</li> <li>• Power tariff system (draft) (submitted in September 2009)</li> <li>• Prospect of future tariff (submitted in February 2011)</li> <li>• O&amp;M Manual (submitted in February 2010)</li> <li>• Various records (in custody by EUMP)</li> </ul>
<p><u>2. Establish technical guidance for maintenance of gate, screen (trashrack), penstock and other civil structures and make it function</u>                      2.1 Prepare long and mid-term maintenance plan                      2.2 Revise manual for operation and maintenance of civil structures where necessary and translate it from English to Khmer                      2.3 Conduct periodical inspection and maintenance of civil structures through OJT                      2.4 Record and compile relevant data (operation record, repair and inspection record, trouble shooting record and the like)</p>	<p>2.1 Long and mid-term maintenance plan was prepared and confirmed by the 2nd JCC meeting in June 2009. Long and mid-term plan for after-project was submitted by final JCC meeting on February 2011.                      2.2 O&amp;M manual was revised and added to be tailored to actual conditions and translated into Khmer. Second version of O&amp;M manual considering the performance was submitted on February 2011.                      2.3 Formats were prepared for inspection and other records and was used by CP through OJT.                      2.4 Data control was done through compilation and analysis of annual data such as flow measurements, operation and repairs and trouble shootings.</p>	<ul style="list-style-type: none"> <li>• Long and mid-term maintenance plan (submitted in March 2009)</li> <li>• Long and mid-term maintenance plan revised version (submitted in February 2011)</li> <li>• O&amp;M Manual (submitted in February 2010)</li> <li>• O&amp;M Manual revised version (submitted in February 2011)</li> <li>• Various records (in custody by EUMP)</li> </ul>
<p><u>3. Establish technical guidance for maintenance of generation facilities and make it function</u>                      3.1 Prepare long and mid-term maintenance plan for generation facilities                      3.2 Strengthen operation and maintenance of hydropower facilities                          3.2.1 Revise manual for operation and maintenance of hydropower facilities where necessary and translate it from English to Khmer.                          3.2.2 Conduct periodical inspection and maintenance of hydropower facilities through OJT.                          3.2.3 Record and compile relevant data (operation record, repair and inspection record, trouble shooting and the like)                      3.3 Strengthen operation and maintenance system of diesel power facilities                          3.3.1 Revise manual for operation and maintenance of diesel power facilities where necessary and translate it from English to Khmer.                          3.3.2 Conduct periodical inspection and maintenance of diesel power facilities through OJT.                          3.3.3 Record and compile relevant data (operation record, repair and inspection record, trouble shooting and the like)</p>	<p>3.1 Long and mid-term maintenance plan was prepared and confirmed by the 2nd JCC meeting in June 2009. Long and mid-term plan for after-project was submitted by final JCC meeting on February 2011.                      3.2.1 O&amp;M manual for hydropower was revised and added to be tailored to actual conditions and translated into Khmer. Second version of O&amp;M manual considering the performance was submitted on February 2011.                      3.2.2 As for strengthening of operation and maintenance of hydropower plants, hardware skills including understanding of mechanical structures and basic functions was improved through periodical inspection and training by providing first experience in overhaul inspection and repair.                      3.2.3 Data control was done through compilation and analysis of annual data such as operation and maintenance, repairs, spare parts control and trouble shootings                      3.3.1 O&amp;M manual for diesel power was revised and added to be tailored to actual conditions and translated into Khmer. Second version of O&amp;M manual was submitted on February 2011.                      3.3.2 As for strengthening of operation and maintenance of diesel power plants, hardware skills                      3.3.3 Data control was done through compilation and analysis of annual data such as operation</p>	<ul style="list-style-type: none"> <li>• Long and mid-term maintenance plan (submitted in March 2009)</li> <li>• Long and mid-term maintenance plan revised version (submitted in February 2011)</li> <li>• O&amp;M manual (submitted in February 2010)</li> <li>• O&amp;M Manual revised version (submitted in February 2011)</li> <li>• Various records (in custody by EUMP)</li> <li>• Daily operation report</li> <li>• Event record sheet</li> <li>• Others</li> </ul>
<p><u>4. Establish technical guidance for maintenance of transmission/distribution facilities and make it function</u>                      4.1 Prepare long and mid-term maintenance plan for transmission/distribution facilities                      4.2 Revise manual for operation and maintenance of transmission/distribution facilities where necessary and translate it from English to Khmer                      4.3 Conduct periodical inspection and maintenance for transmission/distribution facilities through OJT                      4.4 Record and compile relevant data (repair and inspection record, trouble shooting and the like)</p>	<p>4.1 Long and mid-term maintenance plan was prepared and confirmed by the 2nd JCC meeting in June 2009.                      4.2 O&amp;M manual was revised and added to be tailored into actual conditions and translated into Khmer (second version was submitted in February 2011)                      4.3 As for operation and maintenance of transmission/distribution facilities, basic hardware skills were improved through practicing trouble shooting, repair works and new connection works.                      4.4 Data control was done through compilation and analysis of annual data such as operation and maintenance, repairs, spare parts control and trouble shootings.                      4.5 Site survey, technical study and advise for making specification was done for the connection to Viet Nam.</p>	<ul style="list-style-type: none"> <li>• Long and mid-term maintenance plan (submitted in March 2009)</li> <li>• Long and mid-term maintenance plan revised version (submitted in February 2011)</li> <li>• O&amp;M manual (submitted in February 2010)</li> <li>• O&amp;M Manual revised version (submitted in February 2011)</li> <li>• Various records (in custody by EUMP)</li> <li>• Fault Outage Recovery Log Sheets</li> <li>• Scheduled Outage Reports</li> <li>• Event Records</li> <li>• Drawing up the specification for the connection to Viet Nam</li> <li>• Action plan record</li> <li>• Others</li> </ul>

※1: This is an estimated figure. The total number of households is that of buildings within the distribution network of urban area of Sen Monorom and it is a calculation value using the actual increasing rate 5.5% based on a survey in September 2008 before power supply by EUMP.

## 4. Recommendations

This project was aimed to enable absolute laymen to operate and maintain the donated power facilities in a limited duration of 28 months. JICA project team evaluates that that goal has been attained in that CPs have gained basic abilities to produce power for 24 hours throughout a year, reaching a collection rate of 97%. As for management bases, it was strengthened with the transfer to EdC in June 2010, enabling sustainability in terms of organization.

It is certain that power demand will increase with the service area expanding in the province of Mondul Kiri. With the power facilities donated by Japan as basis, those will be extended and EdC is proceeding to connection with Vietnam to augment power capacity.

In order to keep the stable power supply established by this project, the following points should be considered.

### (1) Strengthening the backup system for operation and maintenance

During the project execution, a number of trouble shootings were experienced but they are not enough for future continued power supply. When an unexpected trouble occurs, the current number of EUMP's staff is not sufficient to tackle it. Such a situation should require expertise of technical staff of the supplier or hydropower experts, so that it is desirable to strengthen such backup system as to be able to handle it.

### (2) Appropriate maintenance of the power facilities

EdC promised to make long-term use of the donated power facilities and necessary maintenance and repair. Those expenses can be budgeted by EUMP preparing an appropriate mid- and long-term plan. However, there found some cases taking much time in ordering spare parts and such cases may threaten stable power supply. It is important to do a well-planned management of spare parts taking into consideration the time required for procurement.

### (3) Technical matters related with connection with Vietnam

After connecting with Vietnam, there will be a possibility of the power facilities of Mondul Kiri being affected by a trouble of the power system of Vietnam contrary to the current operation as independent system.

During the project, JICA team provided technical guidance to EdC with respect to planning and preparations for ordering. It is also advisable for EdC to verify the conditions and obtain technical guidance at the time of implementation.

### (4) Dissemination of hydropower technology

Being of a small size, this project is a hybrid of hydropower and diesel power. Moreover, it will be connected with Vietnam in several years. Such a system can be deemed to be a miniature of a national grid. For EdC, aiming to learn and raise the level of hydropower technology, it can be used as training facilities of OJT to learn the basic technology for operation under a system consisting of a multiple power sources.

## 5. Assignment of Experts

The table below shows a list of experts assigned for the project in the 1<sup>st</sup> and 2<sup>nd</sup> periods.

### Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri

#### List of dispatch of experts (period of activities in Cambodia 2008.12~2011.2)

Assignment	Name	No. of trip	Duration of dispatch	No. of days
Leader/management	Koji Mishima	1	2008/12/16 ~ 2009/2/28	75
		2	2009/3/15 ~ 2009/3/24	10
		3	2009/6/7 ~ 2009/6/26	20
		4	2009/11/16 ~ 2009/12/7	22
		5	2010/2/11 ~ 2010/2/28	18
		6	2010/5/26 ~ 2010/6/9	15
		7	2010/9/19 ~ 2010/10/8	20
		8	2010/11/16 ~ 2010/11/30	15
		9	2011/2/15 ~ 2011/2/27	13
Total				208
Administration	Tetsuro Tanaka	1	2008/12/9 ~ 2008/12/19	11
		2	2009/3/15 ~ 2009/3/24	10
		3	2009/6/14 ~ 2009/6/23	10
		4	2009/11/25 ~ 2009/12/4	10
		5	2010/2/19 ~ 2010/2/28	10
		6	2010/9/7 ~ 2010/9/16	10
		7	2011/2/17 ~ 2011/2/26	10
Total				71
Civil engineering	Takahito Oikawa	1	2008/12/9 ~ 2008/12/23	15
		2	2009/2/1 ~ 2009/2/15	15
		3	2009/6/7 ~ 2009/6/26	20

Assignment	Name	No. of trip	Duration of dispatch	No. of days
		4	2009/9/1 ~ 2009/9/30	30
		5	2009/11/28 ~ 2009/12/27	30
		6	2010/5/18 ~ 2010/6/1	15
		7	2010/9/20 ~ 2010/10/6	17
		8	2010/12/3 ~ 2010/12/15	13
		9	2011/2/13 ~ 2011/2/27	15
Total				170
Power generation	Yukitaka Hiraga	1	2008/12/9 ~ 2008/12/23	15
		2	2009/1/11 ~ 2009/2/9	30
		3	2009/3/27 ~ 2009/4/25	30
		4	2009/5/24 ~ 2009/6/20	28
		5	2009/11/12 ~ 2009/12/8	27
		6	2010/2/17 ~ 2010/2/26	10
		7	2010/5/27 ~ 2010/6/25	30
		8	2010/7/31 ~ 2010/8/14	15
		9	2010/9/25 ~ 2010/10/14	20
		10	2010/10/31 ~ 2010/11/29	30
		11	2011/2/9 ~ 2011/3/2	22
Total				257
Transmission/distribution (1 <sup>st</sup> period)	Takashi Okuhara	1	2008/12/9 ~ 2008/12/23	15
		2	2009/3/15 ~ 2009/4/10	27
		3	2009/6/14 ~ 2009/7/6	23
		4	2009/10/8 ~ 2009/11/1	25
		5	2009/12/4 ~ 2009/12/8	5
Subtotal				95



Assignment	Name	No. of trip	Duration of dispatch	No. of days
Transmission/distribution (2 <sup>nd</sup> period)	Junya Shinohara	1	2010/5/18 ~ 2010/6/1	15
		2	2010/7/18 ~ 2010/8/1	15
		3	2010/9/19 ~ 2010/10/7	19
		4	2010/12/11 ~ 2010/12/25	15
		5	2011/2/13 ~ 2011/2/27	15
Subtotal				79
Total				174
Hydropower (1 <sup>st</sup> period)	Kiyoshi Kokubu	1	2009/5/29 ~ 2009/6/9	12
		2	2009/11/25 ~ 2009/12/6	12
Hydropower (2 <sup>nd</sup> period)		4	2009/11/11 ~ 2009/11/22	12
Subtotal				36
Hydropower (2 <sup>nd</sup> period)	Shuichi Iwahana	3	2010/5/31 ~ 2010/6/11	12
Subtotal				12
Total				48
Diesel power	Yoshinobu Bojo	1	2009/6/8 ~ 2009/6/17	10
		2	2009/11/13 ~ 2009/11/26	14
		3	2010/8/1 ~ 2010/8/12	12
		4	2010/11/1 ~ 2010/11/12	12
Total				48
Grand total				976

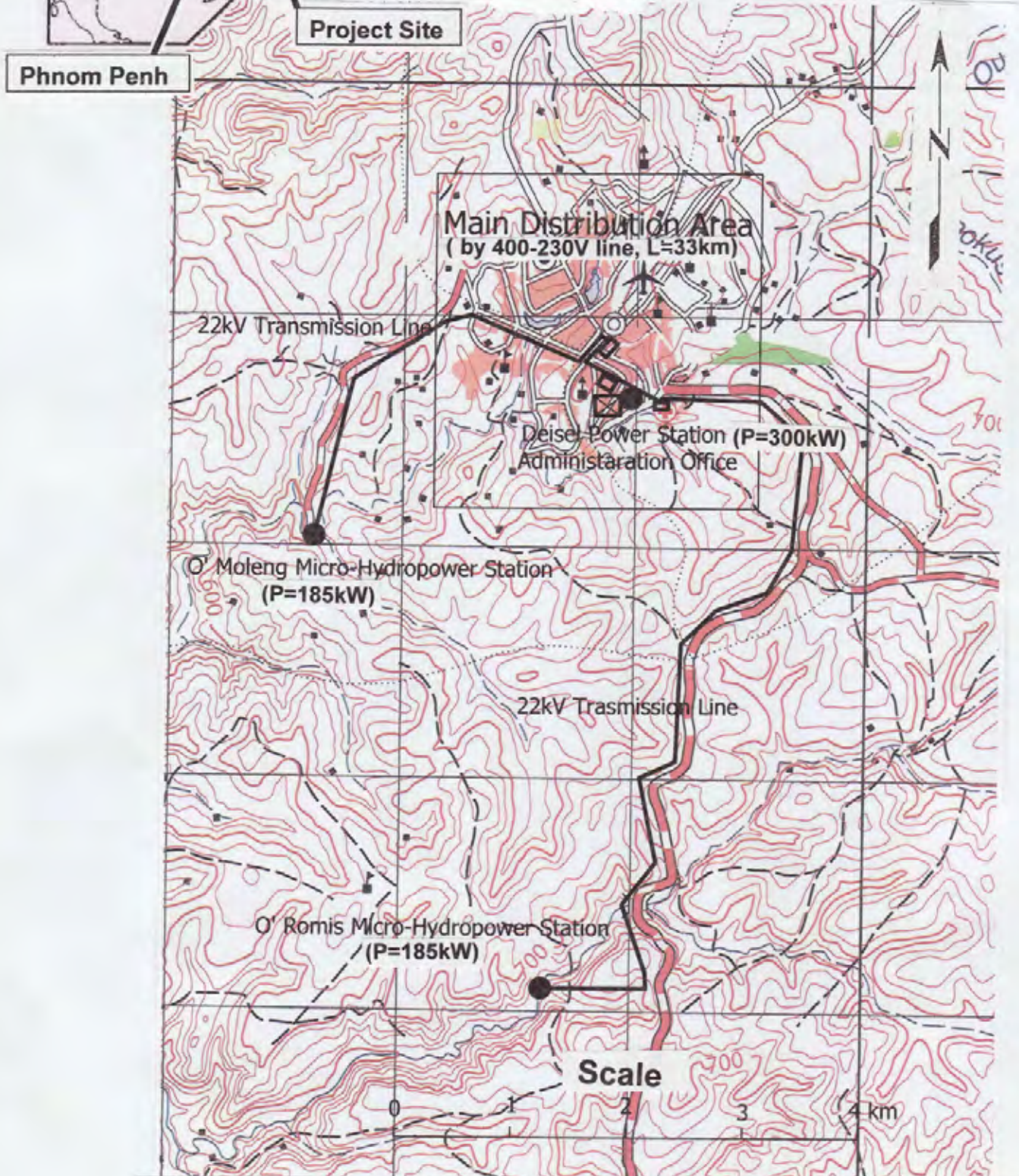
## Appendix - O

1. Location Map -----A-O-1
2. List of Main Electric Facilities-----A-O-2
3. List of Counter patars personnel-----A-O-3
4. Letter List -----A-O-8



# Project Location Map

## Senmonorom District, Mondul Kiri Province



The Project for the Rural Electrification on  
Micro-Hydropower in Remote Province of Mondul Kiri

## List of Main Electric Facilities of EUMP

Outline	
1.	O'Moleng Hydropower Station: Maximum Output 185kW Access Path (L=411m), Intake Weir (H=5.87m, L=60.0m) , Sedimentation Basin (L=23m), Penstock D=600 ~ 1200mm, L=415m, Hydropower Generating Facilities 185 kW, Generator & Control Facilities 250 kVA, Power Station Earthing Work 1 lot, Outlet
2.	O'Romis Hydropower Station: Maximum Output 185kW Access Path(L=1,850m), Intake Weir (H=5.22m, L=41.0m) , Sedimentation Basin (L=20.2m) , Water way (1.0m(B)×1.4m(H), L=1,015m), Head Tank 、(B=4m, L=20m), Spillway (L=92m) , Penstock (D=600-800mm, L=63m), Hydropower Generating Facilities 185 kW, Generator & Control Facilities 250 kVA, Power Station Earthing Work 1 lot, Outlet
3.	Diesel Power Generation: Maximum Output 300kW Powerhouse (A=144m <sup>2</sup> ), Diesel Engine & Aux. Facilities 300 kW x 1 unit ,Generator & Control Facilities 375 kVA x 1 unit, Power Station Earthing Work 1 lot
4.	Transmission and Distribution Facilities 22kV Transmission Lines(L=28km), 400-230V Distribution Line (L=33km), Switchyard and Transformer 1 lot, General Electrical Work :1 lot
5.	Administration Office One-Story (A=189m <sup>2</sup> ) VHF Radio System Facilities
Equipments	
1.	Pickup type vehicle 4WD (Engine capacity: 2,477cc)
2.	Work vehicle with mobile elevating work plat form (Engine capacity : 3,900cc)

**LIST OF COUNTERPART PERSONNEL  
(December 2008: Commencement of the Project)**

No	Name	Assignment title	Position
1	Mr. Kong Pisith	Project Director	Director of EUMP
<b>I. Management and administration part Output (1)</b>			
2	Mr. San Darith	Manager	Deputy director of EUMP
3	Mr. Pong Samnak	Deputy manager	Chief of administration section
4	Mr. Im Vichet	Member	Administrator
5	Mr. Kong Botrachhanny	Member	Bill management
6	Ms. Chres Malout	Member	Cashier
7	Mrs. Ny Sopor	Member	Cleaner
<b>II. Technical Part Output (2), Output (3) and Output (4)</b>			
8	Mr. Chin Sokhun	Manager	Deputy director of EUMP
9	Mr. Thai Khin	Deputy Manager	Chief of technical section
10	Mr. Chheoum Kosal	Member	Hydropower
11	Mr. Um Monychetra	Member	Hydropower
12	Mr. Sin Simeng	Member	Hydropower
13	Mr. Yang Soyen	Member	Hydropower
14	Mr. Heang Vandy	Member	Hydropower
15	Mr. Thim Seang hai	Member	Hydropower
16	Mr. Heng Sokhorn	Member	Hydropower
17	Mr. Pen Pidou	Member	Hydropower
18	Mr. Eng Rithy	Member	Hydropower
19	Mr. Toch Phally	Member	Hydropower
20	Mr. Sot Sarim	Member	Diesel Station
21	Mr. Sum Dara	Member	Diesel Station
22	Mr. Yeb Thav	Member	Diesel Station
23	Mr. Theng Setha	Member	Diesel Station
24	Mr. Savuth Sothea	Member	T & D Line
25	Mr. Ret Soksamdy	Member	T & D Line
26	Mr. Ros Samnang	Member	T & D Line
27	Mr. So Sovannarith	Member	T & D Line
28	Roem Navy	Member	Driver

Note: In case of unavoidable reason, the counterpart personnel are subject to be revised.

**LIST OF COUNTERPART PERSONNEL**  
**(June, 2010: After transfer to EDC)**

No	Name	Assignment title	Position
<b>I. Management part</b>			
<b>Output (1)</b>			
1	Mr. Chin Sokhun	Manager	Chief of EDC
2	Mr. Thai Khin	Deputy manager	Deputy Chief of EDC
<b>II. Administration part</b>			
<b>Output (2)</b>			
3	Mr. Im Vichet	Division Manager	Chief of Administration Division
4	Mr. Sot Sarim	Member	Assistant of Procurement
5	Mrs. Mey Champey	Member	Assistant of Administration
6	Ms. Yen Srim	Member	Cleaner
7	Mr. Hang Rotha	Member	Driver
<b>III. Accounting part</b>			
<b>Output (3)</b>			
8	Mrs. Chres Malout	Division Manager	Chief of Accounting Division
9	Mrs. Ty Souyatra	Member	Accountant
10	Mr. Kong Butrachany	Member	Billing and Costumer Management
11	Ms. Teing Pisey	Member	Assistant of Accounting
12	Mrs. Ny Sopor	Member	Cashier
<b>III. Technical Part</b>			
<b>Output (4), Output (5), Output (6), Output (7), Output (8)</b>			
13	Mr. Theng Setha	Division Manager	Chief of Technical Division
14	Mr. Savuth Sothea	Member	Chief of T&D section, Meter reading, Invoice Delivery
15	Mr. Ret Soksamdy	Member	Deputy Chief of T&D section, Meter reading, Invoice Delivery
16	Mr. Reom Navy	Member	Staff of T&D section, Meter reading, Invoice Delivery
17	Mr. Ruos Panha	Member	Staff of T&D section, Meter reading, Invoice Delivery
18	Mr. Thim Seanghi	Member	Staff of T&D section, Meter reading, Invoice Delivery
19	Mr. Reom Navang	Member	Staff of T&D section, Meter reading, Invoice Delivery
20	Mr. Yeb Thav	Member	Chief of Diesel Power Plant
21	Mr. Som Dara	Member	Deputy Chief of Diesel Power Plant
22	Mr. Eng Tola	Member	Operator of Diesel Power Plant

23	Mr. Nol Nin	Member	Operator of Diesel Power Plant
24	Mr. Hang Vuthy	Member	Operator of Diesel Power Plant
25	Mr. Yang Soyen	Member	Chief of O'Moleng Hydropower
26	Mr. Eng Rithy	Member	Deputy Chief of O'Moleng Hydropower
27	Mr. Cheoum Kosal	Member	Operator of O'Moleng Hydropower
28	Mr. Heang Vandy	Member	Operator of O'Moleng Hydropower
29	Mr. Um Monychetra	Member	Operator of O'Moleng Hydropower
30	Mr. Pen Pidou	Member	Chief of O'Romis Hydropower
31	Mr. Heng Sokhorn	Member	Deputy Chief of O'Romis Hydropower
32	Mr. Sor Soranda	Member	Operator of O'Romis Hydropower
33	Mr. Sin Simeng	Member	Operator of O'Romis Hydropower
34	Mr. Toch Phally	Member	Operator of O'Romis Hydropower

**LIST OF COUNTERPART PERSONNEL  
(February 2011)**

No	Name	Assignment title	Position
<b>I. Management part Output (1)</b>			
1	Mr. Chin Sokhun	Manager	Chief of EoM
2	Mr. Thai Khin	Deputy manager	Deputy Chief of EoM, Technical Manager
<b>II. Administration part Output (2)</b>			
3	Mr. Im Vichet	Division Manager	Chief of Administration Division
4	Ms. Roeurng Phaynary	Member	Warehouse and Fuel Oil Controller
5	Mr. Ruos Panha	Member	Warehouse and Fuel Oil Controller
6	Ms. Yoen Srim	Member	Cleaner
<b>III. Accounting part Output (3)</b>			
7	Mrs. Chres Malout	Division Manager	Chief of Accounting Division
8	Mrs. Ty Souyatra	Member	Accountant
9	Ms. Teing Pisey	Member	Cashier
10	Mrs. Ny Sopor	Member	Cashier
<b>IV. Exploitation part Output (4)</b>			
11	Mr. Kong Butrachany	Section Chief	Chief of Exploitation Section
12	Mr. Sot Sarim	Member	Billing Management
13	Mrs. Mey Champey	Member	Customer Management
<b>V. Technical Part Output (5)</b>			
14	Mr. Savuth Sothea	Section Chief	Chief of T&D section, Meter reading, Invoice Delivery
15	Mr. Ret Soksamdy	Member	Deputy Chief of T&D section, Meter reading, Invoice Delivery
16	Mr. Reom Navy	Member	Staff of T&D section, Meter reading, Invoice Delivery
17	Mr. Thim Seanghi	Member	Staff of T&D section, Meter reading, Invoice Delivery
18	Mr. Som Dara	Member	Staff of T&D section, Meter reading, Invoice Delivery
19	Mr. Hang Rotha	Member	Staff of T&D section, Meter reading, Invoice Delivery
20	Mr. Reom Navang	Member	Driver for T&D



<b>VI. Production Part</b>			
<b>Output (6), Output (7), Output (8)</b>			
21	Mr. Theng Setha	Division Manager	Chief of Production Section
22	Mr. Yeb Thav	Member	Chief of Diesel Power Plant
23	Mr. Nol Nin	Member	Operator of Diesel Power Plant
24	Mr. Eng Tola	Member	Operator of Diesel Power Plant
25	Mr. Hang Vuthy	Member	Operator of Diesel Power Plant
26	Mr. Yang Soyen	Member	Chief of O'Moleng Hydropower
27	Mr. Eng Rithy	Member	Operator of O'Moleng Hydropower
28	Mr. Cheoum Kosal	Member	Operator of O'Moleng Hydropower
29	Mr. Um Monychetra	Member	Operator of O'Moleng Hydropower
30	Mr. Heng Sokhorn	Member	Chief of O'Romis Hydropower
31	Mr. Sin Simeng	Member	Operator of O'Romis Hydropower
32	Mr. Toch Phally	Member	Operator of O'Romis Hydropower
33	Mr. Sor Soranda	Member	Operator of O'Romis Hydropower

## The Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondulkiri Province

### List of Issued Letter

No	Date	Letter No.	Place	Name of Letter	To
1	28-Jan-09	JT-001	C	Data Request of Electric Costumers	EUMP
2	28-Jan-09	JT-002	C	Influence toward O'Moleng Power Station by Private development at the upstream	EUMP
3	30-Jan-09	JT-003	C	Recommendation on Report of Fault Record	EUMP
4	30-Jan-09	JT-004	C	Repairing of Electrical Facility at O'Moleng Power Station	EUMP
5	10-Feb-09	JT-005	C	Collection of water flow data and maintenance of water level gauge	EUMP
6	21-Mar-09	JT-006	C	List of Thing to Do before June 2009	EUMP
7	23-Mar-09	JT-007	C	Electric Power Tariff and Billing System for Electric Unit of Mondulkir Province	EUMP
8	1-Apr-09	JT-008	C	Second Join Coordination in June 2009	EUMP
9	15-Apr-09	JT-009	C	Recommendation on FUALT OUTAGE RECOVERY LOG SHEET	EUMP
10	15-Apr-09	JT-010	C	Recommendation on SPARE PARTS LIST and TOOLS LIST	EUMP
11	17-Apr-09	JT-011	C	Recommendation on Acceptance test for Electrical facility at O'Moleng P.S	EUMP
12	20-Apr-09	JT-012	C	Request for 2nd JCC Meeting held in June	EUMP
13	21-Apr-09	JT-013	C	Submission of Technical term of Indicators at Power station	EUMP
14	24-Apr-09	JT-014	C	Submission of Long and Mid-term Plan and Tariff Charge System	EUMP
15	29-Apr-09	JT-015	C	Presentation of Business Performance at JCC meeting of June 2009	EUMP
16	19-May-09	JT-016	C	Submission of Schedule for Periodic Inspection (1 <sup>st</sup> )	EUMP
17	1-Jun-09	JT-017	C	Request for 2nd JCC Meeting held in June	JCC
18	23-Jun-09	JT-018	C	Drainage measures at O'Romis hydropower station	EUMP
19	20-Jun-09	JT-019	C	Recommendation on the Puniton and Preventive measures for the Can accident on 3rd May	EUMP
20	12-Aug-09	JT-020	C	Request of Assignment of Staffs for Editing O&M Manuals	EUMP
21	5-Oct-09	JT-021	C	Submission of Periodic Inspection Report (1st)	EUMP
22	21-Oct-09	JT-022	C	Submission of Schedule for Periodic Inspection (2 <sup>nd</sup> )	EUMP
23	26-Nov-09	JT-023	C	Slow paying by Provincial government office	EUMP
24	27-Nov-09	JT-024	C	Authorization of the Tariff price system by EAC	EUMP
25	27-Nov-09	JT-025	C	Stability of 22kV electric pole No.OR-051 of O'Romis line related with Construction work of the Route No. 76 National Road	EUMP
26	2-Dec-09	JT-026	C	Third Joint Coordination Meeting for the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri	MIME
27	24-Dec-09	JT-027	C	Submission of Draft version of Technical part of the Operation and Maintenance Manual for the Mondul Kiri electrification Project	MIME
28	12-Jan-10	JT-028	C	Need to do for implementation of FY 2010	EUMP

## The Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondulkiri Province

### List of Issued Letter

No	Date	Letter No.	Place	Name of Letter	To
29	15-Mar-10	JT-029	C	Submission of Completion Report for the First Period of the Operation and Maintenance Manual for the Mondulkiri electrification Project	MIME
30	21-May-10	JT-030	C	Progress of repairing work of O'Romis Reservoir	EUMP
31	24-May-10	JT-031	C	Discussion of the Work Plan for the Second Period of O&M Project of Electrification for Mondulkiri Province and Future Power Tariff System	EUMP
32	2-Jun-10	JT-032	C	Submission of Periodic Inspection Report (No.2)	EUMP
33	15-Jun-10	EDC/EOM JT-001	C	Recommendation to EUMP for Repairing Work for Entrance Access Road at O'Romis Hydropower Station, Mondulkiri Province	EUMP
34	17-Jun-10	EDC/EOM JT-002	C	Request for Review of the Guide line and Manuals for Operation & Maintenance of Electric Unit of Mondulkiri Province	EDC
35	5-Jul-10	EDC/EOM JT-003	C	Request for Mission on Reviewing the Guide line and Manuals for Operation & Maintenance on T&D	EDC
36	5-Jul-10	EDC/EOM JT-004	C	Request for Mission on Survey of Interconnection to Vietnam for T&D	EDC
37	10-Aug-10	EDC/EOM JT-005	C	Submission of 3rd Periodic Inspection Report, Electricity of Mondulkiri (EDC/EM)	EDC
38	8-Aug-10	EDC/EOM JT-006	C	Fourth Joint Coordination Committee Meeting for the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri	MIME
39	10-Sep-10	EDC/EOM JT-007	C	Request for Attendance of Mr. H. Yamakawa (JICA senior volunteer, EDC) for Meeting on Mondulkiri Electrification Project, Mondul Kiri Province	EDC
40	1-Oct-10	EDC/EOM JT-008	C	Submission of 3rd Periodic Inspection Report (Hydro and DG power stations), Electricity of Mondulkiri (EDC/EOM)	EDC
41	6-Oct-10	EDC/EOM JT-009	C	Recommendation of Specifications for 22kV Interconnection Plan, EDC	EDC
42	28-Sep-10	EDC/EOM JT-010	C	Request for Attendance for Fourth Joint Coordination Committee Meeting for the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri	EUMP
43	28-Sep-10	EDC/EOM JT-011	C	House near O'Romis powerhouse and light along the access path	EDC
44	3-Nov-10	EDC/EOM JT-012	C	Request for Attendance of Mr. H. Yamakawa (JICA senior volunteer, EDC) for Meeting on Mondulkiri Electrification Project, Mondulkiri Province	EDC
45	7-Dec-10	EDC/EOM JT-013	C	Request for Attendance the Meeting on Future Tariff Rate for the Rural Electrification on Micro-Hydro Power in Mondulkiri Province	EDC
46	13-Dec-10	EDC/EOM JT-014	C	Request for Attendance of the staffs of Electricity of Mondulkiri (EoM) for the Meeting on Future Tariff Rate of Mondulkiri Electrification Project	EDC
47	17-Jan-11	EDC/EOM JT-015	C	Final Joint Coordination Meeting for the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondulkiri	EDC
48	16-Feb-11	EDC/EOM JT-016 A	C	Periodic Inspection Report (4th) The Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondulkiri	EDC
49	7-Feb-11	EDC/EOM JT-016	C	Request for Attendance the Meeting on the Discussing about the Seminar on 22nd February, 2011 of Mondulkiri Electrification Project	EUMP
50	15-Feb-11	EDC/EOM JT-017	C	Request for Interview of the Ex-post Situation Study on the project for Operation and Maintenance on Micro-Hydropower in Rural Province of Mondulkiri	EDC
51	25-Feb-11	EDC/EOM JT-018	C	Recommendation of Disaster Prevention Plan, The Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondulkiri	EUMP

## The Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondulkiri Province

### List of Received Letter

No	Date	Letter	Place	Name of Letter	From
1	6-Feb-09	KIG/TEC/EUMP-001	C	Request for Repair Schedule of Electrical Facility at O'Moleng Power Station	EUMP
2	14-Feb-09	KIG/TEC/EUMP-002	C	Cc: Release of Letter of Guarantee	EUMP
3	26-Apr-09	KIG/TEC/EUMP-003	C	Test Acceptance for Electrical facility at O'Moleng P.S	EUMP
4	30-Apr-09	KIG/TEC/EUMP-004	C	No Subject	EUMP
5	1-May-09	KIG/TEC/EUMP-005	C	Claim for Spare parts of Motor Driven Air Compressor at DG station	EUMP
6	2-May-09	KIG/TEC/EUMP-006	C	Presentation of Business Performance at 2nd JCC meeting on 19th June 2009 and submission of long and Mid-term Plan and Tariff rate System of EUMP	EUMP
7	5-May-09	KIG/TEC/EUMP-007	C	EUMP Car accident	EUMP
8	14-Aug-09	KIG/TEC/EUMP-008	C	Assignment of Staffs for Editing O&M Manuals	EUMP
9	15-Aug-09	KIG/TEC/EUMP-009	C	The Current Performance of EUMP	EUMP
15	15-Dec-08	KIG/TEC/EUMP	C	Cc. Claim for Electrical Generating Facility at O'Moleng Power Station	EUMP
16	26-Jan-09	KIG/TYO/JP/NK	C	Cc. Recommendation and Countermeasure for Claim of Electrical Generating facilities at O'Moleng Power Station	Konoike
17	20-Feb-09	KIG/TYO/001/JP-NK	J	Tax exemption for the repairing materials in warranty	Konoike
18	10-Jun-09	KIG/TEC/EUMP	C	Bcc. Proposing Power Tariff to Electric Authority of Cambodia for Determines the Power Tariff for EUMP	EUMP
19	16-Jul-09	KIG/TEC/EUMP 65/09	C	Cc. Announcement	EUMP
20	6-Aug-09	KIG/TEC/EUMP 071/09	C	Cc. Requesting for Report of a Trouble of the Signal "Stop" On the Control Panel at O'Romis site	EUMP
21	20-Aug-09	KIG/TEC/EUMP 072/09	C	Cc. Requesting to Excellency for taking a measure to intervention of the building such as the small cottage at the land block area of Hydropower Electricity at O'Moleng	EUMP
22	2-Oct-09	KIG/TEC/EUMP 092/09	C	Cc. Propose for Coordinating of Paying the Monthly Energy Consumption Ranging from January to September 2009	EUMP
23	31-Dec-09	KIG/TEC/EUMP	C	Cc. Repair the slope soil at O'Romis access No.13	EUMP
24	8-Jan-10	KIG/TEC/002/10 EUMP	C	Cc. Propose for intervention of Parrot Cigarette Company that pick up an advertisement near by the electric pole OM-079 (The head of the airport)	EUMP
25	4-Jun-10	No. 2861 EDC	C	Nomination of EDC's Counterpart Team	EDC
26	14-Sep-10	No. JC22- 510	C	Cc: Terminal Evaluation of the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri (EUMP)	JICA
27	14-Sep-10	No. JC22- 511	C	Cc: Terminal Evaluation of the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri (Provincial Hall)	JICA
28	15-Sep-10	No. JC22- 519	C	Cc: Terminal Evaluation of the Project for Operation and Maintenance of the Rural Electrification on Micro-Hydropower in Mondul Kiri (DIME)	JICA

## **Section 2 Annual Report on Activities**

**First Period (from December 2008 through March 2010)**

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# **Chapter 1 Overview of Support Services in the 1<sup>st</sup> Period**



## Chapter 1 Overview of Support Services in the 1st Period

### 1.1 Activities and Achievements of the 1st Period (Overview)

The main features of this project is: that it is power supply mainly by hydropower, one of the few renewable energy projects at work in Cambodia and that it is operated as public corporation by locally hired inexperienced staff. It is necessary to establish techniques for operation and maintenance in synchronization with a plural set of power plants composed mainly by hydropower and to collect electricity bills for sound management of EUMP without fail, so that an appropriate system must be established from scratch so as to make EUMP a power utility sustainable in operation/maintenance and management/administration.

For the above purposes, the activities shown in the workflow stated later were developed. The main tasks include ‘support to establishment of an appropriate system and organization’, ‘suggestion of a logical and appropriate power tariff system’, ‘guidance to operation and periodical inspection of the power facilities, including troubleshootings’ and ‘preparation of guidelines and operation manual in Khmer.’

The above activities have brought about the following achievements with a view to the project purposes.

- ① EUMP will make 14% of profit in 2009 with sound management
- ② Power supply will continue for 24 hours to people of Sen Monorom town.

Shown below are the achievements by sectors of management, civil structures, power generation facilities and transmission/distribution facilities resulting in the above overall achievements.

#### (1) Management and administration system

##### a) Improve the collection rate of electricity bills

Guidance to establishing and applying the billing system from the onset resulted in an average collection rate of 97% of power sales.

##### b) Take appropriate accounting procedures in EUMP.

Monthly income statement was prepared and an annual financial report to MIME was prepared at the end of the fiscal year.

#### (2) Civil structures

##### a) The manual of EUMP was revised in each sector taking into account the experience and actual conditions obtained from two-year ‘trial’ operation.

The first version of O&M manual (in English and Khmer) of civil structures was prepared taking into account the performance of operation and maintenance obtained form OJT of the first period.

- b) Bring up such personnel as can understand the manual to a certain degree and conduct maintenance of the civil structures.

Experience was gained by practice regarding flow measurements, clearing of trash rack at intakes and drainage works of roads.

(3) Generation facilities

- a) The manual of EUMP was revised in each sector taking into account the experience and actual conditions obtained from two-year 'trial' operation.

The first version of O&M manual (in English and Khmer) of power generation facilities was prepared taking into account the performance of operation and maintenance obtained from OJT of the first period.

- b) Bring up such personnel as can understand the manual to a certain degree and conduct maintenance of the power generation facilities.

The method for normal operation and recording was acquired through actual power generation. 2 semi-annual periodical inspection works brought about hands-on learning of the functions and features of the facilities.

(4) Transmission/distribution facilities

- a) The manual of EUMP was revised in each sector taking into account the experience and actual conditions obtained from two-year 'trial' operation.

The first version of O&M manual (in English and Khmer) of transmission/distribution facilities was prepared taking into account the performance of operation and maintenance obtained from OJT of the first period.

- b) Bring up such personnel as can understand the manual to a certain degree and conduct maintenance of the transmission/distribution facilities.

It was judged from operation performance that basic abilities of inspection and maintenance works at normal times and troubleshooting were gained through OJT.

Support services were conducted with an emphasis on making a 'frame' and imparting the minimum 'technique' for operation. The achievements so far made can be said as: 'acquisition of basic techniques for operation of power facilities and establishment of sure collection of electricity bills.'

## **Chapter 2 Management and Administration**

## Chapter 2 Management and Administration

### 2.1 Activities and Achievements of the 1<sup>st</sup> Period

#### 2.1.1 General

In the 1<sup>st</sup> period, the experts in management and administration were dispatched to Cambodia, 5 times between December 2008 and March 2010 totaling 10 times, providing technical transfer of management and administration to the administrative staff of EUMP (Electricity Unit of Mondul Kiri Province), the counterpart of JICA team. As a result, EUMP attained 97% of collection of electricity bills in 2009 and 14% of profit, keeping a smooth operation.

This project started with nothing for power tariff setting and business processing system, so JICA team took the initiative to establish the framework for management in the 1<sup>st</sup> period. During that period, the above system was revised according with the operation performance and the level of proficiency and, in December 2009, the guidelines and manual were prepared taking the above into account. It can be judged that the ability of business processing of the young members of CP in administrative matters has steadily been improved by repeated sequences of business processing such as metering (power consumption measurement), billing, collection of bills and tallying.

The activities and achievements in the 1<sup>st</sup> period are described as follows.

#### 2.1.2 Achievements by PDM Activities

- (1) Prepare long and mid-term plan and financial plan (submitted in April 2009)

A long and mid-term plan and financial plan was prepared in April 2009 considering the conditions of the facilities and organizational operation and the technical level of the staff of EUMP and gained the consent of JCC in its 2<sup>nd</sup> meeting held on 15 June 2009.

The long and mid-term plan and financial plan was aimed at a steady management of EUMP in future. The time horizon was set at 3 years as mid term, during which power would be able to be supplied within the capability of the current power facilities of this project, and at maximum 10 years beyond the mid term as long term. That long and mid-term plan is a rolling plan to be revised annually based on the performance of the previous year and the future prospect. In the 1<sup>st</sup> year, that plan was prepared by JICA team and, from then onward, it is to be revised by EUMP.

The financial plan was prepared with estimated revenues from annual power demand forecast (sales volume) and estimated power tariff (the power tariff was not determined at that time) and with estimated expenses from planned power supply by hydropower on account of seasonal flow fluctuation and by diesel power. At the time of planning (April 2009), the profit rate was assumed at 10% and the year 2009 recorded the profit rate at 14.3%, having attained the target rate of profit. The difference from the assumed profit rate was due to increased river flow, which led to decrease in diesel power supply resulting in saving fuel. Appendix 2-1 shows the power supply

and demand and the balance sheet as of 2009.

(2) Establish a billing system (submitted in April 2009)

As for power tariff, a provisional tariff was applied until the official tariff was approved in the 2<sup>nd</sup> JCC meeting held in June 2009. The provisional tariff was once revised in January 2009 considering opinions of the provincial government and public hearing. The current billing system was prepared in consultation with EAC and based on the power demand and financial results during the period of the provisional tariff.

As stated above, the year 2009 recorded a collection rate as high as 97%. This fact demonstrates that the billing system has been operated efficiently.

(3) Establish the manual for management and administration (submitted in February 2010 and approved in 3<sup>rd</sup> JCC meeting)

A baseline survey was conducted in the 1<sup>st</sup> field activities in December 2008 to grasp the situation of business process of EUMP and its staff as well as their abilities to perform their tasks. That survey revealed that there were no regulations such as articles of incorporation, powers and duties and other regulations for management and administration and, instead of their own regulations, they were doing business processes partly taking the business practice of EdC. Also learnt was that most of the management and staff did not have experience in working at a company, several years of their graduation from high senior school, and that almost none of accounting and other business knowledge were gained.

The above understanding of the actual conditions led to the judgment that it was not practical to try to make technical transfer by the standard of Japanese power utilities and to the determination of the approach of this project of support services for management and operation: minimum technical transfer and improvement of the staff's abilities so as not to impair the operation of EUMP, instead of strict implantation and application of different regulations and manual.

Based on the above approach, preparation was made of power tariff setting and billing system, articles of incorporation and basic regulations such as organization, powers and duties and employment, and relevant guidance was provided. (See Appendices 2-6 ~2-14) As for the long and mid-term plan, an important management tool, guidance was provided by means of Excel model. Regarding the accounting, the accountant had a certain degree of knowledge and experience in accounting and she prepared the annual financial report with assistance from MIME. Other staff members than the accountant should have basic knowledge of accounting, so that some lectures were given on introductory accounting, while guidance was provided in a manner of questions and answers with the accountant about daily accounting matters.

Workflows were prepared by each administrative staff regarding their respective tasks in order

for them to make sure their business processes and to become aware of close relationship with the tasks of other staff members. (See Appendices 2-15 and 2-17)

The above achievements were compiled in draft Guidelines and O&M Manual in December 2009 both in English and Khmer and distributed to the JCC members and, through preview by JCC members, approved by JCC in its 3<sup>rd</sup> meeting held in February 2010. It is expected that that manual will be opportunely revised to become more tailored to their conditions by the staff of EUMP.

(4) Control of operation of power facilities through OJT

Power supply requires not only the operation section directly engaged in power generation and transmission/distribution but also the 120 support section for efficient function of the entire power utility. To that effect, EUMP was set up with such sections as personnel, inventory control and procurement. There was poor recognition of working hours and other work system, so advice was given to prepare attendance sheets and enter the hours worked therein every day. And guidance was given to prepare registers of materials and spare parts of the power facilities. As for diesel power, which requires fuel, guidance was provided as to estimated fuel consumption and fuel procurement from Phnom Penh. For purposes of smooth operation of the power facilities, the administration section was provided with OJT guidance of work procedures in labor control and procurement of equipment and materials.

(5) Record and compile relevant data (customers, power sales and revenues and expenses)

Formats of registers and records were prepared for customer book, monthly power sales, power tariff, accounting books, facilities and materials and those data are being accumulated and controlled by use of the granted computers. See Appendix 2-17 and 2-18 for specific examples.

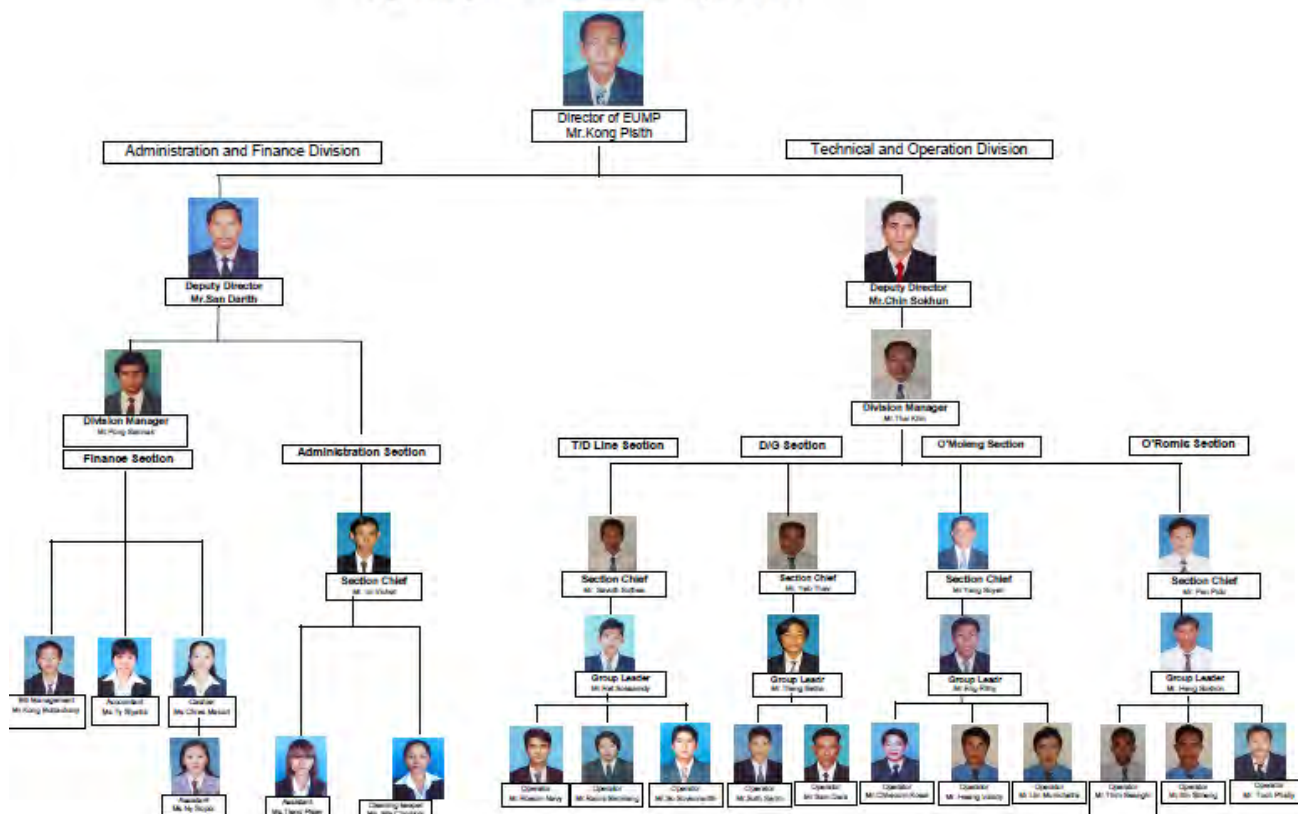
## 2.2 Organization of EUMP

### 2.2.1 Organization

EUMP’s organization is composed of the management, administration division and technical and operation division. The administration division comprises the finance section including accounting, cashier and bill management, the general affairs section including general affairs and personnel/labor matters and the procurement section including procurement and inventory control. The technical and operation division comprises 2 hydropower sections and 1 diesel power section as well as transmission/distribution section.

The management consists of 3 board members, 1 Director and 2 Deputy Directors, in charge of administrative and technical divisions, all of them from DIME of Mondul Kiri province of MIME. The staff members were locally recruited and employed as employees of EUMP.

Fig. 2-1 Organization Chart of EUMP (Feb.2010)



### 2.2.2 Tasks of Administration Section

In order to make clear the tasks of each member, a table of task assignments was prepared. (See Appendix 2-9) At the same time, a line of command was established to make clear who has the power to instruct and authorize and to whom the inferior should report. (See Appendix 2-11).

## 2.3 Activities

### 2.3.1 Field Activities Record

	Duration	Field activities
<u>Koji Mishima</u>		Leader/management
1 <sup>st</sup> field activities First	15 December 2008 through 28 February 2009 (75days)	Establishment of JCC, preparation for operation system establishment (organization • provisional power tariff), guidance for operation before system establishment in EUMP
Second	15 March 2009 through 24 March 2009 (10 days)	Consultation with EAC about power tariff
2 <sup>nd</sup> field activities	7 June 2009 through 26 June 2009 (20 days)	2 <sup>nd</sup> JCC meeting, coordination for long and mid-term plan and power tariff
4 <sup>th</sup> field activities	16 November 2009 through 7 December 2009 (22 days)	Preparatory works for guidelines and manual
5 <sup>th</sup> field activities	11 February 2010 through 28 February (18 days)	3 <sup>rd</sup> JCC meeting, explanation of O&M manual, performance report for 2009
<u>Tetsuro Tanaka</u>		Administration
1 <sup>st</sup> field activities First	9 December 2008 through 19 December 2008 (10 days)	Baseline survey, guidance for operation before system establishment in EUMP
Second	14 March 2009 through 23 March 2009 (11 days)	Lectures on task assignments and other administration matters, preparatory works for billing system
2 <sup>nd</sup> field activities	14 June 2009 through 23 June 2009 (10 days)	Preparation of articles of incorporation and different regulations, administration OJT and audit
4 <sup>th</sup> field activities	25 November 2009 through 4 December 2009 (10 days)	Administration OJT and audit, preparatory works for guidelines and manual
5 <sup>th</sup> field activities	19 February 2010 through 28 February 2010 (10 days)	3 <sup>rd</sup> JCC meeting, explanation of O&M manual, performance report for 2009

### 2.3.2 Field activities Report

This report summarizes survey works, countermeasures, evaluation and guidance in each item of management and administration tasks during the dispatching period.

#### (1) 1<sup>st</sup> field activities (December 2008 through April 2009)

##### Management issues

The main purpose of the 1st field activities was: technical wise, learn the structures and basic



functions of the power facilities by doing by themselves to such an extent as not to damage the facilities and in terms of organization management, become able to collect electricity bills and gain a basic consent regarding power tariff, the only income source.

### **A. st field activities December 2008~February 2009**

#### **1. 1<sup>st</sup> JCC meeting: 18 December 2008: Phnom Penh**

Attended by

- MIME : Dr. It Prain, Secretary of State  
Dr. Bun Narith, Deputy General Director, General Dept. of Energy
- EUMP : Mr. Kong Pisith, Director of EUMP, DIME Director
- JICA : Mr. Shigeki Miyake, Assistant Director, JICA Cambodia Office  
Mr. Takeshi Washizawa, JICA expert (MIME)
- JICA team : Koji Mishima, Chief Advisor of JICA Project Team  
Yukitaka Hiraga, Advisor for Generation  
Takahito Okuhara, Advisor for Civil Structure

The 1<sup>st</sup> JCC meeting was held in 18 December 2008. The contents of this project of technical cooperation were explained in line with the inception report and granted consent by Cambodian side. At the time of that meeting, power had already started to supply and electricity bills had been collected for the first time in November 2008. It was soon after a request for reduce the power tariff by the provincial government dated 12 December to EAC, discussions were centered on the power tariff set at the time of the grant aid period. The power tariff setting method was basically understood by JCC. It was decided that JICA mission was to suggest a power tariff based on the actual performance data toward March.

#### **2. Consultation with Mondul Kiri Provincial Government: 4 January 2009**

Attended by

- Provincial government : Ms. Aisi Sokuntheari, Vice governor and other 2 officials
- EUMP : Mr. Kong Pisith Director of EUMP DIME Director
- JICA team : Koji Mishima

Major point: A request for lowering the provisional power tariff, especially giving consideration to public services and low-income class because of its high level as claimed by the provincial government

#### **3. Consultation with EAC about power tariff setting method: 12 January 2009**

Attended by

- EAC : Dr. Ty Norin, Chairman- Secretary of State
- EUMP : Mr. Kong Pisith, Director of EUMP

JICA : Mr. Shigeki Miyake

JICA team : Mishima, Hiraga

Consultation was made with EAC about the suggested power tariff to be applied during the provisional period considering power supply for low-income class and public services at the request of Mondol Kiri provincial government.

The suggested power tariff was based on the following concepts: the average level of the power tariff based on the costs remains unchanged, that is, no change in total revenue; and, the tariff category changed from kind of use (residential and commercial) to consumption volume. The less the consumption, the lower the tariff and the more consumption, the higher the tariff. This method would lead to relief for low-income class with less power consumption. For the public services, the minimum tariff was suggested irrespective of its power consumption.

The above tariff suggestion was rejected as unacceptable for the following reasons:

- ① Differing power rates by consumption cause cross subsidy between users. That concept may be accepted in developed countries but cannot be accepted in Cambodia at the current level of national development.
- ② In Phnom Penh, a similar method is adopted and causes deficit, while it cannot be raised for political reasons. This situation accelerates financial deterioration of EdC.
- ③ Regarding the tariff for the public services, the fact is that it is quite difficult to raise the power tariff once it is set at a low level. There are some cases of resale through illegal channels.

The above opinion of EAC was considered to have reality based on the actual situation of Cambodia, so that the adoption of differing power tariff by power consumption was withdrawn.

The power tariff setting method was based on the power tariff law but except for the following two points, which had not been experienced. On these matters, repeated consultations had been made with EAC from the time of soft components of the grant aid project, so that EAC gave its consent to them.

Power tariff setting specific to EUMP

- ① Depreciation costs will not be considered because of the nature of the grant aid project but provision will be made for overhaul fund reserve in preparation for relatively large size of repairs such as overhaul in order to keep the facilities sound in future.
- ② Hydropower resources are river flow, influenced by climate change and varying power generation. Draught provision will be made for increase in diesel power generation in preparation for irregular draught, procrastinating dry season and exceeding water shortage.

#### 4. Public hearing on power tariff: 29 January 2009

A public hearing was held on power tariff in Sen Monorm town hosted by Modol Kiri provincial government.

Attended by:

Chairperson: Vice governor of Mondol Kiri province in charge of power : Ms. Aisi Sokuntheari

EAC : Dr. Ty Thany, Director in charge of finance and power tariff and other 3 officials

EUMP : Mr. Kong Pisith Director of EUMP DIME Director

JICA team : Mishima

User side : about 80 people

Officials of provincial government and regional offices of central government, county representatives, district representatives and others

Major point:

Opinions from local people mainly concerned lowering the power tariff. Responding to such opinions, EAC explained that the official power tariff would be proposed within several months based on the actual performance records. JICA team explained that the current provisional tariff was set last year at the time when fuel prices were high and that it was technically possible to lower the tariff level by 200 riel/kWh through fuel price adjustment.

Finally, the chairperson proposed 200 riel/kWh reduction of the tariff, which was agreed unanimously. Applying that reduction was to be applied from 20 January onward (corresponding to bill collection for the cutoff date of 20 February). It was agreed that an official power tariff would be discussed based on several months of actual performance records between EUMP and EAC with guidance of JICA team.

### **B. March 2009 1<sup>st</sup> field activities**

#### 1. Consultation with EAC about power tariff system

Attended by

EAC : Dr. Ty Norin Chairman  
Mr. Hul Kunnak Vuth,  
Dr. Ty Tany, Director, finance and tariff

EUMP : Mr. Chin Sokhum Deputy Director

JICA : Mr. Washizawa, JICA expert (MIME)

JICA team : Mishima, Tanaka

In the 1<sup>st</sup> JCC meeting and the local public hearing, it was said that the official power tariff was going to be proposed in March. JICA team made a suggestion of official power tariff and billing system to be applied from June based on the actual performance of operation and power sales of EUMP.

### Billing system

EAC was content with the suggested billing system, which included those matters not yet made in Cambodia and incorporating some knowhow of Japanese power utilities. EAC urged EUMP to make the billing system its internal regulation.

JICA team intended to explain the billing system to EUMP's staff and direct them to make adjustments and revisions according to their conditions.

EAC made a request to make its Khmer version, which was to be incorporated in O&M manual.

### Power tariff

A power tariff was proposed for official approval considering the circumstances so far learnt.

The method of cost calculation had already been agreed by repeated consultations. A revision was made of the provisional tariff by adjustment of fuel price in February 2009. The recent average cost decreased by about 100 riels from the current tariff level. A major point was to adopt fuel price adjustment applied to fuel cost of diesel power generation.

EAC basically agreed with that proposal and the procedure and submission of necessary documents were going to be proceeded by EUMP and EAC.

### Administration Issues

Meetings were held with EUMP's administration staff in their offices as a baseline survey of EUMP's administration on the following dates.

12 December 2008	14:00-17:30
13 December	8:00-12:00
15 December	8:00-12:00

Attended by: All of administration staff of EUMP 6 people and its deputy director

JICA team: Tanaka, Ms. Davy (assistant to JICA team)

### I. Main points

- 1) Mission of EUMP
- 2) Reason for necessity of gaining reasonable profit by increasing revenues and decreasing expenses
- 3) Recognition of administration section within EUMP
- 4) What is a company?
- 5) Role of management board
- 6) Corporate organization as operating function
- 7) Scope and content of administration tasks

(See Appendix 2-2)

- 8) Matters to be established in doing administration tasks
- i) Smooth decision-making and communications: line of command and information, communications with technical section, communications with outside (especially with customers and relevant authorities)
  - ii) check and balance system: prevention against irregularities
  - iii) Necessity for internal regulations and manual
  - iv) Necessity for administration staff prepared for multiple functions: check and balance and periodical personnel change
  - v) Clear task assignments and responsibilities: necessity for regulations regarding organization, task assignments, powers and duties

#### II. Current tasks of administration staff

Mr. San Darith: (Deputy director in charge of administration) Overall control of administration matters and the most responsible for administration

Mr. Pong Samnak: (Head in administration) accounting and cash control

Mr. Im Vichet: (Deputy head in administration) general affairs and warehouse control

Ms. Chres Malout: (Cashier) cash handling regarding connection fee of new customers and deposit

Mr. Kong Botrachhany: (Billing) computer-aided bill preparation

Ms. Hong Leakhena: (Assistant to cashier) assistance of cash handling

#### III. Confirmation of existence of forms by check list

As shown in Appendix 2-3, no forms have been prepared at the moment. Advice was given to prepare necessary forms together with manual.

#### IV. Identified issues and measures

- 1) There are many new application for power supply, which makes the administration staff busy. No attendance sheet has been prepared, so that control of working hours including overtime is not being done. Advice was given about how to prepare an attendance sheet and to prepare it soon.
- 2) The task assignments, as mentioned in II, do not cover the whole tasks of administration. Advice was given to determine clearer task assignments once the busy period has passed. Advice was also given in such that it is necessary to collaborate with each other in actual works but also important is to make clear the responsible person of each task.
- 3) Bookkeeping has not yet been done but will be started in January 2009.

Considering the currently busy situation and their inexperience, advice was given to control cash and keep books at least. They have taken an accounting lecture once but their knowledge was half lost as they said. They wanted to take similar lectures again.

- 4) They are poorly aware of company registration, tax matter, work conditions and accounting standards. Explanation was given about the necessity for compliance with relevant laws and advice was given to examine such laws.

#### V. List of things to do by March 2009

A list of things to do by the 2<sup>nd</sup> field activities (late March 2009) was given to EUMP administration section as seen Appendix 2-4 'To Do List' and agreed by them. In the next field activities, their progress will be checked and advice given where necessary.

#### VI. Espert's remarks

EUMP has just been set up, busy with paperwork for new customers. Considering their inexperience, it is thought that it will not bring expected effects to teach them too many things in a short time. And it is desirable for them to work out the business procedures and forms for administration tasks by themselves with reference to examples of other Cambodian organizations because it is necessary to respect the country's practice and laws. Advice will be given at proper occasions to help them prepare their own manual. By doing this, such consciousness that their company is going to be built by themselves will be fermented in a direction toward future self-sustainability without easily relying on others. If there is something beyond their ability, suggestions will be given in advance and appropriate guiding methods will be searched for including provision of framework and examples.

Considering the education level, experience, ability and age of EUMP's administration staff, it is more practical to set such a goal as to establish the minimum level of administration system for operation of EUMP taking time with assistance of JICA team, instead of a perfect administration system, during 2 periods of this project of support services.

In this connection, JICA team would like to have particular consideration from JICA for flexible change of activity schedule for such as business trip timings according to progress of EUMP.

#### **(2) 2nd field activities (May through June 2009)**

##### **Management issues**

2nd JCC meeting: 15 June 2009: Phnom Penh

Venue: Conference room of MIME, Phnom Penh

- JICA Cambodia Office: 3 officials
  - Mr. Yusuke Murakami, Deputy Representative
  - Mr. Shigeki Miyake, Assistant Director
  - Mr.Heng Salposeth, Project Officer
- MIME: 6 officials
  - Dr.Ith Praing, Secretary of State
  - Mr.Klaut Randy Secretary of State
  - Dr.Say Phirum
  - Dr.Bun Narith, Deputy General Director, Energy,
  - Mr.Much Chhun Horn Director, Hydropower Mr.Nong Sareth Deputy Director, Hydropower
- EAC: 2 officials
  - Dr. Ty Norin, Chairman,
  - Mr.Theng Marith Director, Tariff
- EDC : 1 official
  - Mr. Houg Chantha Head of Engineering Office, Hydropower planning Dept.
- EUMP: 11 officials
  - Mr.Kong Pisith Director, Mr. San Darith Deputy Director Administration, Mr. Chin Sockun Deputy Director, Technical, Administration staff 4 members, Technical staff 4 members
- JICA team: 7 members
  - Koji Mishima, Chief Advisor
  - Tetsuro Tanaka, Advisor for Administration
  - Takahito Oikawa, Advisor for Civil Structure
  - Yukitaka Hiraga, Advisor for Power Generation
  - Takashi Okuhara, Advisor for Transmission/distribution
  - Yoshinobu Bono , Supervisor of diesel power equipment
  - Ms.Eang Sodavy, Local Coordinator

### Summary

Half a year have passed since the start of EUMP. The major purpose at the setup time is to enable basic tasks such as power generation, transmission/distribution and bill collection and to establish power tariff as well as preparation of management policy including long and mid-term plan. In this meeting of JCC, the former was reported by EUMP and the latter was suggested by JICA team, both approved by JCC.

### Main points

1) Situation report of EUMP's administration:

Mr.San Darith, deputy director of EUMP in charge of administration, reported the

current situation and performance including the organization, line of command and monthly revenues and expenses.

2) Situation report of EUMP's technical section:

Mr.Chin Sokhun, deputy director of EUMP in charge of technical section, reported the current situation and performance of the technical section including problems of operation and maintenance, situation of a periodical inspection (6 months of the start) The following remarks were made by EUMP Director.

- Would like to see the situation of O&M after half a year.
- Look forward to further technical transfer from JICA team through OJT
- Going to keep attention to financial situation in light of increasing relationship between investment and power consumption and tariff revision.
- A remark was given by an member from EdC about measures against lightning for transmission lines. Responding to that, JICA team made a fresh request technical cooperation from EdC, which has expertise in transmission and distribution.  
(Edc is reluctant to provide cooperation for rural electrification)

3) Power tariff system: See 'Power Tariff System' submitted in April 2009

a) Suggested power tariff: Mishima, JICA team

Repeated consultations have so far been made with EAC and this JCC meeting confirmed the suggested power tariff as substantially consented by EAC in March this year.

An additional proposal to the power tariff was made by EUMP. Regarding the power tariff for residential use at low voltage, it will remain the same as suggested by JICA team and a new category will be set for customers at medium voltage with a tariff level 75% of that of the low voltage. Mr. Theng Marith, Director of tariff of EAC commented on that proposal stating that 81% is more appropriate on account of a high level of current transmission loss.

As for setting the power tariff, necessary procedures will be taken by EUMP and EAC.

b) Billing system: Tanaka, JICA team

As for this matter as well, consultations with EAC were repeatedly made as were with the above power tariff and the content has almost been established. EUMP's staff is now under training for that.

Concretely, that billing system covers a procedural sequence of different tasks from application and supply contract with customers, metering of power consumption, billing based on measurements and bill collection.

How to handle arrears of bill payments by customers was also proposed as part of the billing system, important factor affecting the revenues and management discipline.



4) Long and mid-term plan: See ‘Long and Mid-term Plan’ submitted in April 2009

Firstly, JICA team explained the significance of the long and mid-term plan and added that the plan was to be revised yearly by EUMP.

JICA team explained that although the plan may include some errors in demand forecast due to poor accumulation of actual records of the just started up utility, a stable power supply with the current installed capacity will be possible for a few years, while from then onward it would take some measures to cope with increased demand.

It was also informed that the suggested power tariff would be only applicable under the current stable power supply situation with the current power facilities and when the supply and demand balance changes, it would be necessary to make tariff revision.

In connection with the above explanation by JICA team on the long and mid-term plan, Dr. Bun Narith (MIME) raised a question of whether there are any plans for increase in installed capacity (kW) of Mondul Kiri power system and extension of MV and LV. JICA team responded by saying that the proposed plan is to see annual requirements and budget for operation and maintenance of the existing facilities and that new development plans are to be examined by Cambodian government, so the plan does not include such expansion plans.

### Administration issues

The 2<sup>nd</sup> field activities were conducted from 14 June through 22 June 2009 as follows.

#### I. Approval of billing system by JCC

In the 2<sup>nd</sup> JCC meeting held in 15 June, the billing system, prepared as part of the manual for administration, was explained and approved.

#### II. Articles of incorporation and organizational regulations

The articles of incorporation and regulations on organization, powers and duties, and employment rules, prepared as part of the manual for administration, were explained to EUMP’s administration staff. (See Appendices 1-3) A request was made to discuss them within EUMP and take steps to make them official internal regulations without delay.

And also task assignments were suggested for the administration section and another request was made to discuss them and determined.

As a reaction to the accident of a corporation’s vehicle, a request was made to prepare regulations on control of corporation’s vehicles and disciplinary code to make them internal regulations. (See Appendices 4 & 5)

#### III. Workflow of accounting

A general workflow of accounting works (see Appendix 2-17) was shown to all of the administration staff and explained together with its relations with the tasks of other staff members of the administration. Some lectures were given as to basic accounting knowledge. The accountant of EUMP does not understand well the roles of journal and ledger and non-fund transactions, so JICA team made an explanation of such matters.

#### IV. List of things to do by the 4th field activities

The list of things to do by the next field activities was prepared as To Do List and given to the administration staff of EUMP to do so.

### **(3) The 4th field activities**

The 4<sup>th</sup> field activities were conducted from November through December 2009 as follows.

#### I. Workflows of administration staff

In the previous 3<sup>rd</sup> field activities, JICA team instructed the administration staff to prepare workflows of their tasks, which were sent to JICA team as seen in Appendix.2-17 In this field activities, the workflows were explained by each of the administration staff and questions and answers were made. The major points were in the following..

#### 1. San Darith (Deputy Director)

- i) As recruitment, promotion, pay hike and dismiss are important procedures, advice was given to make the related procedures internal regulations.
- ii) It was learnt that an assessment meeting is held quarterly on performance of employees. Advice was given to make a determination of promotion and pay hike based on that assessment.
- iii) It is now a time of preparation of next year's budget as the year end is approaching, so advice was given to commence the preparation soon.

#### 2. Pom Samnak (Division Manager, Finance)

- i) Advice was given to make analysis of revenues and expenses, which are important factors to prepare next year budget and long and mid-term plan.
- ii) His position is the key to check and balance of cash handling, so advice was given to become more conscious of it.

#### 3. Im Vichet (General affairs and procurement)

- i) The current payroll is temporary, so it is necessary to determine the formal payroll system and its level by the management in December. This matter is also related with next year budget an long and mid-term plan, so advice was given to set about the preparation soon.
- ii) The attendance sheet started to be used but overtime has not been paid based on the attendance sheet. Advice was given to prepare an internal regulation for overtime

and pay overtime based on that regulation together with the start of the formal payroll system.

- iii) Travel allowances are paid later, so advice was given to discuss with the management whether advance payment system will be introduced or not.
- iv) Records were made about carry-in and carry-out of the warehouse. But the original stock has not been grasped, so that the actual quantities of the stock are not known. As the end of December is the closing date of accounting, advice was given to conduct inventory count of the warehouse with cooperation with technical staff in December.

#### 4. Ty Shouyatra (Accountant)

- i) Advice was given to learn accounting procedure for advance payment of travelling allowances if introduced and for inventory loss.
- ii) Discussions were held about internal regulations on annual budget and accounting methods.

#### 5. Chres Malout (Cashier)

- i) It was revealed that reconciliation of cash on hand and the cashbooks is not made every day, so advice was given to do so.
- ii) The customers are to visit the cashier's window of EUMP to pay electricity bills. The cashier also handles claims from customers regarding power supply suspension due to arrear. Discussions were made as to how to handle such a situation.

#### 6. Kong Butrachany (Customer management)

- i) The regulation stipulates that power supply is to be suspended if an arrear exceeds 12 days and this regulation has been applied strictly.
- ii) Power supply suspension has been done to about 20 customers so far due to arrear. The regulations stipulates that if non-payment continues beyond 2 months, the customer-related facilities are to be removed but in fact there has not been such case. The reason for this is that the cashier does not know about that regulation and did not report non-payment to the staff in charge of customer management, who is to request removal work to the transmission section. Advice was given to understand their related regulations.

## II. Progress of To Do List

The following is the progress of 'To Do List' as instructed to fulfill in the previous field activities.

Items 1&2 internal regulations on billings system, organization, employment, disciplinary code, control of corporation's vehicles: prepared but not yet approved by Director. It

was instructed to make them internal regulations upon the approval of Director by early December.

Item 3 workflows of administration staff: prepared by all of the staff. Discussions were made based on the workflows as mentioned in I to deepen their understanding of their own tasks and their relationships with the tasks of other staff.

Item 4 study on relevant lawas

i) Company Law (San Darith)

It is not clear whether the Company Law is applicable to EUMP. It was confirmed that the articles of incorporation (draft) does not violate the said law.

ii) Accounting Law (Ty Shouyatra)

The actual practice of EUMP accounting follows the guidelines for entry of expenses published by the Ministry of Finance, so that it was confirmed that there is no particular problem.

iii) Tax Law (Chres Malout)

It is not clear whether tax law applicable to private companies is applied to EUMP. If imposed, JICA team instructed to study how much the tax burden would be.

iv) Labor Law (Im Vichet)

It was confirmed that the employment regulation (draft) does not violate the Labor Law.

#### **(4) The 5th field activities (February 2010)**

##### **1. The 3rd JCC meeting: 23 February 2010: Phnom Penh**

Venue: Conference Room of MIME, Phnom Penh

##### 1. Percipient

- JICA Cambodia Office: 3 officials

Mr. Yasujiro Suzuki, Chief Representative,  
Mr. Takanobu Shinoda, Deputy Assistant Director  
Mr. Sok Chhay, Program officer

- MIME : 11 officials

Dr.Ith Praing, Secretary of State  
Mr.Khaut Randy, Secretary of State  
Mr.Tun Lean, Director General, General Dept. of Energy  
Dr.Bun Narith Deputy General Director  
Mr.Much Chhun Horn Director, Hydropower,  
Mr.Nong Sareth Deputy Director, Hydropower

- EAC : 1 official

Mr.Suon Ponnarith

- EDC : 4 officials

- Mr.Chan Sodavath, Deputy Managing Director, Charman of Senate  
Mr. Houg Chantha, Chief of Technical  
Mr. Peah Ratha, Chief of Technical  
Mr.Ngeth Lavy, Chief of MV division
- EUMP :14 officials  
Mr.Kong Pisith Director,  
Mr. San Darith Deputy Director, Administration  
Mr. Chin Sockun Deputy Director, Technical
- JICA team : 5 members  
Koji Mishima (Chief Advisor/Management),  
Tetsuro Tanaka (Administration),  
Masataka Hiraga (Power generation),  
Ms.Eang Sodavy (Local Coordinator),  
Nozomi Sato (J-Power: Support from Tokyo)
- Observer : 1  
Mr. Yamakawa, JICA Senior Volunteer (for EDC)  
- Interpreter: Mr.Kry Meng Ang

### Summary

O&M manual was explained and the annual performance for 2009 was reported confirming smooth operation of EUMP. MIME announced the transition of EUMP to EdC dated 8 January and it was made clear that the relevant procedure was being taken. As for the manual, a comment was given to the effect that there was no deficiency in the English version. It is thought, however, the articles of incorporation and other organizational regulations, being prepared with EUMP as autonomous organization, should be replaced with the corresponding regulations of EdC after the transition. It was confirmed that the support services in the next year must be well coordinated with EdC. Regarding the internal regulations, even though EUMP is to be merged into EdC and the relevant regulations are to be changed, it is considered to be significant for EUMP's staff to gain practice of doing their works according to the internal regulations.

### Main points

- 1) Overall explanation by JICA team  
Explanation was made in line with Figure 1-1 of Chapter 1.
- 2) The business performance for 2009 was reported by Mr.Kong Pisith, Director of EUMP.
- 3) O&M manual was explained and the performance of the administration section for 2009 was reported by Mr.San Darith, Deputy director, administration. (See Appendix 1-4)
- 4) O&M manual was explained and the performance for 2009 of power generation and transmission/distribution. (See Appendix 1-5)

5) Comments from MIME on O&M manual

There is no problem about the English version but Khmer version is necessary to be corrected in use of appropriated words by experts. JICA team responded by saying that the first version was prepared by JICA team but from now onward, it is necessary to correct and revise the manual by CP.

6) Explanation by MIME of transition of EUMP to EdC

In this JCC meeting, the transition of EUMP to EdC was announced. Regarding the legal form, there have been some discussions so far. EUMP is currently operated as public corporation by the ministerial order of MIME. But, according to Cambodian law, it is necessary to take procedure for cabinet approval. Without such an approval, there remains a legal issue regarding the autonomy of EUMP. The announcement of the transition has solved that issue. It can be thought that, with such a transition, future demand increase can be coped with under the competent organization.

7) Next period program

The 2<sup>nd</sup> period is to be the last of support services. The 1<sup>st</sup> period aimed to establish the frames such as 'learning of basic techniques for operation of power facilities and establishment of sure collection of electricity bills' by the initiative of JICA team, while the 2<sup>nd</sup> period is aimed at attainment of self-sustainability of EUMP, so that JICA team will support EUMP's initiative to keep it going by themselves.

The 2<sup>nd</sup> period support services include 4 field activities, during which advice will be given for preparation of long and mid-term plan and power tariff revision. In the last 9<sup>th</sup> field activities scheduled in February 2011, an assessment will be made on the capabilities of EUMP and the final report will be submitted to JICA after returning to Japan. In September 2010, JICA is scheduled to dispatch a mission for interim evaluation of this project. The next 4<sup>th</sup> JCC meeting will be held at that timing.

## II. Progress of To Do List by February 2010

JICA team requested, in the 4<sup>th</sup> field activities in November 2009, the administration staff to do the following matters by the 5<sup>th</sup> field activities.

Item 1 internal regulations of: finished

Item 2 inventory count: done in the end of 2009

Item 3 formal payroll system: determined together with their level of salary of EUMP employee

Item 4 Advance system for travelling allowances: determined not to be introduced

Item 5 Annual budget: budget prepared by themselves for 2010 for the first time although rough

## III. To Do List by the next field activities

Appendix 2-16 shows 'To Do List' to be fulfilled by September in the support services of the 2nd period.

## **Appendix 2 Management and Administration**

- Appendix 2- 1 : Annual Balance Sheet of Energy and Finance of EUMP in 2009**
- Appendix 2- 2 : System of Administrative Task**
- Appendix 2- 3 : Check List for Base line survey**
- Appendix 2- 4 : List of Things to Do before March 2009**
- Appendix 2- 5 : List of Things to Do before November 2009**
- Appendix 2- 6 : Articles of Incorporation**
- Appendix 2- 7 : Regulation on Organization and Powers and Duties**
- Appendix 2- 8 : Organization Chart of EUMP**
- Appendix 2- 9 : Power and Duty for Administration Division**
- Appendix 2-10 : Power and Duty for Technical Division**
- Appendix 2-11 : Line of Command and Control**
- Appendix 2-12 : Employment Regulation**
- Appendix 2-13 : Regulation for Control of the Corporation's Vehicles**
- Appendix 2-14 : Disciplinary Code**
- Appendix 2-15 : General Work Flow for Accounting Works**
- Appendix 2-16 : List of Things to Do before February 2010**
- Appendix 2-17 : Work Flow of Each Administration Staffs**
- Appendix 2-18 : List of Things to Do by September 2010**
- Appendix 2-19 : Billing book**
- Appendix 2-20 : Annual financial report of EUMP**



## **Chapter 3 Electric Power Civil Engineering**

## Chapter 3 Electric Power Civil Engineering

### 3.1 Activities and Achievements of the 1<sup>st</sup> Period

#### 3.1.1 General

The electric power civil engineers performed the field instructions five times and the domestic work three times in total in the first period (between December 2008 and March 2010).

In order to achieve the project target of establishing “the system to implement proper management control and to perform the operations of civil engineering structures, electric power facilities, and transmission and distribution equipment in Electric Utility Management Project in Mondul Kiri Province (EUMP)” which is indicated in the Project Design Matrix, the Electric Power Engineering Division performed technical guidance (employee education, OJT training, etc.) and business support (creating manuals, establishing the performance record system, etc.) so that “the maintenance skill guidance of civil engineering structures including the gate, screen and penstock would be established and functioning.”

The business performance and evaluation of the first period are explained below:

#### 3.1.2 Activities and Achievements of the 1<sup>st</sup> Period

- (1) Prepare long and mid-term maintenance plan for civil structures:

The mid-term and long-term plan on maintenance and repair of civil engineering structures was established in April 2009 based on the status of EUMP equipment, and the organization management and technology level of the staff in the first field survey (between December 2008 and April 2009), and approved in the 2<sup>nd</sup> JCC (held in June 2009).

In order to calculate the necessary costs for maintenance control of civil engineering with accuracy, a certain level of performance (repair history of civil engineering structures) is required. However, because the operation is still in the initial stage with only a small amount of data, planning has been carried out in general terms. Hereafter, we may need to revise it in order to reflect the business forms in EUMP, future concepts, and maintenance and repair performance.

- (2) Revise manual for operation and maintenance of civil structures where necessary and translate it from English to Khmer:

Based on the business implementation status of EUMP, the capacity level of staff, and the natural conditions of the site throughout the year, etc., the O & M manuals prepared in the software component of the Grant Aid Operation were revised (English and Khmer versions), the contents of which were approved in the 3<sup>rd</sup> JCC (held in February 2010).

If the contents of the manuals are found to not correspond with the work conditions of EUMP during future operations, they shall be reviewed and revised if required. In addition, if any work that needs to be added to the manuals is generated, we will guide EUMP through the necessary review of additional operational procedures that will then be added in order to make the manuals coincide with the actual conditions.

(3) Conduct periodical inspection and maintenance of civil structures through OJT:

We found that the civil engineering members (the operators of the power stations) among EUMP staff lack not only the knowledge of the hydro electric power generation but also basic technological knowledge. Therefore in the first period, we placed an emphasis on developing their basic knowledge through on-the-job training by focusing on the essential skills required to maintain and control the hydro electric power stations.

The maintenance of the civil engineering structures requires skills to "detect irregularities", "analyze the cause such irregularities" and "establish proper repair procedures" by observing the site conditions. We think that it is effective for them to develop their skills at the site by dealing with the actual conditions and gaining their own hands-on experience every time any problem or malfunction occurs. In the first period, patrol duties were utilized for on-the-job training that included guidance regarding minor road repairs, control and repair of slopes, and emergency and rainwater drainage measures. In the second period, we will continue to utilize the patrol duties for their OJT to help them think together and discuss countermeasures at sites, helping them gain experiences to improve their skills.

(4) Record and compile relevant data (operation record, repair and inspection record, trouble shooting record and the like):

We not only organized the measurement data and frequencies of the levels of reservoirs and water tanks, and similar items that were necessary for operation but also prepared recording formats and the manuals for measurement methods. The level data of diversion weirs and water tanks was measured three times a day since the completion of the recording formats (February 2009) and digitalized in Excel files.

We provided instruction regarding the flow rate measurement several times at the sites, although some of the staff did not seem to have understood (flow rate calculation) completely. This training will also be repeated in the second period.

### 3.2 Outline of Civil Engineering Facilities

#### (1) O'Moleng Power Station

Access path	W: 2.8 m, L: 411 m
Diversion weir	H: 5.87 m, L: 60 m
Sand basin	W: 2 to 4 m, H: 5 to 6 m, L: 23 m
Hydraulic pressure iron pipe	Dia.: 600 to 1,200 mm, L: 415 m
Power station building	Total floor area: 56 m <sup>2</sup>

#### (2) O'Romis Power Station

Access path	W: 2.8 m, L: 1,850 m
Diversion weir	H: 5.22 m, L: 41 m
Sand basin	W: 2 to 3 m, H: 2.8 to 3.5 m, L: 20.2 m
Waterway	W: 1 m, H: 1.4 m, L: 1,015 m
Water tank	W: 1 to 4 m, H: 1.6 to 5 m, L: 20 m
Effluent outlet	W: 1 m, H: 1.2 m, L: 92 m
Hydraulic pressure iron pipe	Dia.: 600 to 800 mm, Length: 63 m
Power station building	Total floor area: 56 m <sup>2</sup>

#### (3) Diesel Power Station

Power station building	Total floor area: 144 m <sup>2</sup>
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#### (4) Administration Office:

Office building	Total floor area: 189m <sup>2</sup>
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### 3.3 Activities

#### 3.3.1 Field Activities Record

(1) Members

[Counterpart]

Deputy General Manager (in charge of engineering)	Mr. Chin Sokhun
Chief in charge of engineering	Mr. Thai Khin
Assistant Chief (in charge of O'Moleng Station)	Mr. Heng Sokhon
Assistant Chief (in charge of O'Romis Station)	Mr. Pen Pidu
Chief Aid (in charge of O'Moleng Station)	Mr. Eng Rithy
Chief Aid (in charge of O'Romis Station)	Mr. Yang Soyen
Operators (in charge of O'Moleng Station)	Mr. Heang Vandy, Mr. Um Monichetra, Mr. Chheoum Kosai
Operators (in charge of O'Romis)	Mr. Thim Seanghai, Mr. Sin Siemeng, Mr. Toch Phally
[JICA Team]	
Electric Power Civil Engineering Sect. (Chugoku Electric Power Co., Inc.)	Takahito Oikawa

(2) Outline of the Guidance

Term	Guidance items	Current conditions
<b>The 1<sup>st</sup> Guidance</b> Round 1(15 days) From: Dec. 9, 2008 To: Dec. 23, 2008	<ul style="list-style-type: none"> <li>• Opening of 1<sup>st</sup> JCC Meeting</li> <li>• Grasping the contents of existing manuals</li> </ul> <p style="text-align: right;">Other tasks</p>	<ul style="list-style-type: none"> <li>• Explained the contents of implementation as based on the Inception Report draft.</li> <li>• Careful reading of the existing manuals, and confirmation of the implementation status of the existing manuals.</li> </ul>
<b>The 1<sup>st</sup> Guidance</b> Round 2 (15 days) Form: Feb. 1, 2009 To: Feb. 15, 2009	<ul style="list-style-type: none"> <li>• How to record operational data.</li> <li>• Various measurement methods of civil engineering-related maintenance and control</li> </ul> <p style="text-align: right;">Other tasks</p>	<ul style="list-style-type: none"> <li>• Established and provided instruction regarding recording rules such as measurement frequencies and locations of and formats for the control data required for the operation.</li> <li>• Provided hands-on training regarding the measurement method for the flow rate in the O'Romis waterway.</li> </ul>
<b>The 2<sup>nd</sup> Guidance</b> (20 days) From: June 7, 2009 To: June 26, 2009	<ul style="list-style-type: none"> <li>• Various measurement methods of civil engineering-related maintenance and control</li> <li>• How to inspect civil engineering-related equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Trained how to operate the measurement devices (level indicators).</li> <li>• Trained to inspect the civil engineering equipment before the flood season.</li> </ul>

Term	Guidance items	Current conditions
	Other tasks	
<b>The 3<sup>rd</sup> Guidance</b> (30 days) From: Sept. 1, 2009 To: Sept. 30, 2009	<ul style="list-style-type: none"> <li>• Training of operation, maintenance and control of the civil engineering equipment on the occasion of the flood</li> <li>• Revision of manuals.</li> </ul> <p style="text-align: center;">Other tasks</p>	<ul style="list-style-type: none"> <li>• Went on hands-on patrol duties after heavy rain.</li> <li>• Discussed and trained in the repair of collapsed slopes and similar conditions.</li> <li>• The manuals were reviewed in view of the work situation and actual conditions of EUMP.</li> </ul>
<b>The 4<sup>th</sup> Guidance</b> (30 days) From: Nov. 28, 2009 To: Dec. 27, 2009	<ul style="list-style-type: none"> <li>• Regular inspection of the hydro electric power stations</li> <li>• Explanation of the revised manuals</li> </ul> <p style="text-align: center;">Other tasks</p>	<ul style="list-style-type: none"> <li>• The interior of O'Moleng sand basins was inspected (together with the no-water inspection of water wheels and generators)</li> <li>• Organized the revised manuals (drafts), which were then explained to EUMP.</li> </ul>

### 3.3.2 Field Activities Report

#### 1) The first guidance (Round 1) (Period of stay: Dec. 12 to 15, 2008)

##### A. Technical guidance

- Remove foreign material from screens

As part of the soft components implemented during the construction work period, staff was instructed to immediately remove foreign material adhering to the screens. Then they were trained to clean up the foreign material of the screens when water level checks are carried out three times a day. There are many dead leaves at the site that adhere to the screens. Nonetheless, the screens were kept clean at all times.

- Water level measurement

As a part of the soft components implemented during the construction work period, watermarks were installed in both diversion weirs in O'Moleng and O'Romis Power Stations and O'Romis waterway, and staff was instructed to check the level three times a day (7:00 AM, 12:00 PM, and 6:00 PM). We checked the measurement conditions of EUMP and gave instructions to continue the measurements in a similar manner.

It is necessary to ascertain the condition of water overflowing from the sand basins and water tanks in order to review the operating conditions according to each season. Accordingly, the existing recording format was revised so that the water levels of those items would be checked in the future. (The watermarks had been installed during the construction period.)

- Generator operation

The water flow rate is decreased in the dry season. In particular, , the inability to

generate power is expected between March and April due to a lack of flow rate. The O'Moleng and O'Romis Power Stations are river run-off power stations, requiring the inlet valve of the water turbine to be adjusted according to the flow rate at any given time. If the opened valve allows an excess of intake volume, the air seeping in through the valve may cause damage to the generator due to aeration.

At present, the problem is not very serious because there are sufficient flow rates, but we explained repeatedly that there is a possibility that the lack of water flow may cause failures. Staff was instructed that the level of the water tank must be constantly monitored (sand basin in O'Moleng), and if the level starts to go down, the inlet valve opening must be lowered.

B. Business support

- Participation in 1<sup>st</sup> JCC Meeting

We participated in the JCC Meeting held in Phnom Penh on December 22, 2008, and explained and discussed the future work plans (the contents of the guidance to EUMP) of the JICA team based on the Inception Report.

- Revision of manuals

We reviewed the contents of the existing manuals and the work status of EUMP in order to ensure that the maintenance and control manuals correspond to the actual work conditions in EUMP.



○ Cleaning up foreign material  
The foreign material adhering to the intake screen of the diversion weir in O’Romis Power Station was removed.

- We instructed the staff to maintain the inflow capacity of water by thoroughly removing the foreign material.



○ Instructing in how to check the water level  
Reading of the watermarks in the O’Romis waterway was used as a training example.

We also instructed staff in how to check the water levels at the diversion weir and sand basin.



○ O’Romis water tank  
We instructed staff to always monitor the water level in the tank in order to keep the balance at the overflow discharge top line by adjusting the output of the generator.



2) First guidance (Round 2) (Period of stay: February 3 to 11, 2009)

A. Technical guidance

- Checking the implementation status of the previous instructions

The water levels were recorded as we instructed in Round 1 in the designated formats without fail.

- Measuring the flow rate

To help assemble the basic data to create a Q-h curve (water level-flow rate curve) at O’Romis Power Station, we decided to perform the flow rate measurement in the O’Romis waterway.

We instructed them to perform measurement regularly (once every two or three months) in order to accumulate the data.

- Checking the operation status of the hydro electric power station and giving instructions

The O’Romis Station had concerns about the lowered water level of the tank due to the lowered river water flow. Therefore, we checked the operation status of the water level annunciator and trained the staff in the checking method.

The annunciator is set to make a temporary warning (alarm only) at -1.5m of the lowered water level and to make an automatic emergency stop at -2.5m of the water level. This time, only the temporary warning was checked and it was confirmed that it functions roughly at the designated lowered water level.

We found that EUMP had independently installed a tension-system preliminary warning at a water level of -1 m. We instructed them that daily inspection must be performed without fail to avoid causing operational failure of the tension system due to the clogging of foreign material.

At O’Moleng Power Station, we instructed the staff that, at a minimum, they need data from the dry season in order to complete the flow rate-water level curve. Accordingly, before the completion of this curve, they will have to check the water level of the tank every hour to keep the level at approximately -30 cm from the overflow discharge top line. In view of safety, a level of -1 m should not cause any problems. However, we explained that balancing at a higher level to secure the water head would lead to the higher generation output with the same flow rate.

B. Business support

- Measures related to tourists

Some tourists visited the power station in the dry tourist season. We instructed them that while taking pictures may be permitted; entry into the facility buildings and touching of the generation equipment must be completely prohibited.

- Making the water level record more efficient

There is some overlapping of data records between the civil engineering group and the power station group. To make the work more efficient, we decided to add the water level data to the power station operation record.



- Instructing staff how to measure flow rate (Round 1)  
The procedure was explained using the flow chart of the flow rate measurement shown on the next page. (The Khmer version is attached in the manual.)



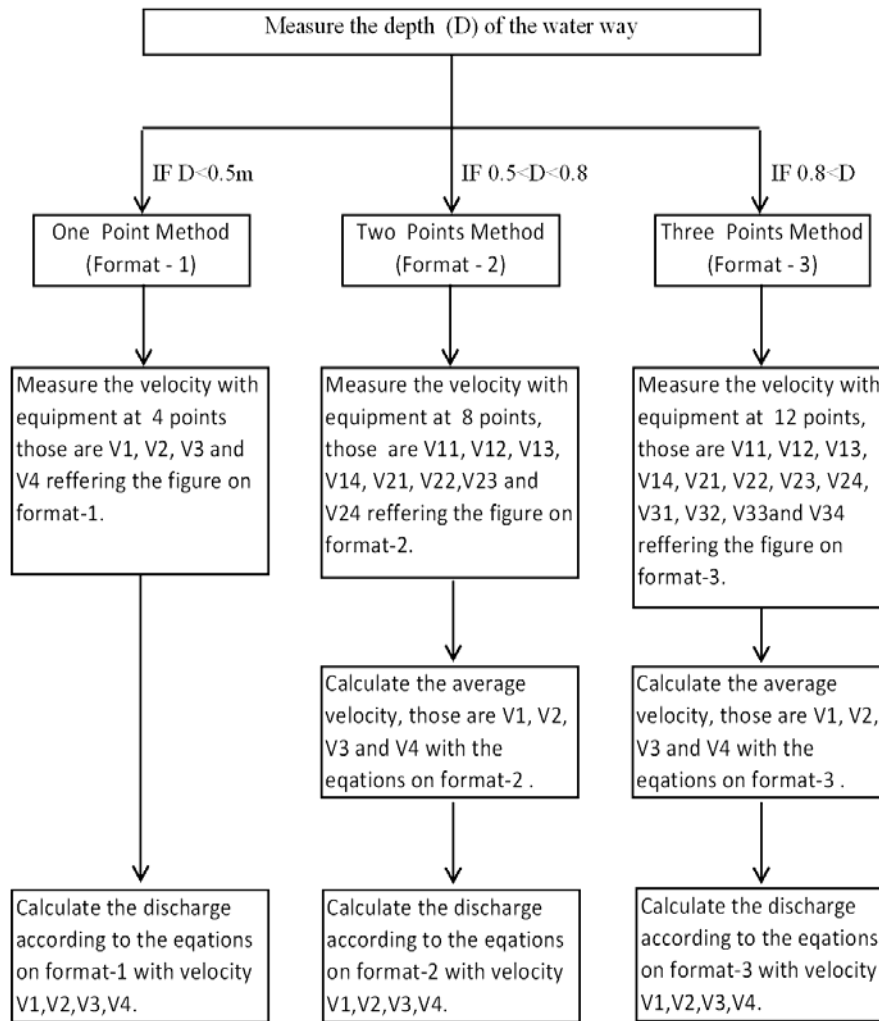
- Hands-on measurement training in flow rate (Round 2)  
At O’Romis waterway
  - The provided current meter was used.



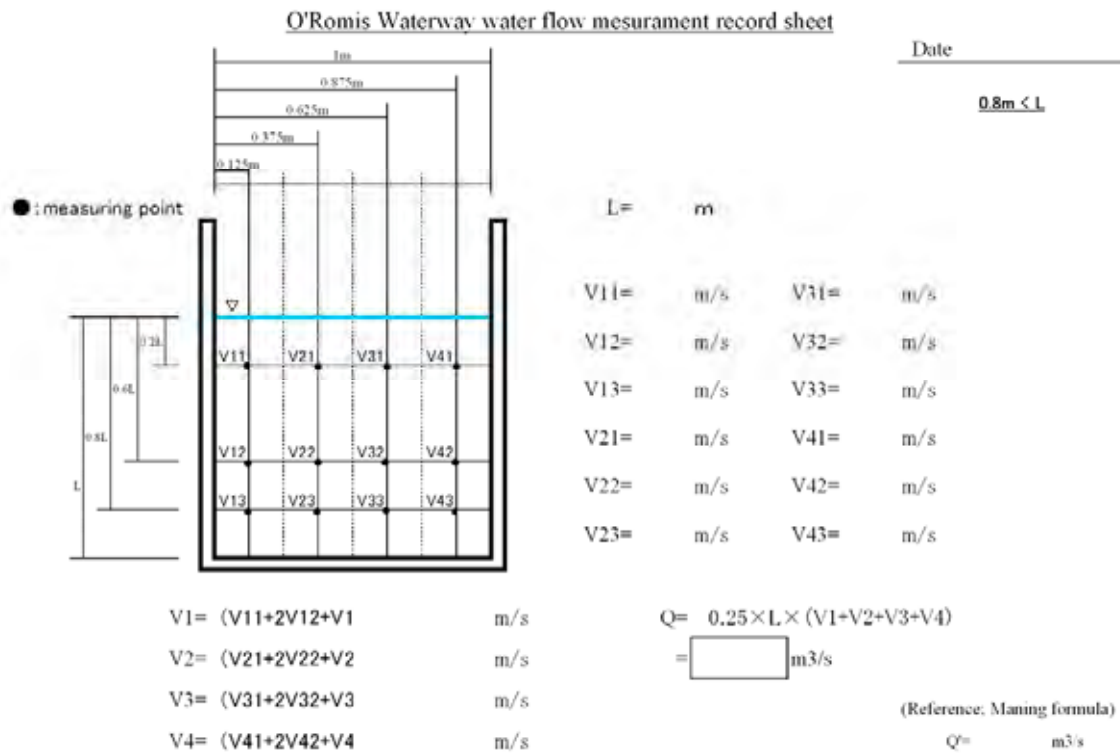
- Water-level gauge  
This tension-system equipment independently installed by EUMP requires diligent maintenance.

How to measure the discharge of O'Romis waterway

Measurement of discharge of O'Romis waterway should be done following the flow below;



**Figure 3-1 Flow Rate Measurement Procedures**



**Figure 3-2 Water Flow Measurement Record Sheet**

3) The Second Guidance (Period of stay: June 10 to 13, 2009)

June 17 to 24, 2009

A. Technical guidance

- Pre-rainy season inspection

The civil engineering facilities experienced the first rainy season. Accordingly, we conducted facility inspection together with Mr. Kong Pisith, General Manager, Mr. Chin Sokhun, Deputy General Manager (Engineering) and others.

The details are as follows:

- The water drain built along with the waterway of O’Romis Power Station had accumulated mud such that when it rained, the water was flooding over to the maintenance road. In order to keep the roadside ditch functioning, the water drain must be cleaned out if required.
- The foundation soil supporting the transmission lines near the water tank of O’Romis Power Station was washed away by rainwater, possibly threatening the safety of the foundation. Therefore, the foundation must be protected by lining with concrete or similar methods
- The roadside ditch for the maintenance road was constructed only on the hillside. However, there were traces of flooding by overflowing of gutters. Therefore, while observing the rainfall conditions hereafter, we will plan to drain the rainwater into the mountain stream by constructing a transversal waterway if required.

- Rat countermeasures

The blackout caused by the breaking of the control cable wire presumably due to being chewed by rats had occurred twice in the O’Romis Power Station. We implemented and provided guidance regarding countermeasures against rats, as shown below, after studying similar cases in Japan:

- Fill openings with putty when fitting cables into piping.
- Install rattraps in the power station facility.
- Clog any clearance that may enable rats to enter.

- Guidance of how to use the civil engineering measurement devices

Instruction was provided regarding usage of the following provided devices:

- Current meter (previous and repeated training)
- Level indicator (for measurement)

B. Operations support

- Revision of manuals

A manual for the maintenance and control of civil engineering work was created. A

checklist format was adopted and attached to the manual in order to clarify the inspection items and timing, and to ensure that a specific record is maintained. This time, only an English version was prepared. The Khmer version will be prepared by the next Guidance period (September 2009) to offer instruction and guidance to the staff of the power stations during the site duties.

- Participation in the 2nd JCC Meeting

We attended the JCC Meeting held in Phnom Penh on June 15, 2009; where we explained and discussed the mid-term plan draft prepared by JICA Team.



- Site training:  
The condition of the side ditch of the waterway in O’Romis Power Station
- We pointed out during the pre-rainy season inspection that the side ditch was filled with sediment and advised that it be removed.



- Hands-on training at the site:  
How to operate the level indicator
- The vertical drop was measured using the level indicator near the office.



- Hands-on training:  
Countermeasures against rats
- The cables in the station were chewed by rats many times. Traps were placed and the cable laying clearance was blocked.



4) Third guidance (Period of stay: Sept. 4 to 25, 2009)

A. Technical guidance

- Site patrol

After every heavy rain, we carried out site patrol duties accordingly with EUMP staff members to check for any irregularities of civil engineering structures in the access path slopes, diversion weirs, and similar locations. During the period of stay, small landslides occurred twice along the O’Romis waterway.

- Guidance of maintenance and control of civil engineering facilities

- A curved area was found at the connection area between the unlined roadside ditch of the O’Romis access path and the roadside ditch of the waterway, where the flow velocity was lowered, causing the ready accumulation of mud. Accordingly, we instructed the staff to smoothen the connection (countermeasures were completed).
- We explained that mud and dead leaves accumulated in the roadside ditch must be removed regularly. However, the maintenance and control of the civil engineering facilities are carried out by the operators (four members) in the power station. As the operation duties (three-shift system) of the power station have priority over the duties of maintenance and control, the latter duties could not be taken care of properly. This time, all members including clerical employees carried out cleaning duties.
- Collapsed road shoulders were found between the entrance to the national road and the diversion weir of O’Romis Access Path Zone A. Reinforcement measures such as the piling up sandbags were indicated (countermeasures were completed).
- Heavy rain caused the slopes along the waterway in O’Romis power station to collapse where the waterway ditch was buried. Earth and sand were removed, and emergency treatment (piling up sandbags) was indicated and implemented. We concluded that permanent measures would need to be taken such as reconstruction work of the collapsed slopes and bank protection using *futon-kago* (wire mats). However, as the ground was loosened at that time due to the rainy season, drilling work was expected to cause further collapse, which was not recommended for safety reasons. Therefore, we instructed them to implement the permanent measures after the rainy season (countermeasures were completed).
- Zone A of the O’Romis Access Path had a large amount of flooding and overflow into the roadside ditch from the mountainside during the rainy season. Transversal waterways were constructed in the middle in order to make the rainwater flow more smoothly (countermeasures were implemented).

B. Operations support

- Consultation support with the Ministry of Tourism

The Ministry of Tourism is planning the construction of cottages for tourists near the O'Moleng Falls, which was agreed to on the condition that they do not interfere with the power station facilities. Therefore, we accompanied the members of the Ministry of Tourism and EUMP during the site check in order to help them check, discuss, and arrange for the areas subject to restriction.

- Revision of manuals

When defining the items related to service regulations and punitive clauses, we needed to consider the situation and policy of organizations in Cambodia such as the EUMP and MIME. Accordingly, the JICA team created a draft and explained it to EUMP, seeking their comments.

- Consultation on the extension of distribution lines

As a client requested, EUMP was independently devising a plan to extend distribution lines. We felt that implementation EUMP alone was technically difficult, so we inquired about the details. They were planning to supply electricity to a quarry plant, which we judged would require a large load at startup, eventually affecting the system. Therefore, we asked the transmission and distribution group to deal with this problem.



○ Repair Guidance Round 1

The connection between the waterway ditch (with three faces made of concrete) and the roadside ditch (unlined) was improved at the O'Romis Power station.



○ Repair Guidance Round 2

This transversal waterway was constructed at the O'Romis Power station (after digging was completed).



○ Repair Guidance Round 3

This transversal waterway was constructed at the O'Romis Power station (completed).



○ Maintenance and control guidance  
Provided instructions regarding emergency measures against collapsed slopes due to rainfall during the rainy season.

- Removal of the earth and sand
- Setting up of sand bags



○ Discussion support  
Supported the boundary check with officials of the Ministry of Tourism near tourist areas around the O'Moleng Falls.

- We explained the definition of the area managed by the power station.



○ Discussion regarding manuals

- Explained the configuration of the manuals.
- Checked the conditions at EUMP and incorporated this in the manuals.

5) Fourth Guidance (Period of stay: Nov. 30 to Dec. 21, 2009)

A. Technical guidance

- Survey of a sand basin at O'Moleng Power station

At the time of regular inspection of water turbines and generators in O'Moleng Power station, we examined the cracks caused on the sidewalls of the sand basin with EUMP after the water was drained.

The results were as follows.

[Examination results]

At present, repair is not required for the following reasons:

- There were no water leaks from the waterway (because the cracks did not cover the entire side walls and no cracks were found on the walls below the normal water level).
- There were no structural stability problems as all cracks were caused vertically in parallel with the design section.

In addition, we instructed the staff to continue their observations during the daily inspection and implement sealing measures if the expanded cracks caused leaks from the waterway and determined to be an operational problem.

- Flow rate measurement guidance

In the Round 2 site survey, we instructed the staff in how to measure the flow rate in O'Romis Power station. However, it seemed that the explanation had not been well understood. Therefore, we made a flow chart of the flow rate measurement procedures in English and Khmer and these were used for reinstruction of the measurement method.

B. Business support

- Study and guidance of operating procedures for O'Romis Power station:

The O'Romis Power station needs opening adjustment of water turbines according to the flow entering the waterway in the dry season. As the water turbines are adjusted manually in the dry season of the last year, (in order to prevent air commingling into the water turbines) we instructed the staff to control the water output so that the water continues to overflow from the effluent outlet.

Now that we have accumulated one year of data since the start of operations, we discussed the water level-output relationship needed to maintain effective operation as based on the results, and established the output adjustment procedures as shown in Table ○-3. The staff was instructed to operate using this flow chart for the dry season this year.

- Support of discussion with public works/Ministry of Transport on protection of transmission line poles

When the public works/Ministry of Transport was working on the improvement of Route 76, to establish a detour route they dug up some of the electricity pole footings of O’Romis transmission lines. It was pointed out that some of them had safety problems. Therefore, we attended the conference between /public works/Ministry of Transport and EUMP in order to provide technical guidance and propose solutions.

- Guidance to secure the clearance of transmission and distribution lines at the cross-sections with the national roads

At the cross-sections of O’Romis transmission lines (22-kV intermediate pressure, bare conductor) with the roads, the concerns were that the clearance between the road and the transmission line might drop below the standard (8 m in case of intermediate pressure) due to the heightened road base for the improvement construction of National Route 76. Accordingly, we measured the clearance at the sites to consider the countermeasures. We needed to check the final elevation of the road base before consideration, so we asked the Mondul Kiri Bureau of the public works/Ministry of Transport on December 8, 2009. They said that the final elevation of the road base (height of the finished surface) had not yet been decided.

We advised EUMP to grasp the current situations as there seemed to be some similar cross-sections in the city areas.

- Update of the manuals

Among the maintenance and control manuals, we organized the technical edition of Volume II (Standards) and Volume III (Reference materials).

This time, we created the final draft of these manuals.

These manuals will be used in the management and control guidance for hands-on training during operations for next year. Any items unsuitable for the actual conditions will be revised upon discussion with EUMP.



- Opening/closing of the gates  
During the “no-water” inspection, we instructed the staff how to open and close the intake gates.



- Water discharging at O’Moleng Sand Basin  
The sand drain gate was opened to discharge water and sand into the O’Moleng Sand Basin.



- Site guidance  
Instructing staff how to measure the flow rate:
  - Repeated training was given to master the measurement of the flow rate.



○ Site check support

Measurement of clearance at the cross-section of transmission line with the road:

- We measured under hot lines, so a picture of the site was used for measurement without having to extend the pole.



○ Explanation of manuals

The final draft of the technical volume of the maintenance and control manuals was explained.



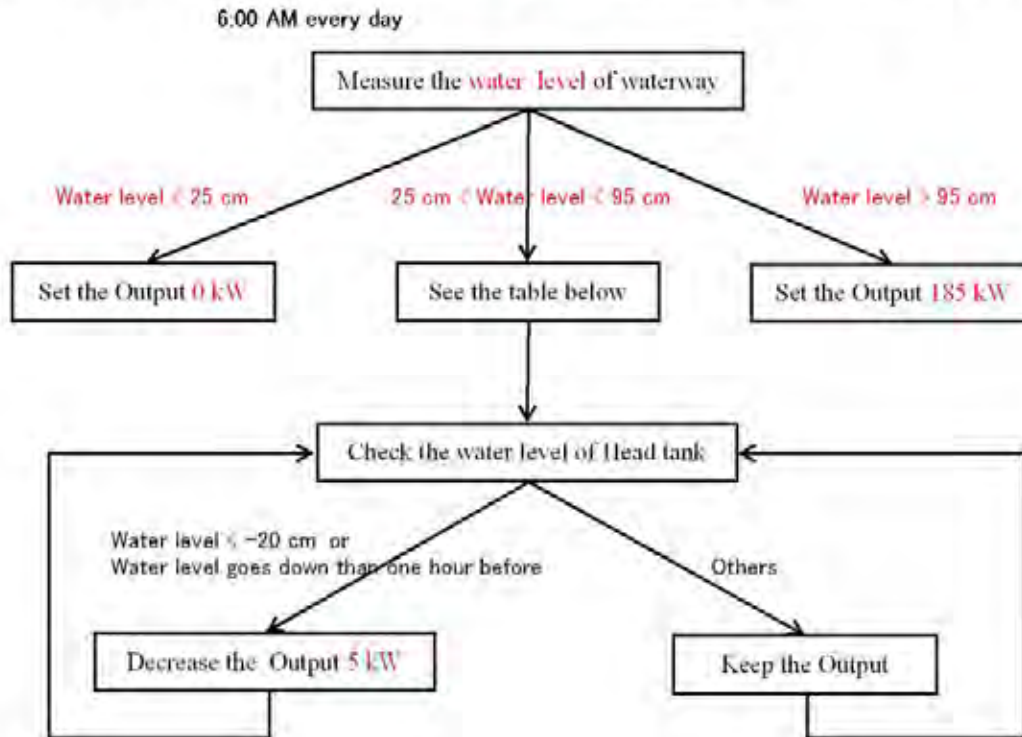
[For reference] Cottages near O'Moleng Falls

The cottage construction of Ministry of Tourism for which we provided advice in the third site survey was completed outside the power station control area.



Ver.2 Dec,2009

## How to set the Output at O’Romis Power Station



### Output table

Range of water level (cm)	Output (kW)
- 25	0
25 - 30	30
30 - 35	40
35 - 40	50
40 - 45	60
45 - 50	70
50 - 55	80
55 - 60	90
60 - 65	100
65 - 70	110
70 - 75	120
75 - 80	130
80 - 85	145
85 - 90	160
90 - 95	175
95 -	185

**Figure 3- 3 O’Romis Power Station Operation Table**

### 3.3.3 Work in Japan

Term	Guidance items	Current conditions
<b>Round 1</b> (2 days) From: Dec. 4, 2008 To: Dec. 5, 2008	<ul style="list-style-type: none"> <li>Preparing the Inception Report</li> </ul>	The project target, activity plan, and similar items were organized in the Inception Report.
<b>Round 2</b> (4 days) From: Mar. 10, 2009 To: Mar. 13, 2009	<ul style="list-style-type: none"> <li>Preparing the long-term and mid-term plan.</li> <li>Preparing the mid-term report</li> </ul>	We supported the staff to calculate civil engineering maintenance and repair costs, and to create a future budget. The business status of the year 2008 (Dec. 2008 to Mar. 2009) was reported in the first period mid-term report.
<b>Round 3</b> (3 days) From: Mar. ____, 2010 To: Mar. ____, 2010	<ul style="list-style-type: none"> <li>Preparing the first period final report</li> </ul>	The business status of the first period (Dec. 2008 to Mar. 2010) was reported.

### 3.3.4 Comments of the Activity in the 1<sup>st</sup> Period

#### (1) Technical guidance

##### 1) Operation

- No-water operation

The intake gate operation was explained in the soft component duties executed in the construction period, enabling the staff to operate the opening and closing of the gate without any problems.

- Discharging sands

In the first period, the facility was very new and sand accumulation was small, so the sand was not discharged. After studying to what extent the sand has accumulated in the second period, we will explain the discharge methods including gate operation.

- Output adjustment

To protect the water turbines and generator, the water level of the water tank (the sand basin in O'Moleng Station) must be constantly kept above a certain level, which will protect the hydraulic pressure iron pipe from air commingling. At the same time, as a safety measure, if the constant overflow operation from the effluent outlet is executed in the dry season, it will increase costs and be inefficient because of increased diesel oil burning due to lowered output of hydro power (waste of generation expenses). It is operationally efficient to balance the water level of the water tank at the top of the effluent outlet to prevent overflow. However, in that case, generation adjustment (output adjustment) according to the inflow amount is required. This mechanism was explained to EUMP completely and appeared to be clearly understood. EUMP independently installed the water-level gauge to strengthen the water level monitoring system for output adjustment. In the first period, due to a lack of experience, overflow sometimes occurred in the dry season. In the second period, operation rules created based on the performance

records of the first period will be used for output adjustment (output adjustment is performed based on the inflow amount calculated from the level in the waterway) and the rules will be kept updated based on the performance records in the second period.

2) Patrol

Along with EUMP, we undertook patrol duties accordingly to confirm the site situations, review the inspection points, and similar tasks. The inspection items and the points of inspection have been incorporated into the manuals. In the second period, we will carry out on-the-job training for facility inspection as based on the manuals.

3) Maintenance

- Cleaning of the screen

Clean up work was instructed in the soft component work executed during the construction period. Therefore sufficient cleaning work is being done.

- Maintenance and repair of the civil engineering structures

Instruction was provided regarding the drafting of countermeasures, execution methods, and similar topics related to the failure items found in the patrol and facility inspections.

Major items are as follows:

- Emergency treatment of the slopes collapsed in the rainy season
- Construction of road traversal waterways
- Reinforcement of the access path shoulders
- Reinforcement of electricity pole footing and similar items

It is considered that the above repairs can be easily handled by EUMP to independently implement hereafter by reference to the execution examples recorded at this time.

4) Various measurement

- Water level

Some of the staff members could not read the watermark at the start, but in the fourth guidance (in one year after the project started) all members were able to read it.

- Flow rate monitor

We prepared the simple procedures and fill-in-the-blank calculation sheets to simplify measurement and to try to have employees master the skills by repeated instructions. However, some of the staff may not have understood all the procedures. In the second period, we will repeat the training.

- Level measurement

In the first period, we did not use the level indicator for practical work, but the staff practiced how to make measurements using the level indicator at the administration office. The measuring tool is sufficiently simple that they seemed to understand the operation procedure.

(2) Operations support

1) Updating of manuals

We reviewed the contents of the existing manuals and the facilities in EUMP in order to update the manuals to correspond with the actual conditions.

## 2) Organizing the operation records

We organized data such as the water level of reservoirs and water tanks that need to be measured for operation and measurement frequencies, and providing instructions regarding how to measure and record the data. The designated data was measured according to the indicated frequencies, and recorded in the designated formats.

The data was also computerized and saved in Excel files for easy reference and processing, as well as the storage of a paper-based record.

## 3) Expanding the knowledge of hydroelectric power generation

Because all the EUMP staff members have just begun to work in the field of hydroelectric power generation, they needed to understand the names of the respective facility structures and functions. We prepared the easy and comprehensible “Basic Knowledge of Hydroelectric Power Generation” in order to expand their knowledge.

The managerial staff was gathered to attend a lecture on the hydroelectric power generation accordingly as well as to master a wider range of knowledge in the fields of surveying, design, and planning.

## (3) Evaluation

We found that the operators of the power stations among EUMP staff had lacked not only knowledge regarding hydroelectric power generation but also basic technological knowledge. In the first period, while placing an emphasis on developing their basic knowledge, we helped them master the minimum skills to maintain and control the hydroelectric power station.

After the one year training was over, they were able to perform routine work although they did not understand detailed theory. Accordingly, we recognize that they have acquired the operational technology necessary to operate the power station.

Regarding the maintenance of civil engineering structures, the skills to “detect abnormality,” “analyze the cause of the abnormality,” and “draw up a proper repair method” after watching the site condition are required. We think it is effective for them to develop their skills every time any abnormality occurs by coping with the situations and building up their experiences. In the first period they gained experience in making minor road repairs, controlling and repairing slopes, dealing with emergencies and draining rainwater, with which we think EUMP alone will be able to deal with to a satisfactory extent hereafter.

In the second period, we intend to repeat operational training by going further into the theory (such as explaining the definition formula of flow rate calculation) in order to establish and enhance their skills. As for the maintenance duties, we will continue to take opportunities to carry out OJT patrol duty in order to help them think together and discuss the countermeasures at the sites, something that will surely improve their technological competence with experience.

## **Appendix 3 Civil Work Structures**

- Appendix 3-1: Flow measurement**
- Appendix 3-2: Format of flow measurement and example of record**
- Appendix 3-3: Example of the operation record (O’Romis Daily record)**
- Appendix 3-4: O’Romis power station access path Restoration work of landslide**
- Appendix 3-5: O’Romis power station Reinforcement work for pole foundation**
- Appendix 3-6: O’Romis power station access path Installation work of drainpipe**
- Appendix 3-7: O’Romis power station Improvement work of the drainage system**

## **Chapter 4    Operation and Maintenance of Generating Facilities**

## Chapter 4 Operation and Maintenance of Generating Facilities

### 4.1 Activities and Achievements of the 1<sup>st</sup> Period

#### 4.1.1 General

The first period work in both Japan and Cambodia was starting in December 2008 to March 2010, and the work was carried out to dispatch the advisor with 6 times during that period, then they transferred the technology of operation and maintenance in generating facilities to EUMP (Electricity Unit of Mondul Kiri Province) staff as a counterpart of the project.

EUMP was able to supply the power to the customers for 24 hours in stable condition since commencement of commercial operation in November 2008 up to now.

And also, EUMP carried out the periodic inspection of twice a year under the supervision of the Japanese supervisors both hydro and diesel power facilities. The supervisor transferred EUMP staff how to and what kind of inspection and procedure of disassembly etc. by on-the-job training.

We judged that the knowledge of counterpart has been increased and transferring through the 1<sup>st</sup> period work.

The result of 1<sup>st</sup> period work activities is as follows.

#### 4.1.2 Achievements by PDM Activities

- (1) To establish the medium and long term maintenance plan of power generation

The medium and long term maintenance plan of power generation (first version) provided in April 2009 was approved by the 2<sup>nd</sup> JCC meeting in June 2009, considering of the situation of generating facilities, management system and technical level of EUMP staff, etc. after 1<sup>st</sup> site survey (period of December 2008 to April 2009).

At the time of preparation of the plan, generation facilities has been operating only 6 months past and not enough the accumulated data, then the plan did not reflect the sense of management, budget of repairing, lack of operating technique, damage of the facilities due to the weather conditions and so on.

Therefore, it is necessary to review the plan taking future plan of EUMP management and verification of the content into consideration after one year past.

During the preparation of the plan, JICA team led EUMP to suggest it and the plan was provided in consultation with EUMP staff and JICA team, because the experiences of operating period and knowledge of EUMP staff was not enough.

In the 2<sup>nd</sup> period work, it is necessary to level up the EUMP staff for planning capability, because the revision of the plan would be required after March 2010 as a project ended.

- (2) To revise and translate the operation & maintenance manuals regarding hydropower generation from English to Khmer

The revised O & M Manual in Khmer and English version were completed in consideration of the management system, ability of the staff and site training. The manual was approved by 3<sup>rd</sup> JCC meeting in 23<sup>rd</sup> February 2010.

The manual was prepared in description of the compact and clear sentences due to easy understanding of the staff, and also center on the OJT content in considering of the experience of management, staff ability such as fault recovery procedure, plan of scheduled inspection and safety policy which are top priority of the EUMP' operation management system.

However, in case of discrepancy or addition of the contents, the manual should be revised under the operation management. JICA team will direct EUMP to maintain the manual.

- (3) To conduct periodically inspection and maintenance of hydropower generation facilities by OJT

There were many case of the emergency shutdown of machine under the influences of transmission line fault due to disaster such as lightning and/or strong wind and rain.

The fault of hydropower stations may cause the power supply stopping to the customers, and then it is necessary to recover the system as quickly as possible. Therefore, JICA has instructed the recovery procedure at the time of OJT since December 2008 of 1<sup>st</sup> mission and taken care of advice to EUMP when JICA team was not stationed at site.

JICA team has directed the safety measure of OJT in relation with transmission line facilities, because of the first aid of the trouble shooting must be confirmation of public safety, EUMP staff and transmission lines, and then machine starting in normal operation.

As for OJT, JICA team has considered the instruction book in relation with the [Electric Power Technical Standards and Guidelines, published in June 2009] to understand the staff

On other hand, transfer to EUMP regarding technical guidance in soft ware, JICA team has conducted mainly guidance of desk work and/or training of practical inspection.

The guidance for example is as flows. (the reference and text book were prepared in power-points style and using supplied tool of the project such as PC, etc.)

- 1) O&M Management

The basic knowledge of operation and maintenance for Mondul Kiri power system

- 2) Technical Issue

The design concept of Mondul Kiri power system

- 3) Technical Trouble Shooting

The recovery of fault and trouble shooting for Mondul Kiri power system



#### 4) Sequence Diagram

The understanding and how to read the Block diagram and Sequence diagram for Mondul Kiri power system

It is difficult to arrange the time of direction on the transfer of technology to the staff, because they have a routine work and many kind of daily job in power stations. So that it is necessary to continue and repeat the OJT considering their understanding at site. Especially, inspection of control and protection system should be considered in the plan of periodic inspection, 2010.

- (4) To record and organize data, such as operation record, inspection and maintenance record and accident and trouble report etc.

JICA team directed EUMP to provide records of operation and maintenance, fault and event, repairing, spare parts, etc. that as they can manage and maintain reflection of the next plan after verification of operation and maintenance records, etc., and furthermore, as they can report the competent authorities under the law of Cambodia.

Especially, as for making common data base, JICA team directed to provide the accumulated data and records by the supplied tool of the project and advised the analysis and evaluation it.

JICA team confirms that, during the second period work (April 2010 to March 2011), EUMP has to utilize and revise the manual of 1<sup>st</sup> version, because it is important to stock the data even as daily operation or event/fault records and inspection plan, etc.

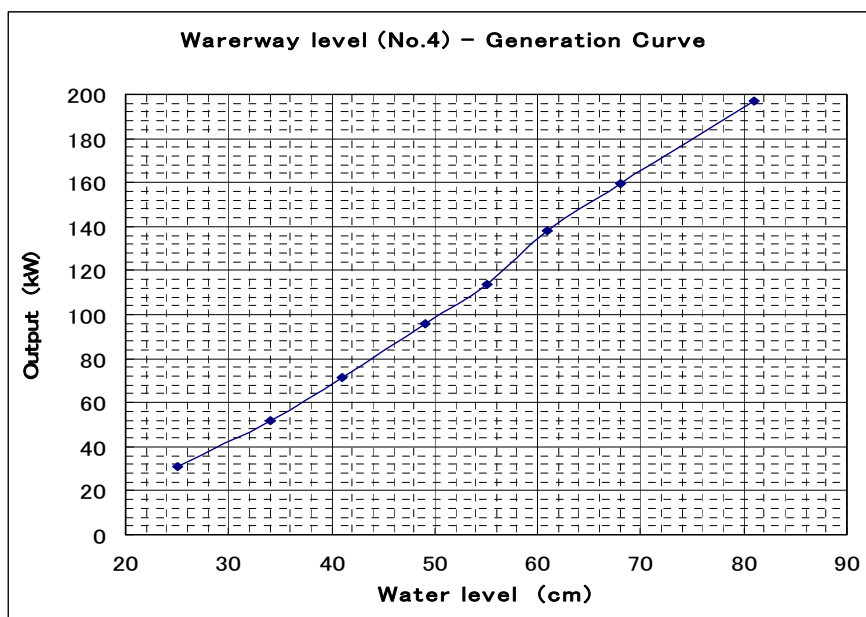
#### **River inflow and Output Curve**

There is a very different inflow between rainy and dry season at both O'Moleng and O'Romis hydropower stations. Especially, the inflow of dry season is deeply decreased about 1/3 of rainy season. Therefore, output of the hydropower station as a run-of-river type is also decreased around 1/3 of the rated output (kW).

In the worst case, turbine generator may trip in emergency due to low water level of intake by the protection sensor. Especially, O'Romis power station has a head tank so that it is very quickly decreased the water level, in avoidance of this trouble, EUMP has carried out the measuring of water inflow at waterway every day for one year.

In fact, EUMP has made a [River inflow (cm) and Output Curve(kW)] under JICA team' advice. From now on, the operator is operable and adjustable the output in accordance with this curve, and then the operator will able to prevent the emergency trip of the turbine generator.

This is a good performance of EUMP' job to be provided a [River inflow (cm) and Output Curve (kW)] which resulted by continuously measuring and accumulated data for one year, and they can keep the stable operation using this guidance curve for the next dry season.



**Dependable Output (kW)**

Water Level (cm)	Generator Output(kW)	Water Level (cm)	Generator Output(kW)
82	197	52	100
76	180	46	80
70	160	40	60
64	140	32	40
58	120	28	30

**4.2 Outline of Generating Facility and Operation Data**

**4.2.1 Generating Facilities**

Generating facilities of EUMP as of March 2010 are as follows.

(1) Hydropower Station

- a) O’Moleng Power Station: Run-of-River type, Installed capacity: 185kW
- b) O’Romis Power Station: Run-of-River type, Installed capacity: 185kW

(2) Diesel Power Station

Diesel Power Station: Diesel oil (C-heavy oil) engine, Installed capacity: 300kW

(3) Power Transmission System

Generated power transfers from each power station by step-up transformer (400V/22kV) through 22kV transmission lines and step-down by 22kV/400V transformer and distribute by 400V/230V, 4-wire distribution lines to the customers.

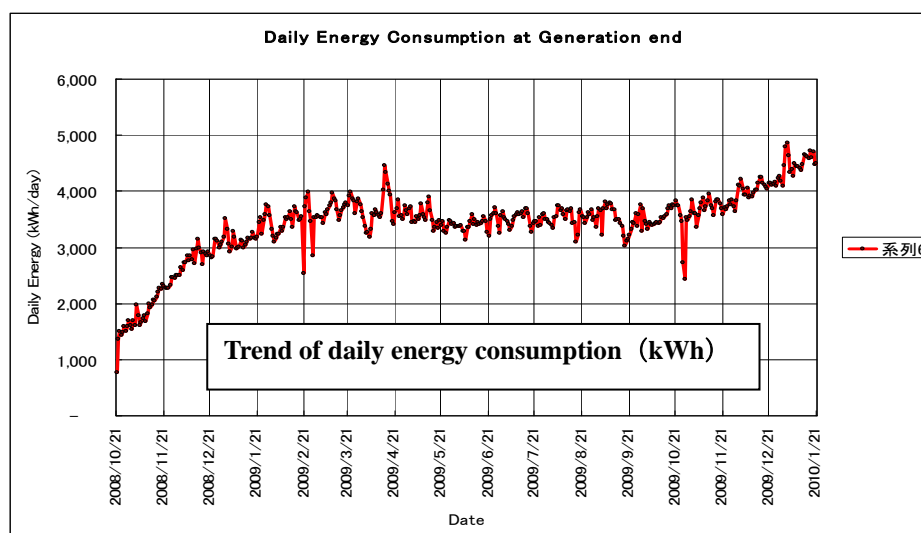
22kV transmission lines: 28km, 400V/230V distribution lines: 33km.

#### 4.2.2 Operation Data in EUMP

Operation Data, starting of 21<sup>st</sup> October, 2008 and up to 28<sup>th</sup> February, 2010 are as follows.

(1) Total Generation Energy (as of 28<sup>th</sup> February, 2010)

- a) Hydropower Station: 1,353,887 kWh
- b) Diesel power Station: 390,704 kWh
- c) Total Generation: 1,744,591 kWh



(2) Operation Hour (as of 28<sup>th</sup> February, 2010)

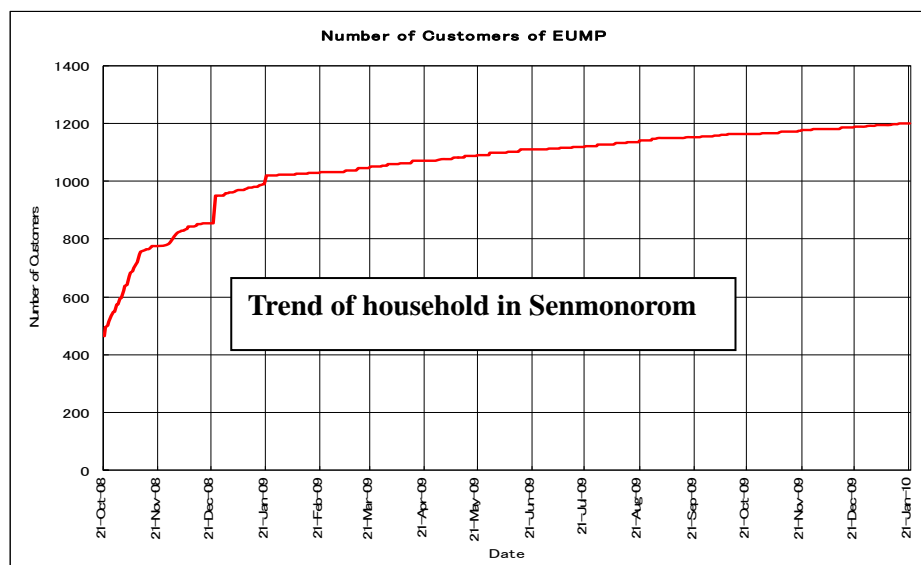
- a) O'Moleng Power Station: 9,240.8 Hours
- b) O'Romis Power Station: 11,100.7 Hours
- c) Diesel Power Station: 2,724.1 Hours

(3) Electrification Ratio in Senmonorom City

- a) At starting of power supply (21, Oct, 2008)  $0\% \Rightarrow 465/1,560=29.8\%$
- b) After 1 year operation (21, Oct, 2009)  $\Rightarrow 1,165/1,560=74.7\%$
- c) At present status (as of 28<sup>th</sup> February, 2010)  $\Rightarrow 1,209/1,560=77.5\%$

(4) Number of Customers and Consumptions

- a) At starting of power supply (21, Oct, 2008) 0% ⇒ 465 Households,  
Daily peak demand= 60kW, Daily energy consumption= 773kWh
- b) After 1 year operation (21, Oct, 2009) ⇒ 1,165 Households  
Daily peak demand= 290kW, Daily energy consumption= 3,825kWh
- c) At present status (as of 28<sup>th</sup> February, 2010) ⇒ 1,209 Households  
Daily peak demand= 390kW, Daily energy consumption= 4,632kWh



(5) Availability Factor (for 1 year: December, 2008 to November, 2009)

a) Time availability factor (Service hours/ Total hours)

O'Moleng power station:  $7,170 / 8,760 = 81.9 \%$

O'Romis power station:  $8,313 / 8,760 = 94.9 \%$

Diesel power station:  $1,723 / 8,760 = 19.7 \%$

b) Capacity factor:

Annual energy production (kWh)/ available output (kW) x 365days x 24H

=  $1,503,200 / 670 * 365 * 24 = 25.6 \%$

(Hydro=  $1,265,085 / 370 * 365 * 24 = 39 \%$ , DG=  $238,892 / 300 * 365 * 24 = 9.1 \%$ )

c) Daily load factor

i) At starting of power supply (21, Oct, 2008) ⇒ 48%

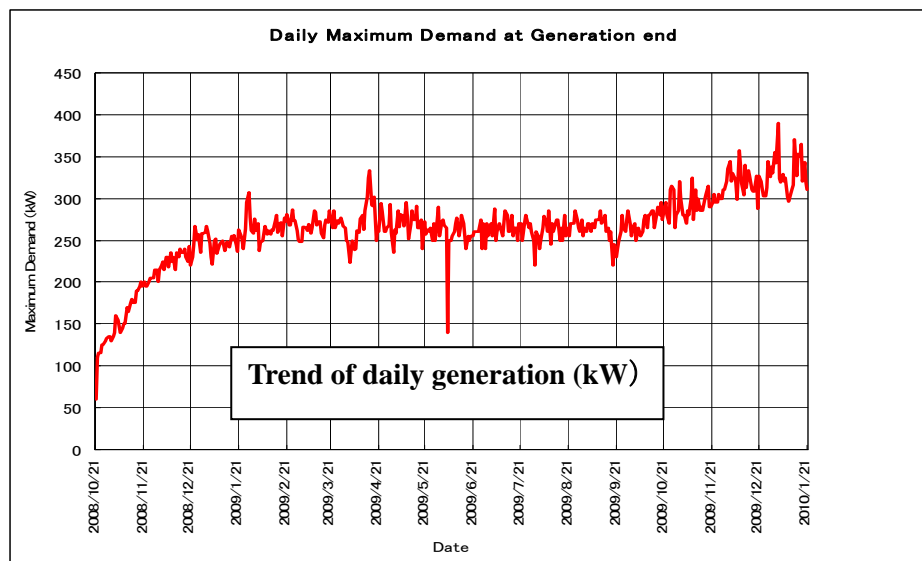
ii) After 1 year operation (21, Oct, 2009) ⇒ 58%

iii) At present status (as of 28<sup>th</sup> February, 2010) ⇒ 61%

(6) Generation Reserve Margin (Supply capability kW/ Demand (3 days Average)kW)

a) Rainy season =  $(670-312) / 312 = 114\%$  (25, Oct, 2009)

b) Dry season: =  $(360-352) / 352 = 2.2\%$  (28, Feb, 2010)



(7) Forced Outage Ratio (as of 28 Feb, 2010)

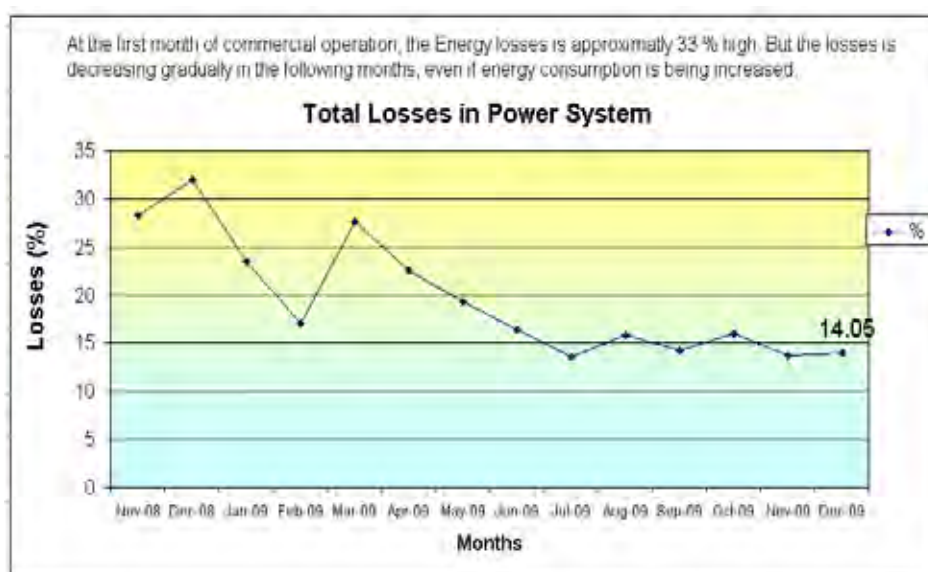
Basically, the power stations have been continuously operating and to supply the power for 24hours to the customers without power outage of scheduled inspection and system failures.

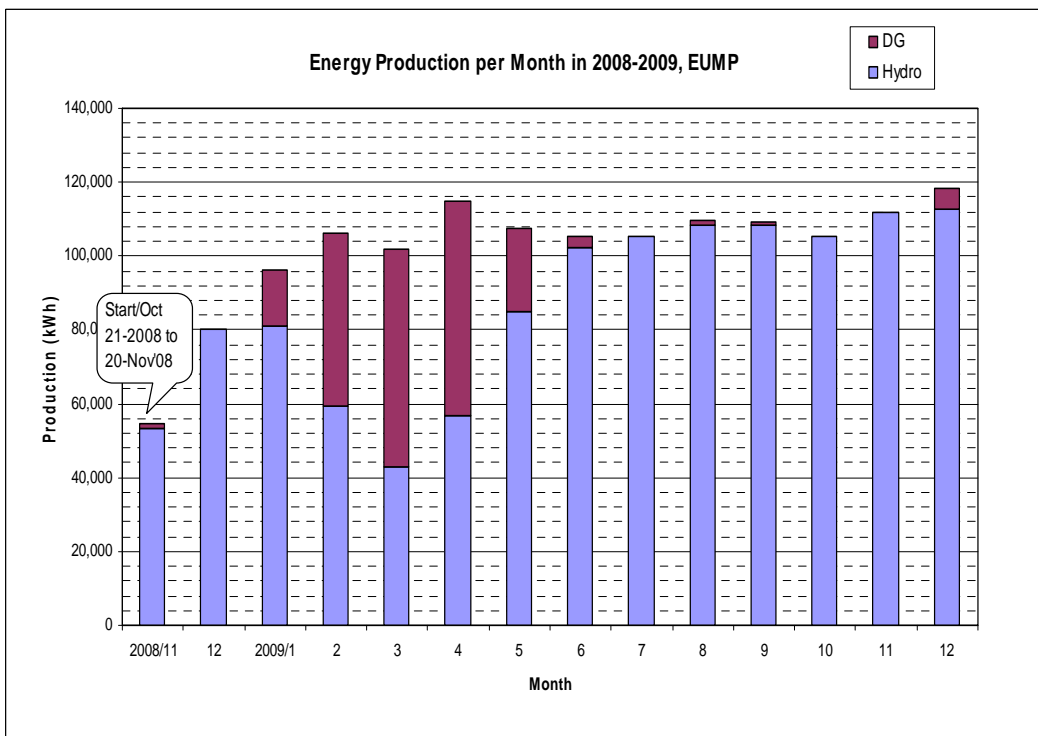
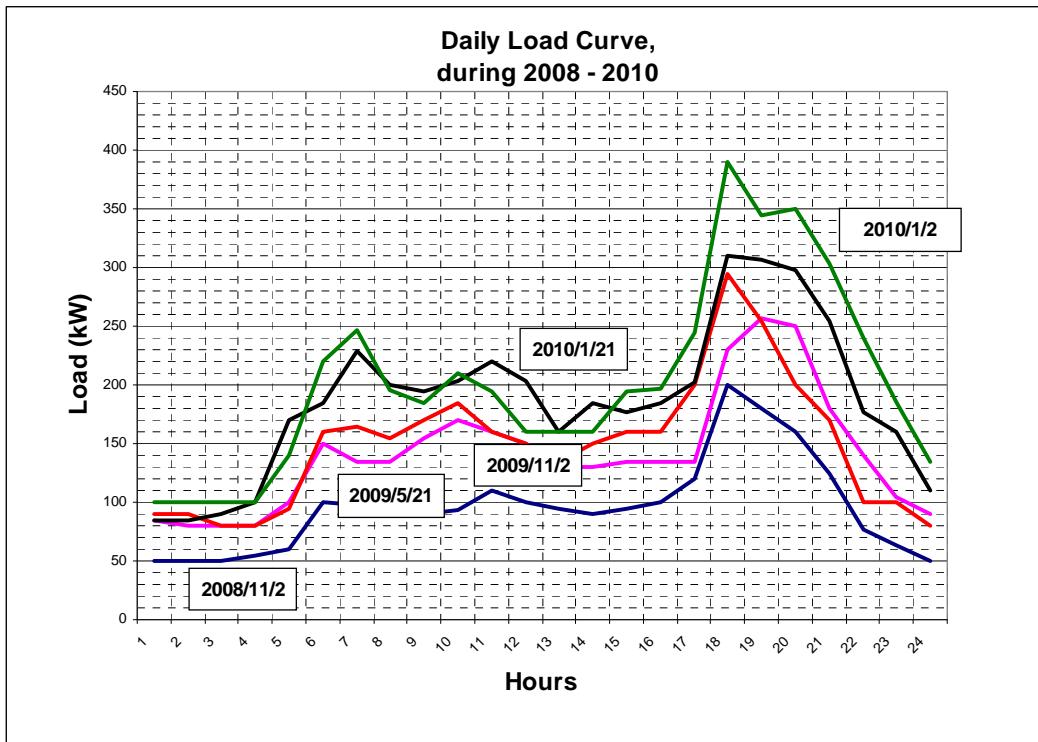
Forced outage ratio = Annual outage hours (AOH)/ Annual operation hours. + AOH.

$$= 72 \text{ H} + 4 \text{ H} / 8,313\text{H} + 76 \text{ H} = 0.9 \% \quad ; \text{AOH (System fault + Periodic Inspection)}$$

(8) Annual Service Capability = 76 H / 8,760 H = 99.1 %

(9) Total Loss of EUMP Power System





### 4.2.3 Scheduled Inspection and Fault Report

In order to skill up of the staff, EUMP, JICA team directed to have a periodic inspection every 6 months and daily patrol / weekly inspection (twice a month) in accordance with Inception report.

#### (1) Periodic Inspection (every 6 months)

Since commercial operation starting of November 2008, the first inspection was carried out in May- June 2009 after 6 months operation. The inspection of the machines was conducted under the supervisors from suppliers of Tanaka hydro Mfg. for turbine and Daihatsu Mfg. for diesel engine, respectively.

It is evaluated that JICA team has transferred EUMP the technical knowledge of the inspection procedure of disassembly/assembly, general inspection of generator and control panel, etc.

### Inspection Report

Inspection of every half year was according to the 1<sup>st</sup> Period work plan, and both inspection results were satisfactory without any problem in turbine, generator and control panel, etc.

The detailed inspection record is referred to [Periodic Inspection Report (No.1 and No.2)] as attached in Appendix 4-5 and 6.

The actual inspection schedule is as follows.

#### 1. Periodic Inspection (No.1)

##### (1) Inspection of Hydropower station on

- Pre meeting for inspection: 2009/05/30
- Periodic inspection for O'Moleng P.S: 2009/05/31 to 2009/06/04
- Periodic inspection for O'Romis P.S: 2009/06/04 to 2009/06/05
- Post meeting for inspection: 2009/06/06

##### (2) Inspection of Diesel power station

- Pre meeting for inspection: 2009/06/09
- Periodic inspection for Diesel P.S: 2009/06/10 to 2009/06/12
- Post meeting for inspection: 2009/06/13

#### 2. Periodic Inspection (No.2)

##### (1) Inspection of Hydropower station

- Pre meeting for inspection: 2009/11/27
- Periodic inspection for O'Romis P.S: 2009/11/27 to 2009/11/30
- Periodic inspection for O'Moleng P.S: 2009/12/01 to 2009/12/02
- Post meeting for inspection: 2009/12/03

(2) Inspection of Diesel power station

- Pre meeting for inspection: 2009/11/16
- Periodic inspection for Diesel P.S: 2009/11/16 to 2009/11/22
- Post meeting for inspection: 2009/11/23



**Muddy condition inside of Bearing Packing for Turbine (before maintenance)**



**Muddy condition of Bearing Packing after one year running**

(2) Daily Patrol

EUMP has conducted regularly the daily patrols/inspection in order to skill up maintenance of hydro and diesel power stations and prepared a record sheet indicated in management values and notes.

(3) Repairing Report

There was a big repairing for speed changer unit at O'Moleng power station during 2009.

This repairing was proposed by the supplier of Tanaka hydro Mfg. in April 2009 as a replacement of new type of speed changer during defect reliability period.

The other minor repairing were as follows



- 1) Hydropower station:
  - Re-adjustment of Speed meter due to influence of lightning and noises and this trouble was not so effectiveness to the system operation.
  - Damage of servo-motor control wires due to mouse bite and this trouble was treated by the scheduled stoppage of the machine.
- 2) Diesel power station
  - Starting failure of auxiliary compressor due to water contaminated inside of compressor, and repairing of the packing.

#### (4) Fault Report

JICA team judged that EUMP has recovered trouble shooting and repairing of the equipment, which operators measured minor trouble by them, but all staff of EUMP can treat it when they have a heavy trouble in the power system within a short time and best effort.

There was not big trouble in the turbine/generator and diesel unit at power stations.

But, EUMP has learned trouble shooting such as a 22kV insulators broken, wire cutting, etc. during 2009 caused by bad weather condition as a lightning, strong wind and rainy. They have recovered such trouble and outage within 2 to 4hours in normal. All faults has been recorded in the [Event Records].

## 4.3 Activities

### 4.3.1 Field Activities Record

The activities and evaluation for Operation & Maintenance of generation facilities are as follows. The detailed contents and survey records are described in Clause 4.3.2 hereinafter.

Time of Work	Work Items	Activities	Results and Evaluation
Preparatory Work 2008/12	Inception Report (Draft)	Inception Report (Draft)	Prepared Inception Report (Draft) and submission to EUMP
1st. Work in Cambodia (No.1) 2008/12	1) Technical guidance of operation and maintenance to EUMP's staffs	The pending matter to be discussion between EUMP and the mission was measured after evaluation of collected data as follows. (1) Daily Operation Data (2) The study of operation and maintenance against inflow of the river in dry season.	EUMP has to make a weekly inspection and accumulation of daily operation data. (1)Daily Operation Data: EUMP has collected and accumulated operation data according direction of JICA mission. (2) Inflow data of the river Have been measured and recorded.
	2) Confirmation of function in generating facilities of EUMP	The starting and stopping procedure have been practiced by the OJT.	The both hydropower stations have been continuously operating good in stable.
	3)1 <sup>st</sup> JCC Meeting	JCC meeting was held about Inception report in attendance of MIME, EAC, EDC, DIME, EUMP, JICA, JICA Team in 22 Dec 2008.	The inception report has been approved by JCC meeting in Dec. 2008.
1st. Work in Cambodia (No.2) 2009/1	1) Technical guidance of operation and maintenance to EUMP's staffs	The pending matter to be discussion between EUMP and the mission was measured after evaluation of collected data as follows. Also, we instructed the measure of hydropower operation during dry seasons and how to change the GV operation zone. (1) Daily Operation Data (2) The practice of operation and maintenance against inflow of the river in dry season. It is necessary to collect operation data such as	(1)Operation data has been recorded every power station, but even of daily and monthly records (such as record of start/stop, change of output, event of failure and work done, etc.) are not enough or lacking, so that we propose the Event Record and Fault Record shall be made and submitted to the Director/Deputy director with in a day or immediately. (2)The change of Guide Vane (GV) was done by the EUMP staff due to the decreasing of inflow of the river. Then, increasing of generation

Time of Work	Work Items	Activities	Results and Evaluation
		inflow and generation output both power stations in order to make its operation curve, therefore, the curve will be prepared at 3 <sup>rd</sup> survey mission (in March 2009).	efficiency and out put of about 20% (kW) after GC changed. (Result) Through the training and actual work to the staff with think deeply, the reasonable operation of the power station and stable supply to the power system may be built. (Instruction) The above 2 items, next mission on 3 <sup>rd</sup> survey will instruct or discuss with EUMP. So, EUMP should be recorded the daily operation and inflow data.
	2) Confirmation of function in generating facilities of EUMP	The starting and stopping procedure have been practiced by the OJT.	The both hydropower stations and diesel power station have been good operating in stable.
1 <sup>st</sup> Work in Japan 2009/5	Interim Report to JICA	Preparation of Interim report and Medium and Long term, Strategy and Financial Plan	Interim report and Medium and Long term plan was prepared in draft and to instruct EUMP for review of it.
1st. Work in Cambodia (No.3) 2009/3	1)Technical guidance of operation and maintenance to EUMP's staffs	The pending matter to be discussion between EUMP and the mission was measured after evaluation of collected data as follows. Also, we reinstructed, as previous mission, the measure of hydropower operation during dry seasons and how to change the GV operation zone. (1) Re-evaluation of operation data for each power station, (2) The study of operation and maintenance against inflow of the river water decreased (3) ON –the-Job Training	(Results) 1) Re-evaluation of operation data for each power station Operation data has been recorded by the PC system which is supplied by the project, and that data will be useful for Annual Report, so on. Fault record will also use for technical transfer to the staff. 2)The study of operation and maintenance against inflow of the river water decreased Through the training and actual work to the staff with think deeply, the reasonable operation of the power station and stable supply to the power system will be built.

Time of Work	Work Items	Activities	Results and Evaluation
		for trouble shooting  (4) Middle & Long Term Maintenance Plan	3) OJT In order to maintain the reliability and the least of shutdown in the power system, we have a training of recovering of the troubles to the EUMP staff. In actual event, they were able to recover the trouble such as hydropower and transmission lines without long stoppage. 4) Middle & Long Term Maintenance Plan, EUMP have been starting the discussion for appropriated plan in considering of operation and financial conditions. (Instruction) It is necessary to collect further operation data (April and May) such as inflow and generation output both power stations in order to make its operation curve, therefore, the curve will be prepared at next survey mission (in June 2009).
	2) Confirmation of function in generating facilities of EUM.	The starting and stopping procedure have been practiced by the OJT.	The both hydropower stations and diesel power station have been good operating in stable.
	3) Discussion of Medium and Long term, Strategy and Financial Plan	(1) Revising Tariff rate (2) Establishment of Tariff System (3) Financial Audit (4) Spare parts	(1) Discussed with EUMP for management of spare parts and procurement (2) Confirmation of management system for generating facilities
2 <sup>nd</sup> Work in Cambodia 2009/5~6	1) 2 <sup>nd</sup> JCC meeting	JCC meeting was held about Medium and Long term, Strategy and Financial Plan in attendance of MIME, EAC, EDC, DIME, EUMP, JICA, JICA Team in 15 June 2009.	Medium and Long term, Strategy and Financial Plan have approved at JCC meeting.

Time of Work	Work Items	Activities	Results and Evaluation
	2)Plan and execution of Periodic Inspection (1 <sup>st</sup> plan)	The mission proposed and discussed EUMP about the inspection plan and execution of the inspection after 6 months operation (1 <sup>st</sup> time).	(1)Periodic inspection for hydro and diesel power station have conducted during 2009/5/31-6/6 under the supervision of Japanese engineers with EUMP staff. Refer to inspection report of No.1. (2)JICA team has transferred the procedure and evaluation of inspection by OJT.
3 <sup>rd</sup> Work in Cambodia 2009/9	No schedule of dispatching	—	—
4 <sup>th</sup> Work in Cambodia 2009/11~12	1)3 <sup>rd</sup> JCC meeting	(1)Submission of O&M manual as a revision and getting approval	The JCC meeting was postponed by the request of Cambodian side up to Feb 2010.
	2)Preparation of O&M manual in Khmer	Revision of O&M manual was prepared and provided in Khmer version.	JICA team and EUMP have submitted O&M manual both English and Khmer versions, and EUMP agreed with the manual as a final.
	3) Execution of Periodic Inspection (2 <sup>nd</sup> plan)	The mission proposed and discussed EUMP about the inspection plan and execution of the inspection after 12 months operation (2 <sup>nd</sup> time).	(1) EUMP and JICA team have conducted the inspection as follows: -O'Moleng and O'Romis hydropower stations were carried out disassembly/assembly inspection from 27 November to 2 December 2009. -Diesel power station was carried out disassembly /assembly inspection from 16 June to 22 November 2009. Refer to inspection report of No.2. (2)As for inspection procedure, EUMP has carried out by themselves, but it is necessary to transfer the knowledge to EUMP staff for its evaluation

Time of Work	Work Items	Activities	Results and Evaluation
			and repairing method.
5 <sup>th</sup> Work in Cambodia 2010/2	1)3 <sup>rd</sup> JCC meeting	(1)Discussion of O&M manual as a revision and getting approval JCC meeting was held in attendance of MIME, EAC, EDC, DIME, EUMP, JICA, JICA Team in 23 Feb 2010.	(1)The O&M manual as a final version both in English and Khmer has been approved by JCC meeting Feb 2010. (2) JCC approved that EUMP presented annual report for administration and technical matter, they also presented the plan of next year, 2010. (3) MIME explained that EUMP will transfer to EDC within this year.
<b>Fault and Repairing Records of EUMP (2008/Dec to 2010/Feb)</b>			
Experiences of Faults and repairing	During December 2008 to March 2009	(1)Hydropower stations  (2)Diesel power station	(1)There was not long period stoppage with big trouble of the plant But, there were 2 times of stop the machines due to the low water level ( 2008/12 and 2009/1and stoppage time were around 1hour, respectively) (JICA'S Instruction) The operators must watch the water level and control the output (kW). (2)There was no trouble.
Experiences of Faults and repairing	During April 2009 to February 2010	(1)Hydropower stations	(1)2009/8/5, Speed meter of O'Romis station was troubled caused by lightning surge from the power system. EUMP measured and re-adjusted the setting values of speed meter, and recovered it according to the manual. (stoppage time around 1 hour) (2)2009/6/17 and 6/19 at O'Romis power station The turbine generator was stopped in emergency trip by ground fault detection, caused by control cables broken by

Time of Work	Work Items	Activities	Results and Evaluation
		(2) Diesel power station	<p>mouse. (repairing was done around 2 hours as a scheduled inspection)</p> <p>(JICA'S Instruction) The cable duct must be maintained with shield cover and clean it.</p> <p>(3) 2009/4/1-6 at O'Moleng power station Speed changer of turbine was replaced as a new type due to increasing temperature, vibration and noise. This was a claim of EUMP and the replacement work was carried out by the supplier own cost during defect reliability period. The machine has been continuously operating from 10 April 2009 up to now without any trouble.</p> <p>(4) 2009/4 at Diesel power station: There was many times starting failure of aux. compressor caused by the rust of packing at the inside of body. The function was recovered after cleaning of the packing and body.</p> <p>(Instruction) The water drain must be done every day by EUMP staff according to the manual.</p>

### 4.3.2 Field activities Report

This report is about activities of operation and maintenance for generating facilities in direction and/or consultation with EUMP from December 2008 to February 2010 at site survey of the JICA mission.

- 1) 1<sup>st</sup> Mission(No.1) : 2008/12/9 to 12/23 (15 days)
- 2) 1<sup>st</sup> Mission(No.2) : 2009/1/11 to 2/9 (30 days)
- 3) 1<sup>st</sup> Mission(No.3) : 2009/3/27 to 4/25 (30 days)
- 4) 2<sup>nd</sup> Mission : 2009/5/24 to 6/20 (28 days)
- 5) 4<sup>th</sup> Mission : 2009/11/12 to 12/8 (27days)
- 6) 5<sup>th</sup> Mission : 2010/2/17 to 2/26 (10 days)

### (The 1<sup>st</sup> Survey (No.1) on Dec 2008)

#### Operation and Maintenance of Generating Facilities

The hearing and data collection was carried out from EUMP staff in order to evaluation for actual condition of operation and maintenance management at site as follows.

#### 1. Date of Survey

1<sup>st</sup> meeting: 12 December 2008

2<sup>nd</sup> meeting: 13 December 2008

3<sup>rd</sup> meeting: 15 December 2008

Attendants

EUMP side: Mr.Kong Pisith(Director of EUMP)

Mr. Chin Sokhun(Deputy Director of Technical Devision)

Mr. Thai Kihn(Chief of Technical Devision)

Mr. Pen Pidu(Deputy Chief of Technical Devision, O’Romis)

Mr. Yeb Thav(Deputy Chief of Technical Devision, Diesel)

Mr.Heng Sokhon(Deputy Chief of Technical Devision, O’Moleng )

Project Mission : Mr. Yukitaka HIRAGA (Electro-mechanical Engineer)

#### 2. Collection Data

The pending matter to be discussion between EUMP and the mission will be measured after evaluation of collected data as follows.

- (1) Daily Operation Data for each power station

1<sup>st</sup> Step

Operation data from 21 Oct 2008 to 10 Dec 2008 for each power stations were collected and to conduct the evaluation,



2<sup>nd</sup> Step

Results of the analysis and evaluation of actual data, the pending matter will be measured and to make a solution it,

3<sup>rd</sup> Step

The method and way of the operation and maintenance in actual condition will be applied.

(2) The study of operation and maintenance against inflow of the river

During dry season, especially March and April, the dependable output (generation) will be limited due to the decreasing of river flow. So that the operation and maintenance system will be built up to get rid of the power system black out or failure in connection with EUMP staff through the OJT.

1<sup>st</sup> Step

In connection with civil management, the generation (kW)- Inflow (m<sup>3</sup>/s) curve will be made according to the water flow measuring data,

2<sup>nd</sup> Step

The operation and adjustment of output will be trained according to the generation (kW)- Inflow (m<sup>3</sup>/s) curve,

3<sup>rd</sup> Step

Applying the actual operation by using the curve, especially the curve of Intake level (m)- Generation output (kW) will be verified.

### 3. Instruction

From the above 2 items, next mission on 2<sup>nd</sup> survey will instruct or discuss with EUMP. So, EUMP has to make a weekly inspection and accumulation of daily operation data.

## (The 1<sup>st</sup> Survey (No.2) Survey on Jan 2009)

### Operation and Maintenance of Generating Facilities

The hearing and data collection was carried out from EUMP staff in order to evaluation for actual condition of operation and maintenance management at site as follows.

#### 1. Date of Survey

1<sup>st</sup> meeting: 14 Jan 2009

2<sup>nd</sup> meeting: 28 Jan 2009

3<sup>rd</sup> meeting: 2 Feb 2009

Attendants

EUMP side: Mr.Kong Pisith(Director of EUMP)

Mr. Chin Sokhun(Deputy Director of Technical Devison)

Mr. Thai Kihn(Chief of Technical Devison)

Mr. Pen Pidun(Deputy Chief of Technical Devison, O’Romis)

Mr. Yeb Thav(Deputy Chief of Technical Devison, Diesel)

Mr.Heng Sokhon(Deputy Chief of Technical Devison, O’Moleng )

Project Mission : Mr. Yunitaka HIRAGA (Electro-mechanical Engineer)

## 2. Collection Data

The pending matter to be discussion between EUMP and the mission will be measured after evaluation of collected data as follows.

Also, we instructed the measure of hydropower operation during dry seasons and how to change the GV operation zone.

### (1) Daily Operation Data for each power station

#### 1<sup>st</sup> Step

Operation data from 10 Dec 2008 to 4 Jan 2009 for each power stations were collected and to evaluate them,

#### 2<sup>nd</sup> Step

Results of the analysis and evaluation of actual data, the pending matter is as follows,  
Operation data has been recorded every power station, but even of daily and monthly records (such as record of start/stop, change of output, event of failure and work done, etc.) are not enough or lacking, so that we propose the Event Record and Fault Record shall be made and submitted to the Director/Deputy director with in a day or immediately.

#### 3<sup>rd</sup> Step

The method and way of the operation and maintenance record as happened event are applied.

### (2) The study of operation and maintenance against inflow of the river water decreased

#### 1) Increasing of generation efficiency during dry season

The change of Guide Vane(GV) was done by the EUMP staff due to the decreasing of inflow of the river as follows (refer to the attached paper).

#### (Progress)

During dry season, water inflow has been decreased from January, and dependable output (generation) is limited about 55kW or less.

#### (Countermeasure)

The GV switched 3/3 to 2/3 operation zone, then efficiency of generation has been increased. Therefore, output both hydropower station have been approx. 20kW increased.

(Result)

Through the training and actual work to the staff with think deeply, the reasonable operation of the power station and stable supply to the power system will be built.

## 2) Preparation of Inflow-Output Curve

It is necessary to collect operation data such as inflow and generation output both power stations in order to make its operation curve, therefore, the curve will be prepared at 3<sup>rd</sup> survey mission (in March 2009).

### 1<sup>st</sup> Step

In connection with civil management, the water flow measuring data and generation output data will be further continuously collected for preparation of the Generation (kW)- Inflow (m<sup>3</sup>/s) curve.

### 2<sup>nd</sup> Step

The operation and adjustment of generation output (kW) will be trained according to the inflow (m<sup>3</sup>/s) data,

### 3<sup>rd</sup> Step

The operation curve of Intake level (m)- Generation output (kW) will be made and verified it according to the actual data of every year.

## (3) Others

### Prevention of Firing in the field

In January, the burn off dead grass has been starting and to prevent the extending of firing under the transmission and distribution lines. The patrol and trimming of the trees and grass under the lines was done by EUMP staff.

## 3. Instruction

From the above 2 items, next mission on 3<sup>rd</sup> survey will instruct or discuss with EUMP. So, EUMP should be recorded the daily operation and inflow data.

## (The 1<sup>st</sup> Survey (No.3) Survey on Mar 2009)

### Operation and Maintenance of Generating Facilities

The hearing and data collection was carried out from EUMP staff in order to evaluation for actual condition of operation and maintenance management at site as follows.

## 1. Date of Survey

1<sup>st</sup> meeting: 31 March 2009

2<sup>nd</sup> meeting: 10 April 2009

3<sup>rd</sup> meeting: 17 April 2009

Attendants

EUMP side: Mr.Kong Pisith(Director of EUMP)

Mr. Chin Sokhun(Deputy Director of Technical Devison)

Mr. Thai Kihn(Chief of Technical Devison)

Mr. Pen Pidun(Deputy Chief of Technical Devison, O’Romis)

Mr. Yeb Thav(Deputy Chief of Technical Devison, Diesel)

Mr.Heng Sokhon(Deputy Chief of Technical Devison, O’Moleng )

Project Mission : Mr. Yunitaka HIRAGA (Electro-mechanical Engineer)

## 2. Collection Data

(1) Items to be discussed and surveyed

The pending matter to be discussion between EUMP and the mission will be measured after evaluation of collected data as follows.

Also, we reinstructed, as previous mission, the measure of hydropower operation during dry seasons and how to change the GV operation zone.

- 1) Re-evaluation of operation data for each power station,
- 2) The study of operation and maintenance against inflow of the river water decreased
- 3) ON –the-Job Training for trouble shooting
- 4) Middle & Long Term Maintenance Plan

1<sup>st</sup> Step

Operation data from 10 Jan to 31 Mar 2009 for each power stations were collected and to evaluate them,

2<sup>nd</sup> Step

The analysis and evaluation of actual data, the pending matter is as follows,

Operation data has been recorded every power station, but event of fault records (such as failure record of power system and power stations) are not enough or lacking, so that we propose the Event Record/Fault Record shall be made and submitted to the Director/Deputy director, immediately.

3<sup>rd</sup> Step

The method and way of the operation and maintenance record as happened event are applied.

(Results)

1) Re-evaluation of operation data for each power station

Operation data has been recorded by the PC system which is supplied by the project, and that data will be useful for Annual Report, so on.

Fault record will also use for technical transfer to the staff.

2) The study of operation and maintenance against inflow of the river water decreased

Through the training and actual work to the staff with think deeply, the reasonable operation of the power station and stable supply to the power system will be built.

3) OJT

In order to maintain the reliability and the least of shutdown in the power system, we have a training of recovering of the troubles to the EUMP staff.

In actual event, they were able to recover the trouble such as hydropower and transmission lines without long stoppage.

4) Middle & Long Term Maintenance Plan

They (EUMP) have been starting the discussion for appropriated plan in considering of operation and financial conditions.

(2) Preparation of Inflow-Output Curve

It is necessary to collect further operation data (April and May) such as inflow and generation output both power stations in order to make its operation curve, therefore, the curve will be prepared at next survey mission (in June 2009).

### 3. Instruction

From the above item, next mission on June 2009 will instruct or discuss with EUMP.  
So, EUMP should record the daily operation and inflow data.

## (The 2<sup>nd</sup> Survey on May - June 2009)

### Operation and Maintenance of Generating Facilities

The hearing and data collection was carried out from EUMP staff in order to evaluation for actual condition of operation and maintenance management at site as follows.

#### 1. Date of Survey

1<sup>st</sup> meeting: 29 May 2009

2<sup>nd</sup> meeting: 5 June 2009

3<sup>rd</sup> meeting: 12 June 2009

Attendants

EUMP side: Mr.Kong Pisith(Director of EUMP)  
Mr. Chin Sokhun(Deputy Director of Technical Devision)  
Mr. Thai Kihn(Chief of Technical Devision)  
Mr. Pen Pidu(Deputy Chief of Technical Devision, O’Romis)  
Mr. Yeb Thav(Deputy Chief of Technical Devision, Diesel)  
Mr.Heng Sokhon(Deputy Chief of Technical Devision, O’Moleng )  
Project Mission : Mr. Yukitaka HIRAGA (Electro-mechanical Engineer)

## 2. Collection Data

### (1) Items to be discussed and surveyed

The pending matter to be discussion between EUMP and the mission measured after evaluation of collected data as follows.

The previous mission instructed the measure of hydropower operation during dry seasons. But the rain season is starting at site and the mission instructed how to change the GV operation zone.

- 1) Re-evaluation of operation data for each power station,
- 2) The study of operation and maintenance against inflow of the river water increasing
- 3) ON –the-Job Training for trouble shooting
- 4) Plan and execution of periodic Inspection for power stations

#### 1<sup>st</sup> Step

Operation data from 1 April to 31 May 2009 for each power stations were collected and to evaluate them,

#### 2<sup>nd</sup> Step

The analysis and evaluation of actual data, the pending matter is as follows,

Operation data and failure record of power system has been recorded every power station very well and to put into the PC system provided by JICA study team. But work procedure and plan are not enough or lacking, so that we propose to provide it during periodic inspection.

#### 3<sup>rd</sup> Step

The method and way of the operation and maintenance record as happened event are applied.

### (Results)

#### 1) Re-evaluation of operation data for each power station

Operation data has been recorded by the PC system, and that data will be useful for Annual Report, so on.

The record of event, fault and work plan will be taken for technical transfer to the staff.

#### 2) The study of operation and maintenance against inflow of the river water increasing

Through the training and actual work to the staff with think deeply, the reasonable operation of the power station and stable supply to the power system will be built.

3) OJT

In order to maintain the reliability and the least of shutdown in the power system, we have a re-training of recovering of the troubles to the EUMP staff.

In actual event, we judged that EUMP staff was able to recover the first step trouble at hydropower and transmission lines without long stoppage.

4) Plan and execution of Periodic Inspection

The mission proposed and discussed EUMP about the inspection plan and execution of the inspection as follows:

a) O'Moleng and O'Romis hydropower stations were carried out disassembly/assembly inspection from 31 May to 6 June 2009.

B) Diesel power station was carried out disassembly/assembly inspection from 10 June to 12 June 2009.

(2) Preparation of Inflow-Output Curve

EUMP collected the operation data from December 2008 to May 2009 such as inflow and generation output both power stations in order to make its operation curve. therefore, the curve will be prepared at next survey mission (in June 2009).

### 3. Instruction

From the above item, next mission on June 2009 will instruct or discuss with EUMP.

So, EUMP should record the daily operation and inflow data.

## (The 4<sup>th</sup> Survey on November - December 2009)

### Operation and Maintenance of Generating Facilities

The hearing and data collection was carried out from EUMP staff in order to evaluation for actual condition of operation and maintenance management at site as follows.

#### 1. Date of Survey

1<sup>st</sup> meeting: 16 November 2009

2<sup>nd</sup> meeting: 27 November 2009

3<sup>rd</sup> meeting: 2 December 2009

Attendants

EUMP side: Mr.Kong Pisith(Director of EUMP)

Mr. Chin Sokhun(Deputy Director of Technical Devision)

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Electric Power Development Co.,Ltd. (J-POWER)  
The Chugoku Electric Power Co.,Inc. (ENERGIA)

Mr. Thai Kihn(Chief of Technical Devision)

Mr. Pen Pidu(Deputy Chief of Technical Devision, O’Romis)

Mr. Yeb Thav(Deputy Chief of Technical Devision, Diesel)

Mr.Heng Sokhon(Deputy Chief of Technical Devision, O’Moleng )

Project Mission : Mr. Yukitaka HIRAGA (Electro-mechanical Engineer)

## 2. Collection Data

### (1) Items to be discussed and surveyed

The pending matter to be discussion between EUMP and the mission measured after evaluation of collected data as follows.

The previous mission instructed the measure of hydropower operation during rainy season. But the dry season is starting at site and the mission confirmed how to change the GV operation zone.

- 1) Re-evaluation of operation data for each power station,
- 2) The study of operation and maintenance against inflow of the river water decreasing
- 3) ON –the-Job Training for trouble shooting
- 4) Plan and execution of 2<sup>nd</sup>. Periodic Inspection for power stations

#### 1<sup>st</sup> Step

Operation data from 1 June to 30 November 2009 for each power stations were collected and to evaluate them,

#### 2<sup>nd</sup> Step

The analysis and evaluation of actual data, the pending matter is as follows,

Operation data and failure record of power system has been recorded every power station very well and to put into the PC system provided by JICA study team. But work procedure and plan are not implemented or lacked, because of that work plan is under the revision by O&M Manual. So we propose to apply it after completion of O&M Manual in Cambodian version.

#### 3<sup>rd</sup> Step

We propose to apply it after completion of O&M Manual in Cambodian version. The EUMP agrees to apply it in the 3<sup>rd</sup> of periodic inspection (June 2010).

### (Results)

#### 1) Re-evaluation of operation data for each power station

Operation data has been recorded by the PC system, and that data will be useful for Annual Report, so on.

The record of event, fault and work plan will be taken for technical transfer to the staff.

#### 2) The study of operation and maintenance against inflow of the river water decreasing.



Through the training and actual work to the staff with think deeply, the reasonable operation of the power station and stable supply to the power system was implemented.

3) OJT

In order to maintain the reliability and the least of shutdown in the power system, we have a re-training of the trouble shooting to EUMP staff through the 2 times of periodic inspections. In actual event, we judged that EUMP staff was able to recover the first step trouble at hydropower, diesel power and transmission lines without long stoppage.

Therefore, we instruct the EUMP to carry out the next step as a technical and evaluation of trouble shooting on the desk work.

4) Plan and execution of Periodic Inspection

The mission proposed and discussed EUMP about the inspection plan and execution of the inspection as follows:

a) O'Moleng and O'Romis hydropower stations were carried out disassembly/assembly inspection from 27 November to 2 December 2009.

B) Diesel power station was carried out disassembly/assembly inspection from 16 June to 22 November 2009.

(2) Preparation of Inflow-Output Curve

EUMP collected the operation data from December 2008 to May 2009 as a "Inflow- Generation Output Curve" both power stations in order to make its stable operation. Civil and Electrical section of EUMP have discussed and apply the operation for both hydropower stations.

### 3. Instruction

Therefore, the curve is applied the actual operation from now with necessary revision of the curve based on actual inflow of every year.

## (The 5<sup>th</sup> Survey on February 2010)

### Operation and Maintenance of Generating Facilities

The hearing and data collection was carried out from EUMP staff in order to evaluation for actual condition of operation and maintenance management at site as follows.

#### 1. Date of Survey

1<sup>st</sup> meeting: 19 February 2010

Attendants

EUMP side: Mr. Chin Sokhun(Deputy Director of Technical Devision)

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Electric Power Development Co.,Ltd. (J-POWER)  
The Chugoku Electric Power Co.,Inc. (ENERGIA)

Mr. Thai Kihn(Chief of Technical Devision)

Mr. Pen Pidu(Deputy Chief of Technical Devision, O’Romis)

Mr. Yeb Thav(Deputy Chief of Technical Devision, Diesel)

Mr.Heng Sokhon(Deputy Chief of Technical Devision, O’Moleng )

Project Mission : Mr. Yukitaka HIRAGA (Electro-mechanical Engineer)

## 2. Collection Data

### (1) Items to be discussed and surveyed

The pending matter to be discussion between EUMP and the mission measured after evaluation of collected data as follows.

The previous mission instructed the measure of hydropower operation during rainy season. But the dry season has started at site and the mission confirmed how to change the GV operation zone due t to decreasing water level..

The present problem is contamination of mad at O’Romis dam, the mad come from the O’Romis’ river under the construction of bridge and national road.

#### 1) Operation Practice of Guide Vane during Dry Season

JICA team directed EUMP staff to practice the [River Inflow and Output Curve] as prepare in December, 2009.

#### 2) Plan of No. 3 periodical Inspection

JICA team directed EUMP to prepare the inspection plan of No.3 coming May to June 2010.

### (2) Held 3<sup>rd</sup> JCC Meeting

JICA team attended 3<sup>rd</sup> JCC Meeting at MIME at 8:30 – 12:30 on 23<sup>rd</sup> Feb 2010.

EUMP presented the following present status, and approved it in the meeting.

1) Generation and production of energy, 2008-2009

2) Operation and maintenance status, 2008-2009

3) Plan and schedule of year 2010

## **Appendix 4 Generation Facilities**

**Appendix 4-1 : Daily load curves (rainy and dry seasons)**

**Appendix 4-2 : Daily operation records (sample)**

**Appendix 4-3 : Energy consumption records (yearly)**

**Appendix 4-4 : Event and fault records (sample)**

**Appendix 4-5 : Periodic Inspection (2009/May, June)**

**Appendix 4-6 : Periodic Inspection (2009/Nov, Dec)**

## **Chapter 5 Transmission / Distribution Line**

## Chapter 5 Transmission / Distribution Line

### 5.1 Activities and Achievements of the 1st Period

#### 5.1.1 General

Transmission and distribution engineering advisor has been dispatched five times for the field work and conducted home work three times in the first year from Dec. 2008 to Mar. 2010.

To achieve the project purpose “To establish the mechanism to properly manage and operate civil work structures, power generation facilities and transmission/distribution facilities within EUMP”, technical assistance and support to EUMP were conducted for the output “Technical guidance for maintenance transmission and distribution facilities is established and functioning well.” such as capacity building, OJT, revising the O&M manual, recording and organizing the data and so on.

Outputs and activities in the first year are as follows.

#### 5.1.2 Achievements by PDM Activities

- (1) To establish the medium and long term plan of transmission and distribution facilities

Mid- and long-term plans concerning transmission/distribution facilities were formulated in April 2009 based on the surveys of EUMP’s facility and management circumstances and staff technical levels conducted in the First Field Work in Cambodia (Dec. 2008 to Apr. 2009), and the plans were approved at the 2<sup>nd</sup> JCC meeting (held in June 2009).

At the time when these plans were formulated, only six months or so had passed since construction of the power facilities for EUMP had been completed, and there was a lack of operational records. Therefore these mid- and long-term plans do not reflect the actual state of EUMP’s operations in such ways as incorporating facility restoration budgeting allowing for facility damage due to adverse weather, etc. This means that after a year or so has passed, these mid- and long-term plans will need to be verified and revised so as to reflect the actual state of and future concepts for EUMP’s operations.

Also, although these plans were framed following consultation and coordination with EUMP’s staff, only a short time has passed since the start of the project in December 2008 and the staff had insufficient experience of the operations, so that there were large contributions from the JICA mission in the plans’ formulation. Since, however, EUMP will have to verify and revise the mid- and long terms plans itself after the Project ends in March 2011, it will be necessary to effect raising of EUMP staff’s plan formulation capabilities during the Second Period of the Project.

- (2) To revise and translate the operation & maintenance manual regarding transmission and distribution facilities from English to Khmer

Based mainly on the EUMP operational and management circumstances and staff skill levels that

we were able to determine in the First and Second Field Works in Cambodia (Dec. 2008 to Jul. 2009), and also on the OJT (online job training) implemented up to that time, we formulated proposals for overall revision (for English and Khmer versions) of the O&M manuals prepared in the soft component under the grant aid project. Such proposals were approved at the 3<sup>rd</sup> JCC meeting (in February 2010).

In consideration of EUMP's experience in facility management and the present skill levels of its staff, it was decided to use mainly guidance via OJT for those items that are highly necessary for operational management, such as basic policy regarding fault recovery procedures, scheduled outage procedures, and safety, and so these items were covered as concisely as possible in the plans, with care being taken to make the content and quantity of such coverage readily understandable to the transmission/distribution staff.

We will impress upon EUMP that the manual's contents will have to be verified and revised as necessary if events should occur during future operation that are at variance with the actual conditions of EUMP's operations, and that EUMP must add content to the manual whenever operations arise that need to be covered by the manual, after first studying the implementation procedures, etc.

- (3) To conduct periodically inspection and maintenance of transmission and distribution facilities by OJT

Due to their special characteristics of being installed outdoors and throughout the central district of Sen Monorom town, which constitutes the service area, the transmission/distribution facilities cannot, even if newly installed, take complete preventive measures against facility accidents such as damage resulting from thunderstorms and other natural phenomena, or from traffic accidents or other acts of negligence by the general public. Also, since facility accidents often lead directly to customer outages, rapid cause investigation and emergency recovery will be required.

Accordingly, OJT relating to accident response methods enabling EUMP to proceed with accident recovery to the extent of its own ability even when the JICA mission members are absent was implemented at the start of the Project in December 2008, and follow-up OJT has been conducted at appropriate occasions during subsequent Field Work in Cambodia. Also, since most transmission/distribution operations – especially accident recovery – involve risk of electric shock, falls, and other hazards, whenever the opportunity has arisen from December 2008 onward we have implemented education in safety awareness via OJT concerning electrical safety, adopting the approach that the most important thing is to assure the safety of the public and of EUMP's staff.

Further, in conducting the OJT, we quoted the Electric Power Facility Technical Standards of the Kingdom of Cambodia that are relevant to the guidance issues, and devoted utmost attention to having the trainees understand the issues in conjunction with such relevance to the standards.

Due to reasons including the fact that the EUMP transmission/distribution engineer staff have many and various daily duties and were unable to find sufficiently long continuous stretches of time for the technical guidance, it was difficult to determine fully, while we were giving the guidance, the degree to which they understood it. Thus, more OJT that continues from and recapitulates the earlier OJT will be required in the future.

(4.) To record and compile relevant data (repair and inspection record, trouble shooting and the like)

We are giving guidance, arranged in due sequence, for preparation of repair/inspection records, accident response records, and the like, to enable the EUMP staff to keep records of actual facility operation which they can subsequently check and reflect in the next work program, and to enable smooth conducting of the reporting for supervisory government agencies that is laid down in the laws of the Kingdom of Cambodia.

We have been giving direct field guidance with regard to record-keeping for which need arose during the OJT periods – such as transmission/distribution line fault recovery response records, including guidance in the methods for using such records – but although we were able to get the staff to understand the basic concepts, recapitulative guidance will be required in order for them to acquire the skills thoroughly.

As regards record-keeping for which need did not arise during the OJT periods, guidance at the moment consists only of entries in the O&M manuals. Thus, in the Second Period it will be necessary to conduct guidance in such records and their uses, utilizing the Khmer-version O&M manuals completed at the end of the First Period.

## 5.2 Outline of Transmission and Distribution Facilities

### 1) 22kV Transmission Line Facilities

22kV Transmission and Distribution Line: 28km

22kV Switchgear Substation with control and protection: 2 places (District office and Hospital)

### 2) 400-230V Distribution Line Facilities

400-230V Distribution Line: 33km

VHF/UHF Radio System Facilities: 1 lot (O'Moleng, O'Romis Hydropower stations, Diesel power station and Administration office)

## 5.3 Activities

### 5.3.1 Field Activities Record

#### (1) Members

[Counter part]

Mr. Chin Sokhun, Deputy Director of Technique

Mr. Thai Khin, Chief of Technical Section

Staff members of Transmission & Distribution team

[JICA team]

Mr. Takashi Okuhara, Transmission and distribution engineering advisor, the Chugoku Electric Power Co., Inc.

Field work timing	Work description	Work implemented	Evaluation of implementation
Preparatory Home Work in Japan Dec. 2008	Preparation of Inception Report	Work of preparing Inception Report	Prepared on schedule.
First Field Work in Cambodia Round 1: Dec. 2008	Determination of EUMP facility functioning and management situations	1) Determined equipment situation via field observation and checking of design documents, etc. 2) Determined operational management situation to date via interviews with EUMP engineering section staff and responsible persons.	1) System configuration, facility overviews, and present conditions of locations, etc., were roughly determined. 2) It was found that regular work such as meter inspection, trimming, and supply construction work was already being suitably addressed.
	Guidance in maintenance, operation, and management for EUMP staff	Provided the following guidance and advice on items that will be necessary in the short term until the next Field Work in Cambodia: 1) Basic safety measures for working on transmission/distribution lines 2) Procedures for investigating fault location when transmission/distribution line accidental outage occurs 3) Methods for planning/recording system switching procedures during work on transmission/distribution lines 4) Planning and recording trimming of trees encroaching on transmission/distribution lines	1) Although the staff possessed fundamental knowledge concerning safety measures, it was contrived to have them – including managers and supervisors – absorb afresh the importance and basic principles of safety measures. 2) Guidance was given in basic procedures for fault location investigation. When transmission/distribution line accidental outages have occurred since, fault location investigations based on those procedures have been conducted. 3) Guidance was given for formulating procedures ahead of the work. 4) Guidance was given for early determination of actual situation, trimming with priority ranking, and recording of results for feedback into plans for subsequent trimming.
First Home Work in Japan Mar. 2009	Preparation of Interim Report	Formulation of mid/long-term maintenance plans for transmission/distribution sections	Tentative (draft) mid/long-term maintenance plans were prepared.



Field work timing	Work description	Work implemented	Evaluation of implementation
First Field Work in Cambodia Round 2: Mar. to Apr. 2009	Determination of EUMP transmission/distribution on team's management situation	Determined the management situation at the stage when 4 months had passed since EUMP's inauguration	Regular work is already being managed well, but for sustainable facility maintenance and operation in the future it will be necessary to further raise technical skills and improve record-keeping/management work, etc.
	Guidance in maintenance, operation, and management for EUMP staff	<ol style="list-style-type: none"> <li>1) Follow-up for guidance implemented in previous Field Work in Cambodia</li> <li>2) Guidance in proper methods of managing spare parts and tools</li> <li>3) Consultation on formulating detailed patrolling plans</li> <li>4) Guidance concerning transmission/distribution loss</li> </ol>	<ol style="list-style-type: none"> <li>1) There were difficulties for preparing fixed-format work records, so the guidance is scheduled for April.</li> <li>2) Periodic management using a control chart is not practiced, so the guidance is scheduled for April.</li> <li>3) Check points for detailed patrolling were exemplified and advice for planning detailed patrols commensurate with actual operational conditions was given.</li> <li>4) Transmission/distribution loss occurrence factors and attention items for reducing loss in daily operations were explained.</li> </ol>
	Deliberative consultations on mid/long-term plans, financial plan, preparation of tariff rate revision documents, and tariff charge system	<ol style="list-style-type: none"> <li>1) Deliberative consultations concerning O&amp;M cost calculation</li> <li>2) Deliberative consultations concerning tariff charge system</li> </ol>	<p>Consultation and coordination was conducted with EUMP regarding addition/disposition of spare parts.</p> <p>Determination of/consultations on operational responses by the transmission/distribution team were conducted.</p>
Second Field Work in Cambodia: Jun. to Jul. 2009	Provision of tools and equipment for Transmission & Distribution work and Guidance how to use	<ol style="list-style-type: none"> <li>1) Safety belt</li> <li>2) Earthing tool</li> <li>3) Insulation resistance tester, Digital multi-meter and Power Quality Analyzer</li> </ol>	Guidance in methods of using was given in practice.
	Consultation on formulation of draft organizational regulations	1) Revising the draft regulation of Transmission and Distribution work	Draft regulation referred to other fields was made.
	Consultation on fault recovery method	1) Discussion on re-energizing in the event of a total system outage	Recovery method was formulated and added to O&M manual by EUMP technical staff and the advisor.

Field work timing	Work description	Work implemented	Evaluation of implementation
	Formulation of the draft revised O&M manual	1) Making the draft revised Transmission & Distribution O&M manual	Revised O&M manual was made in English. Translation into Khmer was ordered.
	Guidance of Transmission and Distribution loss in the field	1) Investigation of the high loss facility in the field	Guidance to investigate loss was given to EUMP staff in the field.
	Guidance of fault locating in the field	1) Guidance of fault locating in the field	Guidance to locate the fault point was given in the field when the fault occurred.
	Discussion of Safety equipment	1) Discussion of Safety Equipment	Checking the situation in Cambodia about safety equipment and advise to procure the safety equipment by local purchase was given to EUMP.
	Inspection on malfunction of power plant	1) Inspection on malfunction of hydro power plant	Inspection of EUMP's work for checking and recovering
	Follow-up of the first field work	1) Follow-up of recording and storing fault recovery	The last guidance was confirmed and follow-up was given to EUMP.
Third Field Work in Cambodia: Oct. to Nov. 2009	Formulation of the draft revised O&M manual	1) Making the draft revised Transmission & Distribution O&M manual	The Khmer version was checked and material was revised.
	Technical Guidance on procedure for scheduled outage	1) Explanation to fill out "Scheduled Outage Procedure Sheet" 2) Operation of switch according to "Scheduled Outage Procedure Sheet"	Guidance was given to EUMP in practice.
	Technical Guidance on Grounding Resistance measurement	1) Lecture of grounding resistance in the SREPTS 2) Hands-on Guidance in grounding resistance measurement 3) Follow-up meeting for grounding resistance measurement training	EUMP's staff members acquired the knowledge and experience about grounding through hands-on guidance. Repair method of grounding equipment was given to EUMP.
	Technical Guidance on trimming of trees approaching lines	1) Technical Guidance on trimming of trees approaching lines	Safety guidance such as earthing in the field was given to EUMP.
	Consultation on Transmission line extension scheme	1) Provision of EDC's Design Standard 2) Observation of planned location 3) Verification of EUMP's plans	EUMP's plans were checked and basic knowledge for design was given to EUMP.
Fourth Field Work in Cambodia: Dec. 2009	Editing Revised O&M manual	Editing O&M manual	Khmer version was reedited to confirm with the material structure of the other sections.
	Technical Consultation	1) Guidance in methods for using power quality analyzer 2) Determination of stone crushing factory load data	Repeat guidance in methods for using power quality analyzer was given to EUMP. Measurement data

Field work timing	Work description	Work implemented	Evaluation of implementation
		3) Consultation on assuring ground height of road crossing transmission line at roadwork site	was checked by this tool. Consultation on future action methods to solve minimum ground height matter was given to EUMP.
Fault history	Fault history from Nov. 2008 to Mar. 2010	Small-scale supply outages, such as low-voltage system outages due to breaker activation, have occurred, besides also transmission/distribution line accidents on Feb. 12 2009 (contact with small animals), Apr. 4 (lightning), and Apr. 5 2009 (insulator damage due to lightning), but all faults are recovered.	Required are measures toward fault recovery, such as storing experience of fault recovery, upskilling and so on.
Issues for future	Second Field Work in Cambodia	1) Upskilling of O&M technique and Enriching O&M manual 2) Acquiring technical know-how to order restorative construction, etc	

### 5.3.2 Filed Activity Record

#### (1) Field Work in Cambodia from Dec. 9 to 23, 2008

##### a) Trimming of trees contacting distribution lines

- Purposes:           i) Prevention of electric shocks to people (general public, EUMP staff)  
                          ii) Prevention of supply outages due to disconnection

Period:               End of month (Dec. 2008)

Scope:               To be implemented for all transmission/distribution lines

Implementers:       Transmission/distribution sections (with diesel power generation sections assisting)

- Method:              i) Prepare map of tree contacting locations  
                          ii) Determine priority ranking  
                          iii) Implement trimming

Points for attention: i) If the trimming work is delayed, it will be difficult to frame schedules for the other work (due to the need for emergency responses for disconnections). Therefore, assign top priority to the trimming work.

ii) Near medium voltage distribution lines, always stop the power before working.

iii) For safety, when working with a bucket truck, pay attention to any people who are beneath the truck.

iv) The tree contacting location map prepared in this trimming will be exceedingly useful for formulating plans for the next one.

##### b) Preparation of stoppage procedure document for outage work on medium voltage distribution lines

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Purposes:	i) Prevention of electric shock accidents due to mistakes in stoppage procedure ii) Qualitative enhancement of the work next time, through checking of the work implementation results
Period:	Ahead of implementation of outage work on medium voltage distribution lines
Implementers:	Persons responsible for transmission/distribution system operation
Method:	Refer to Sample Form (provisional version)

## **(2) Field Work in Cambodia from Mar. 15 to Apr. 10, 2009**

### a) Clarification of EUMP's actual operation situation

As four months had passed since EUMP's inauguration and a certain amount of operational and management performance records had been accumulated, we determined the transmission/distribution team's present operational and management situation through consultations with responsible engineers and verification of daily operation conditions, etc.

#### Summary

Overall, the regular operations are being managed well, broadly speaking, thanks to spontaneous efforts by EUMP. But in order to maintain and operate the transmission/distribution facilities sustainably in the future, it will be necessary to maintain and enhance technical knowledge and skill levels and to construct cooperative setups with contractors and other electric power companies. Also, it was observed that operation result record-keeping and ledger-keeping, and management of equipment, materials and tools, were being carried out inadequately in some respects. Consequently, these will require improvement. Further, in order to construct an annual work PDCA schedule, it will be necessary to observe operational performance for at least one year, since the facility failure response trends (as regards frequency, locale, etc) vary seasonally.

### b) Observation of work in the field

- (1) Meter inspection work ..... AM of Friday Mar. 20, 2009
- (2) Supply construction work ..... PM of Friday Mar. 27, 2009
- (3) Low-voltage line repair work ..... AM of Monday Mar. 29, 2009
- (4) Transmission/distribution line accident recovery .. PM of Friday Apr. 3 and PM of Saturday, Apr. 4, 2009

### c) Guidance in maintenance, operation, and management for EUMP staff

#### (1) Follow-up for guidance implemented in previous Field Work in Cambodia

##### 1. Basic safety measures for work on transmission/distribution lines

Having observed the work of recovery from a transmission/distribution line accident, the procedures seem to be essentially adhered to, but since mistakes in the procedural sequence

were also observed, we intend to give follow-up guidance to have the procedures firmly acquired.

2. Fault location investigation procedure for when accidental outage occurs in transmission/distribution lines

Having observed the work of recovery from a transmission/distribution line accident, the procedure is essentially adhered to.

3. Methods for planning/recording system switching procedures during work on transmission/distribution lines

Records are made, but since there are insufficient fixed-format records, during this Field Work we showed the staff exemplary record forms for fault recovery and gave them guidance in creating fixed-format forms (consultation on Apr. 7, letter forwarded Apr. 15). Guidance in planning scheduled outages is to be given in the next and subsequent Field Works.

4. Planning of trimming of trees encroaching on transmission/distribution lines and preparation of trimming implementation record map

The map has been completed, and it seems it will be incorporated into work schedules for systematic trimming in the future.

- (2) Guidance in proper management of spare parts and tools

Since the staff were not practicing management enabling instant determination of quantities of spare parts and tools available for emergency response to transmission/distribution line accidents, etc., we showed them exemplary control charts and gave guidance on using such charts for regular management of these items (consultation on Apr. 7, letter forwarded Apr. 15).

- (3) Planning of detailed patrols

At present, cursory patrols are conducted once a week. But there are forms of facility damage/breakage whose signs cannot be detected by cursory patrols alone, and so we explained to the staff that it is desirable to conduct detailed patrols of all facilities once every several years, on the assumption that aging deterioration of the facilities will occur in the future. We presented as examples the check points used in detailed patrols in Japan, and advised the staff to frame plans for detailed patrols in accordance with EUMP's volume of operations and workforce size (consultation Mar. 31).

- (4) Explanations concerning transmission/distribution loss

Using documents, we explained to the transmission/distribution team the factors of transmission/distribution loss occurrence and the occurrence situation to date. Alongside that, we gave guidance in preventing cabling errors and mis-connections in construction work, and preventing the occurrence of loss due to human factors, as matters for their attention in day-to-day operations (consultation Mar. 31).

- d) Deliberative consultations on mid/long-term plans, financial plan, and preparation of tariff rate revision documents

We held consultations and deliberations with EUMP on additional quantities of spare parts that require to be procured, as a part of O&M cost calculation pertaining to transmission/distribution (consultations on Mar. 23, Mar. 31 and Apr. 7).

e) Deliberative consultations on tariff charge system

In the series of operations constituting the tariff charge system (namely new supply application, start of supply, meter inspection, and bill collection), the transmission/distribution team is assigned the following tasks:

- technical review and supply construction work when supply application is received,
- meter inspection, bill distribution, work for stopping supply to customers failing to pay, and reconnection work for customers resuming payment, and
- facility removal work when contracts are canceled.

Accordingly, we held deliberative consultations on constructing such system after due coordination with the other teams.

f) Programs for next and subsequent Field Works in Cambodia

- (1) Provision of equipment under the Project, and guidance in use methods
- (2) Guidance in methods for keeping fixed-format records of scheduled outages, etc.
- (3) Incorporation of contents of guidance to date in manuals
- (4) Upskilling in operation, maintenance, and management via OJT

**(3) Field Work in Cambodia from Jun. 14 to Jul. 6, 2009**

a) Holding of 2nd JCC meeting

- (1) The meeting was held from 8:30 to 11:30 AM on Monday June 15, 2009.
- (2) The draft minutes of the meeting were submitted to the JICA Cambodia Office from 6:20 to 7:20 PM on Wednesday June 24, 2009.

b) Supply of transmission/distribution related equipment

- (1) Equipment to be supplied (five items, all to be procured in Japan): insulation resistance testers, digital multi-meters, lineman safety belts, earthing tool, power quality analyzer
- (2) Taking into Cambodia: The equipment was taken into Cambodia on June 14, 2009 (witnessed by Mr. Miyake of JICA)
- (3) Handing over to EUMP: The equipment was handed over on June 19, 2009

c) Guidance in methods of using the supplied equipment

(1) safety belts

Date and time: 8:00 to 9:00 AM, Saturday Jun. 20, 2009

Place: Garden inside EUMP Offices, using actual facility (electricity pole No. DG-002)

Given to: Engineering Deputy General Manager, Engineering Section Chief, 4 members of transmission/distribution team  
(also observed by General Manager and several engineering related employees)

Contents: Guidance on methods for assembling the lineman safety belts, inspecting them before use, and adjusting the torso rope length while on a pole, plus hands-on practice and pole ascent/descent drills.

Remarks: The staff were able to acquire the basic use methods, but repeat training will be required in order for them to use the belts in actual work. The transmission/distribution team have a congested work schedule, which will need to be adjusted to secure time for such training.

(2) Earthing tool

Date and time: 8:00 to 9:00 AM, Saturday Jun. 20, 2009

Place: Garden inside EUMP Offices

Given to: Engineering Deputy General Manager, Engineering Section Chief

Contents: Explanations of the use methods. Hands-on training was omitted, as there were no training facilities available and the principles are the same as for the earthing tool already used by EUMP.

(3) Insulation resistance testers, digital multi-meters, and power quality analyzer

Date and time: 9:30 to 10:00 AM, Monday Jun. 29, 2009

9:00 to 11:00 AM, Tuesday Jun. 30, 2009

8:00 to 9:30 AM, Friday Jul. 3, 2009

Place: EUMP Office Meeting Room

Given to: Engineering Deputy General Manager, Engineering Section Chief, 4 members of transmission/distribution team  
(also observed by General Manager and several engineering related employees)

Contents: Explanations of the use purposes of the insulation resistance testers, digital multi-meters, and power quality analyzer, and of the main differences between the power quality analyzer and the Clamp-on Power Hi-Tester and other Power Hi-Testers. Measurements of power on the EUMP premises, using the insulation resistance testers, digital multi-meters, and power quality analyzer. Explanations of Cambodian Technical Standards (for specified voltage and specified insulation resistance levels).

Remarks: There was a desire to bring as many power station staff as possible into contact with the actual equipment, and the station staff members participating were also actively attending the training. They have essentially grasped the use methods for the insulation resistance testers and digital multi-meters, and it is hoped that they will acquire them firmly through actual operations in the field. The power quality analyzer has complex functions, and it is hoped that additional education concerning them will be given by the Engineering Deputy General Manager, who understands the English manuals.

d) Consultation on formulation of draft organizational regulations

- (1) Monday Jun. 15, and Tuesday Jun. 16, 2009 JICA Project Team internal consultation
- (2) Friday Jun. 19, 2009 Presentation to and consultation with EUMP
- (3) Outcome: Draft Organizational Regulations.
- (4) For future: The English drafts to be translated into Khmer and put into effect as EUMP internal regulations.

e) Consultation on fault recovery procedures

Date and time: 9:30 to 11:00 AM, Friday Jul. 3, 2009

Place: EUMP Office Meeting Room

Given to: Engineering Deputy General Manager, Engineering Section Chief

Contents: Based on the guidance given in December last year and the power generation related guidance given in May and June this year, we verified and consulted with engineering related executives about the procedures for restoring power in the event of a total system outage.

Outcome: Recovery procedures to be directed from the diesel power station (two patterns: one for load 300 kW or less, another for load 400 kW or less) and recovery procedures to be directed from the O'Moleng Hydroelectric Power Station (load 370 kW when both hydroelectric generators are able to operate at maximum output) were formulated and incorporated into the draft revised O&M manuals.

f) Formulation of draft revised O&M manual

Outcome: Draft revised transmission/distribution related O&M manual (English version)

Approaches for drafting the manual: The manual formulated in November of the previous year were revised using the following approaches:

- The text of the manual formulated in November 2008 was not altered, since it is shared with other sections and its contents have general applicability.
- The structure of Appendix 6 (transmission/distribution O&M manual) of the November 2008 version manual was given an overall revision and material was added to it.



- The structure was revised so as to conform with the "Division of Duties Among Transmission/Distribution Sections" in the organizational rules formulated in this Field Work.
- The additional materials were, as a rule, prepared based on the explanations given and materials presented in the Field Work OJT to date.

Translation formalities:

The provisional draft and the final draft were presented for translation to the person in charge at MIME on June 24 and July 3, 2009, respectively.

g) Field investigation and guidance on transmission/distribution loss

Date and time: 2:00 to 5:00 PM, Monday Jun. 29, 2009

Place: PMT26 and PMT02 low-voltage systems

Given to: Engineering Deputy General Manager, Engineering Section Chief, transmission/distribution team (team chief was absent on leave), drivers

Contents: Field investigation was conducted on the PMT26 and PMT02 low-voltage systems, which the June meter inspection results indicated to have particularly large transmission/distribution loss between the pole transformers and the customers. Guidance was given concurrently.

Overall assessment:

- Regarding PMT26, it was found that the cause was mistaken calculation of the transformer power consumption due to the instrumentation for the transformers having been changed subsequent to the May meter inspections. Thus, transmission/distribution loss was not actually occurring. Although there was no shortcoming in the facility maintenance, etc., there was insufficient record-keeping of the instrumentation change results. This will require improvement, so as to avoid the same setback in future operations.
- Regarding PMT02, it was found, upon investigating the connection of the low-voltage line, the connections of the customer meters, and the meters' operation, for each low-voltage pole, that the 3-phase customer meter of pole No. P02-312 was not working. It was replaced on the same day.

h) Field guidance in fault investigation

Date and time: 12:00 to 12:30 PM and 1:30 to 3:00 PM, Wednesday Jul. 1, 2009

Place: EUMP system

Given to: General Manager, Engineering Deputy General Manager, Engineering Section Chief, others

Contents: A system ground fault occurred around 12:00 noon on Wednesday July 7. The alarm persisted after being reset, so we advised EUMP to conduct an investigation of the fault section. Subsequently at around 12:30 the alarm stopped, and so

EUMP conducted an ad-hoc inspection patrol (Mr. Okuhara accompanied the patrol along a part of the section). The fault location could not be found, but after the patrol ended we conducted a consultation with EUMP concerning responses when faults occur.

Overall assessment:

- The fault occurred during the lunch break and the person responsible for keeping the company car keys was absent, with the result that the patrol was late in setting out for the field. The management methods for the keys as regards break times and the nighttime need to be revised so as to enable early responses.
- When a ground fault persists, there is a possibility that –although it is a rare occurrence –members of the public could receive an electric shock (or could already have received one), and so transmission must be promptly stopped. Also, a field patrol must be conducted, after first narrowing down the fault section, to the extent possible, via forced line charging of each switch section, in order to find the fault location quickly. Starting from the time of the First Field Work, we have repeatedly given EUMP guidance in these procedures, but those responsible for commands and orders were somewhat tardy in making judgments and giving instructions. Accordingly we gave stern guidance to EUMP, to impress upon the staff the danger posed by ground faults and the need to respond to them quickly.

i) Consultations on disposition of safety articles

Contents: Although a minimum of the articles necessary for preventing accidents to transmission/distribution workers has been provided under the JICA project, it has emerged from the field investigations to date that the operability and quantity of these articles are not necessarily adequate. The shortfall in such articles could be remedied to a certain extent via provision under the JICA project, but the safety articles, in particular, will need periodic replacement with newly purchased items, and after the JICA project ends, EUMP will have to procure and manage the articles itself within its own budget. Accordingly, we conducted a survey of safety articles procurable in Cambodia, reported the results to EUMP, and advised EUMP to study disposition of the necessary articles.

Items implemented:

(1) Survey of articles procurable in Cambodia (PM of June 25, 2009, Phnom Penh)

We found entities from which insulating gloves and safety shoes could be procured, and confirmed that the necessary articles can be procured in Cambodia, although the delivery schedules are rather slow.

- Insulating gloves: 1 pair of rubber gloves for use with 22 kV has been

supplied to EUMP, but these are thick gloves and therefore unsuitable to work with 400 V, so that low voltage work is carried out without protective equipment, in the main. This is not desirable in terms of safety. We have however confirmed that thin rubber gloves for low-voltage applications are procurable in Phnom Penh (for \$85 or so).

- Safety shoes: Ordinary boots are available at EUMP, but they have no toe guards and their use is avoided because they are uncomfortable in high temperatures. We have confirmed that shoes and half-boots with toe guards are procurable in Phnom Penh (for \$35 to \$55 or so).

(2) Reporting of survey result information to EUMP (AM of June 30, 2009 at EUMP office)

We presented EUMP with catalogs of the above articles that we had obtained in Phnom Penh, informed EUMP of the businesses dealing with the articles, and advised EUMP to consider making the articles available.

j) Inspection of response to generation facility fault

Date and time: Thursday Jun. 18, and Friday Jun. 19, 2009

Place: O'Romis Power Station

Given to: Engineering Deputy General Manager, Engineering Section Chief, O'Romis Power Station staff, others

Contents: The O'Romis Power Station was shut down automatically for a continuous period lasting from the late evening of Thursday Jun. 17, into the early hours of Friday Jun. 19, due to damage to the station-internal signal cables that had been caused by rats. EUMP was initially unable to determine the methods for corrective action, so we conducted investigation of the cause and inspected the restoration work together with EUMP as well as bringing in JICA project power generation team members and manufacturers of equipment that had been delivered. Refer to Photograph 3.

k) Follow-up for guidance implemented in previous Field Work in Cambodia

We inquired of the Engineering Deputy General Manager (on July 2) whether the "Recovery Procedure Record Form for Supply Interrupting Faults" (JT-009, dated 2009/4/15) which we had proposed in previous Field Work had been utilized when supply interrupting faults had occurred subsequently.

We were informed in reply that the only records that had been kept of supply interrupting faults were memory-aiding notes, and the form we had proposed had not been utilized. Despite the fact that we had given verbal explanations of the form to the Engineering Deputy General Manager during the previous Field Work, and moreover had proposed its use in an official letter, he himself had not been able to fully understand the contents.

Accordingly, we handed him a fresh copy of the letter and provided him once more with explanations concerning the utilization methods for the form.

Utilizing the form is a somewhat bothersome procedure for EUMP, which as yet is lacking in operational experience. Nonetheless, it will be necessary to keep a minimum of fault records in order to make the annual operating reports to EAC. Therefore, we will check the form utilization situation once again in the next Field Work, and if utilization is still unsatisfactory, we will study ways of further simplifying the form, in conjunction with EUMP.

#### **(4) Field Work in Cambodia from Oct. 8 to Nov. 1, 2009**

##### a) Formulation of draft O&M manual revised version

###### Outcomes

- Revised draft of transmission/distribution related O&M manual (Khmer version with unrevised structure)
- Revised draft of transmission/distribution related O&M manual (English version with revised structure)

###### Work contents:

- On October 9, we checked the state of progress of the translation of the manuscript into Khmer with the translation business from which such translation had been requested in the previous Field Work (June to July 2009), and provided explanations of parts that were not fully understood.
- On October 24, we took receipt of the Khmer translation of the manuscript requested in the previous Field Work (June to July 2009).
- From October 19 to 21, we revised the structure of the English manuscript so as to make it compatible with the other chapters.
- On October 21 and 28, we placed requests with assistants to turn the unrevised Khmer translation into a Khmer manual arranged in the same sequence as the revised English manuscript.

##### b) Technical guidance concerning scheduled outage procedures

###### (1) Explanation of method of filling out the Scheduled Outage Procedure Sheet

Date and time: 10:30 to 11:00 AM on Tuesday Oct. 13, 2009

Place: EUMP Conference Room

Given to: Engineering Deputy General Manager

Contents: We gave guidance on the method of filling out the "Scheduled Outage Procedure Sheet" that is to be included in the transmission/distribution related O&M manual.

Remarks: He was able to acquire the basic use method, but repeat training will be required in order for him to use the sheet in actual work. The transmission/distribution teams have a congested work schedule, which will

need to be adjusted to secure time for such training.

(2) Implementation of outage and restoration operations based on the Scheduled Outage Procedure Sheet

Date and time: Sunday Oct. 25 to Wednesday Oct. 28, 2009

Place: EUMP Conference Room, field transmission facility, others

Given to: General Manager, Engineering Section Chief, 2 transmission/distribution staff, others

\* The Engineering Deputy General Manager was absent due to a meeting.

Contents: We had them prepare a Scheduled Outage Procedure Sheet for an actual piece of work with power interrupted, then conduct an advance meeting and the outage and restoration operations based on the Procedure Sheet.

➤ For the outage and restoration operations, we gave guidance emphasizing the following points: "Rigorously prevent line charging, by installing earthing and turning off the transformer secondary side switch", "Make sure to remove the earthing after the work, so as to prevent ground fault accidents,", "Before resuming power transmission, send notifications via wireless so as to prevent electric shock accidents", "Operators must not execute any operations until there is an instruction to do so from the person responsible for operation instructions (in this case the Engineering Section Chief)", and "Errors in the operational sequence could lead to electric chock accidents or facility damage accidents".

➤ The JICA mission prepared the basic draft of the operational sequence for the first three days, but for the last day, we had the EUMP Engineering Section Chief think up the operational sequence themselves, so as to improve their operational sequence formulating abilities.

Remarks: We were able to have the staff acquire a certain level of understanding concerning the methods for preparing and using a Scheduled Outage Procedure Sheet. However –perhaps from reasons of habit – EUMP staff do not carry out "formulation and advance checking of written plans, checking of the written procedures during the implementation stage, or recording of the check results" –and this is not limited to transmission/distribution operations. Rather, they have a tendency to think about matters, and to issue verbal instructions and commands concerning them, on the spot. Accordingly, we will have to continue with follow-up guidance in the future so as to entrench the practices of soundly formulating plans and implementing work in line with them.

(In particular, omissions are prone to occur when line charging operation, earthing installation/removal and so forth are left to personal judgment in the field, and there is danger that such omissions could lead to fatality, injury or

facility damage. Therefore, formulating and checking plans in advance is extremely important in terms of safety.)

c) Technical guidance concerning grounding resistance measurement

(1) Explanation of Cambodian Technical Standards pertaining to grounding resistance

Date and time: 8:00 to 8:30 AM on Friday Oct. 16, 2009

Place: EUMP Conference Room

Given to: General Manager, Engineering Deputy General Manager, Engineering Section Chief, transmission/distribution staff, others

Contents: We explained the prescribed levels (Class A to D) for grounding resistance in the Cambodian Technical Standards, and the hazards (for lightning arresters, transformers) that result if those levels are exceeded.

(2) Hands-on guidance in grounding resistance measurement

Date and time: 8:30 to 10:00 AM on Friday Oct. 16, 2009

Place: Three transformer poles (PMT17, 18, 31) in the field

Given to: General Manager, Engineering Deputy General Manager, Engineering Section Chief, transmission/distribution staff, others

Contents: We explained how to use the grounding resistance meter based on the instruction manual, then had the staff actually measure the resistance of the groundings (lightning arrester grounding and transformer grounding) installed to a transformer pole (PMT17).

- The prescribed grounding resistance level for both lightning arresters and transformers is  $10\Omega$  or less. The values measured for the two groundings in the field were  $2.3\Omega$  and  $350\Omega$ , the latter being in excess of the prescribed level. Investigation of the site revealed that development work on an adjacent piece of land (private land) had caused severance of a grounding cable partway along its length.
- In addition, EUMP requested measurement of the grounding resistance at some locations where the grounding cable was exposed near to a power pole, and accordingly we also carried out field verification at these locations, namely PMT18 and PMT31. It was found that rainfall had washed part of the sloping road surface away, and as a result the grounding cables in question had become exposed and severed. At PMT18 the ground near the power pole was too overgrown to permit measurement, but the resistance at the grounding severance point at PMT31 was measured as  $13\Omega$ .

(3) Follow-up meeting for grounding resistance measurement training

Date and time: 10:00 to 10:30 AM on Friday Oct. 16, 2009

Place: EUMP Conference Room

Given to: General Manager, Engineering Deputy General Manager, transmission/distribution staff, others

Contents: We suggested to EUMP that it should implement early repairs for the three poor grounding locations discovered in the training. EUMP was supposed to be able to do the repairs via self-managed work, thanks to the experience it had gained during the construction work. But since the specifications and procurement methods for the equipment and materials to be used were unclear, we stated to EUMP our opinion that they should gather information from the local electrical construction company that had carried out the construction work, and contract the repair work out to such company if necessary.

(4) Grounding resistance repairs

Date and time: 10:00 AM to 4:00 PM on Tuesday Oct. 27, 2009

Place: Transformer poles (PMT17, 18, 31) in the field

Given to: Engineering Deputy General Manager

Contents: Repair work was requested from a local electrical construction company, which then carried out the repair work.

- We had the EUMP staff observe and acquire the electrical construction company's work implementation methods as it carried out the work. Alongside that, we had them verify the specifications and the persons to contact in order to procure necessary equipment and materials via the electrical construction company in readiness for discovery of further poor grounding locations in the future.

Remarks: We were able to have the staff acquire, in a rough manner, the use methods for the grounding resistance meter, but the skills will require more practice in actual use in the future in order to become firmly acquired. Also, Sen Monorom receives frequent and heavy rainfall, which is liable to wash the soil away, and land development here mostly involves excavations that are liable to sever grounding cables. Therefore, when field patrols discover a poor grounding location, the grounding resistance must be checked, and if it is found to be poor, follow-up repairs must be promptly carried out.

d) Technical guidance concerning trimming of trees approaching lines

EUMP had obtained permission for safety trimming of trees near transmission lines from the provincial public administration authorities about one month previously (prior to that there had been difficulty in obtaining approval for trimming from the landowners). Also, it was the end of the rainy season and the trees were growing at a rapid pace. Further, there would be strong winds in the first half of the coming dry season, and it was anticipated that these would cause tree contacting which could result in ground faults, damage to cable sheathing, and disconnection. For these reasons, during the time of our stay the transmission/distribution staff's schedule was mostly taken up with trimming work –apart, that is, from performance of periodic operations. Accordingly, we conducted two tours around the work sites, giving safety guidance in the field.

(1) Trimming of bamboo thickets between electricity poles No. OM185 and 186 (work with 22 kV supply interrupted)

Date and time: 8:00 to 10:00 AM on Tuesday Oct. 13, 2009

Place: At the actual facilities (between electricity poles No. OM185 and 186)

Given to: Engineering Deputy General Manager, Engineering Section Chief, transmission/distribution staff

Contents: We observed and gave field guidance concerning the series of steps consisting of interruption of the power supply by turning the switch off, installation of the grounding short-circuiting equipment, trimming work, removal of the grounding short-circuiting equipment, and restoration of the power supply by turning the switch on.

- We basically let the EUMP staff implement the series of steps spontaneously. However, regarding their installation of the grounding short-circuiting equipment, which they installed at the extremity of the working area that was further from the power station, we gave guidance that from the next time onward they should install it at the extremity that is nearer to the power station.
- A scene was observed where the supply interruption work was halted so that staff members could go back to the office to fetch tools that they had forgotten to bring. Accordingly, we gave guidance that they should check thoroughly that the necessary tools are present before setting out from the office.
- It was not possible to remove the bamboo roots, because the landowners had requested them to be left. Nevertheless, since the bamboo grows extremely quickly, we submitted that if other locations where bamboo is encroaching arise, the roots should be cut to the extent possible, and where it is not possible, patrols should be conducted periodically and cutback implemented



before the bamboo can encroach on the transmission line.

- (2) Tree and bamboo thicket trimming (regular work) between electricity poles No. OM237 and 238

Date and time: 10:00 to 11:00 AM on Wednesday Oct. 28, 2009

Place: At the actual facilities (between electricity poles No. OM237 and 238)

Given to: 2 transmission team staff, others

Contents: We observed the trimming work being implemented and gave field guidance concerning it.

- Since this was work in a location with a lot of car, motorcycle and pedestrian traffic, we gave guidance for thorough supervision of the ground surface workers, to avoid any hazards being posed to the public.
- Scenes were observed of trimmings being thrown down from a bucket truck onto spaces near buildings. Accordingly, we urged that if it was unavoidable to drop trimmings, they should be dropped at a sufficient distance from buildings so that buildings would not be damaged.
- In this work there was no danger of coming near a charged line. However, after the work ended we gave guidance that if such danger arises in the future at a site where they have been directed to perform trimming by a superior, they should themselves take measures to protect their own safety, such as immediately suspending the work and asking the superior for permission to interrupt the power supply.

Remarks: EUMP itself is fully aware of the necessity of trimming and has been lobbying the provincial authorities concerning such necessity –this being one of the ways in which it has evinced its growing self-awareness as an electricity business. It will be desirable in the future to give guidance on a continuous basis concerning safety operations such as electric shock prevention and dealing with falling objects.

- e) Investigation and consultations concerning transmission line extension scheme

Upon receiving information that EUMP was planning extension of its 22 kV transmission lines, we conducted interviews and verification concerning the plan contents.

- (1) Obtaining of documents on distribution line design standards, etc.

- On October 9 we obtained EDC's Distribution Line Design Standard and a document on the Facility Design Briefing for Small-Scale Electricity Businesses held by EAC (the document was prepared, and the briefing given, under the JICA technical cooperation project).
- Also on October 9, we visited EDC's JCC committee members, obtained their agreement to our providing the EDC Distribution Line Design Standards to EUMP, and requested them to cooperate by fielding inquiries if any doubts arose at EUMP as to interpretation, etc., to

which they readily consented.

- At EDC, we learned that its Service Offices, which have jurisdiction over independent systems in the regions, carry out field design and implementation of low-voltage and lesser facilities only, and that design and implementation of 22 kV line extension work was carried out by staff of the Phnom Penh Head Office who have the requisite technical knowledge.
- On October 23, we handed copies of the EDC Distribution Line Design Standards and the document on the EAC's Facility Design Briefing for Small-Scale Electricity Businesses to the Engineering Deputy General Manager.

(b) Observation of planned locations for 22 kV transmission line extensions

- Together with the EUMP Engineering Deputy General Manager and Engineering Section Chief, we conducted observations of the three planned locations.
  - Location 1: new supply for stone crushing plant
    - ✧ New supply for stone crushing plant (100 kW) (at present the plant operates on self-generated power)
    - ✧ The plan is to extend the 22 kV transmission line by about 2.4 km northward from PMT35. One 100 kVA transformer is to be installed at the end of the extension, for supply of power to the stone crushing plant.
  - Location 2: new supply for NGO child protection facility
    - ✧ New supply for NGO child welfare facility now under construction (completion scheduled for next year)
    - ✧ Transmission/distribution line is to be extended 1.2 km southwest from vicinity of electricity pole No. OM110. One 10 kVA transformer is to be installed, for supply of power to several related facilities,
  - Location 3: new supply for small rural community
    - ✧ New supply for a small rural community of about 20 households that was not included in the supply area under the JICA grant-aid construction work. (10 kVA or so at transformer.)
    - ✧ Extension from electricity pole No. OM054 to a nearby location some 1.4 km away, along a newly built road that stretches southward. Running directly onward from the rural community, that road crosses the existing 22 kV line at OM018 – the distance from OM018 to the community is about 0.4 km.
- We heard from the EUMP General Manager that there is additionally a plan for new supply using a transformer to be newly installed in the vicinity of the O'Romis Power Station.
  - Location 4: plan for new supply using transformer to be newly installed in vicinity of O'Romis Power Station
    - ✧ New supply for a child welfare facility now under construction – a private building (relatively large-sized).
    - ✧ One transformer (apparently of 10 kVA or so) is to be installed near electricity pole

No. OR024 for the purpose of the supply.

(3) Interviews with EUMP concerning the 22 kV transmission line extension plans

- We conducted interviews with the EUMP General Manager, Engineering Deputy General Manager, and Engineering Section Chief, in order to investigate the contents of the EUMP plans.
  - Concerning Location 1
    - ◇ We obtained a materials procurement document. Estimates of the material costs have been made, using the designs for the JICA grant-aid construction work as reference. Technical calculations for selection of the electricity pole strength, cable thickness and so forth have not been undertaken. Neither have any technical drawings been prepared yet.
    - ◇ Installation of overhead earth wires had not been incorporated, so we submitted the opinion that they ought to be incorporated. We also submitted the opinion that the LBS which it was planned to install at the point of connection with the existing line was not necessarily required.
    - ◇ With 100 kW added in the nighttime peak time zone, the peak load would approach 400 kW and the generating capacity might be exceeded in the dry season if the consumption by existing customers increased in the future. The idea is to conclude special contracts for power use in the daytime only, containing terms that will avoid a nighttime peak crunch. Equipment-based measures to disable use during the nighttime peak – such as installing timers – are not being considered.
    - ◇ Clear information on how the costs of transmission line construction would be borne was not obtained, but it seems that the General Manager seeks to have the customers bear such costs.
  - Concerning Location 2
    - ◇ The officer of MIME is involved with the facility construction, and the situation is such that EUMP is constrained under the circumstances to comply with the requests for power supply.
    - ◇ It has been announced that the whole cost of the transmission line will be borne by the customers, and the Vietnamese electrical construction company contracted by the customers has already prepared design drawings.
  - Concerning Location 3
    - ◇ The Engineering Deputy General Manager has long shown an upbeat stance to new supply, but the General Manager is of a more cautious stance, feeling doubts as to the costs versus the benefits.
  - Concerning Location 4
    - ◇ The intention has been announced of having the whole cost of the new transformer line borne by the customers.

- We elicited from the EUMP General Manager the basic thinking with regard to cost allocation and the ownership of/maintenance responsibility for the transmission facilities after supply begins.
  - The General Manager's opinion is that new facility construction should be judged on an individual basis, in terms of balance between the cost and the revenue increase expected from the supply.
  - His thinking is that where it is decided to have the customers bear the cost of constructing the transmission facilities, special contracts will be concluded between EUMP and the customers before the facilities are constructed, and when construction is complete, EUMP will own and maintain the facilities.
  - When we inquired of the General Manager what the criteria were for judging whether or not to have customers applying for new supply bear the facility construction costs, we obtained the reply that such criteria existed, but we were unable to obtain a reply as to any specific numerical criteria, such as for the line length.

(4) Verification of EUMP's plans for 22 kV transmission line extension

- We conducted verification concerning the content of the plans for "Location 1" formulated by EUMP.
  - Although detailed technical verification has not been completed, it appears probable that implementing extension of the transmission facilities according to EUMP's plan – except as regards the electricity pole strength – will not pose any technical problems. However:
    - ◇ AAAC55mm<sup>2</sup>, the same as under the JICA grant-aid construction work, has been selected for the cable thickness, but since the design of that construction work was electrically in excess of requirement, it would be more sound to select cables under AAAC55mm<sup>2</sup> in thickness, in view of the costs. However, if one takes account of aspects such as the strength problem due to the long spans, and the need for unified standards of spare parts, one may conclude that AAAC55mm<sup>2</sup> is appropriate and that there will be no problem with implementing the work according to the plans.
    - ◇ Electricity pole strengths of 3 kN for line angle 10 degrees or less, 6 kN for 10 to 30 degrees, and 9 kN for 30 degrees and over have been selected based on the criteria for the JICA grant-aid construction work. Roughly speaking there is no problem with this.  
But:
      - The span lengths and line angles have been gauged by eyes by the EUMP staff, and will need to be re-verified individually using design drawings that will have to be prepared.
      - The JICA grant-aid construction work criteria do not cover strength verification for all forms of line, and so re-verification needs to be carried out with regard to the criteria themselves.
    - ◇ It would be desirable to newly install overhead earth wires in all the sections, as an

anti-lightning measure.

- ◇ The problems listed below are present, and therefore it would be appropriate to outsource the detailed design and construction work implementation to an electrical construction company or similar entity in Phnom Penh or other major city.
    - More detailed technical deliberations will be required in order to minimize the construction costs, but the EUMP staff cannot easily be said to possess the knowledge level for technical calculations that would enable them to carry out such technical calculations and it would be difficult to have them acquire such ability merely through OJT over a limited period.
    - Rough estimates have been calculated only for materials costs and the cost of contracting out the pole erection work. The work of fitting out the poles and extending the cables is planned to be performed directly by EUMP, but the EUMP staff have scant experience of actual construction work, and there is risk of work implementation errors which could result in facility accidents.
  - There are the following issues to be deliberated as regards aspects other than transmission/distribution technical matters. Such issues can, however, be tolerated – to the extent that Cambodian business practices do not pose problems.
    - The present plan, reflecting the present daily load curve, is for supply only in the daytime, when there is excess capacity for an additional 100 kW supply. But in the future the demand baseline is likely to rise with increase in the customers for the existing system and increase in the spread of electrical products. Thus, EUMP should look ahead to a number of years hence, envision the demand at that time, and clarify its response policy as to what kind of criteria it will use for accepting new supply.
    - The facility configuration is such as to allow customers to receive 100 kW of power, even during the nighttime peak, if they disobey their contracts. EUMP needs to deliberate thoroughly whether it might not be necessary to incorporate measures in the facilities that would prevent supply capability being exceeded due to contract disobedience.
    - The criteria for deciding that customers should bear the cost of new construction of electricity company facilities must be clarified, or unfairness will arise in contrast to the customers who have no such burden – which would be undesirable for a public utility business. (In Japan, the policy for such cost burden allotment is clearly set forth in the Electricity Supply Articles.)
- (5) Guidance in methods for preparing design drawings for 22 kV transmission line extension plans
- Responses to the above issues will need to proceed in coordination with the management planning team members and similar persons. Meanwhile, judging that in order to put the transmission line extension plan for Location 1 into action it will be necessary at the minimum to prepare design drawings and select the electricity pole strengths and the types

of foundation concrete infill and pole guys, we advised the Engineering Deputy General Manager and Engineering Section Chief to prepare design plans, and furthermore instructed them both in preparation of documents on "Method for Measuring Line Angle" and "Method for Selecting Guy Base Opening" for use as reference in site surveys.

(6) Remarks

- Expanding facilities and acquiring new customers so as to secure demand is a sound approach for an electric utility business. Nonetheless, considering that the essential supply capability of this system is no more than 400 kW or so in the dry season, boundless expansion of the system can be expected to lead in the future to supply capability shortfall, and to require considerable amounts of time and labor to have staff acquire the knowledge necessary for the facility planning and design. Accordingly we believe that the JICA mission will have to thoroughly discuss and pool ideas about whether it should track these matters, and if so, to what extent and in what ways.

**(5) Field Work in Cambodia from Dec. 4 to 8, 2009**

a) Attendance at O&M manual editing meeting

Date and time: 9:00 to 12:00 AM on Saturday Dec. 5, 2009

Place: Meeting room in Phnom Penh

Attendees: From EUMP: Director Kong Piseth, Deputy Director of Technique Chin Sokhun, Transmission/Distribution Team Deputy Senior Staff Ret Soksamdy

From JICA: Mission Head Mishima, mission members Hiraga and Okuhara, secretary

Contents: We pooled knowledge with EUMP and the JICA mission concerning methods for integrating and editing the O&M manuals, which have been formulated separately for particular operations and technical fields (civil engineering, power generation, transmission/distribution). It was decided that editing and proofreading in the future should be implemented via collaboration between the EUMP and JICA mission secretaries.

Appended Reference Document

- Revised draft of transmission/distribution related O&M manual (Khmer version with revised structure)
  - \* Khmer version prepared during the October Field Work, reedited so as to conform with the material structure of the other sections.

b) Technical guidance concerning transmission/distribution

(1) Guidance in methods for using power quality analyzer

Date and time: 9:00 to 12:00 AM and 1:30 to 2:30 PM on Saturday Dec. 5, 2009

9:00 to 11:30 AM and 4:30 to 5:30 PM on Sunday Dec. 6, 2009

- Place: Meeting room in Phnom Penh
- Attendees: From EUMP: Deputy Director of Technique Chin Sokhun,  
Transmission/Distribution Team Deputy Senior Staff Ret Soksamdy
- From JICA: Mission member Okuhara
- Contents: EUMP having communicated a desire for refresher guidance in the use methods for the power quality analyzer supplied by JICA in June, we gave guidance on the items below, using the actual instrument and a PC.
- Referring to the analyzer's instruction manual, we gave explanations of and hands-on practice in the instrument's (analyzer's) screen transitions, the contents of each screen, and the methods for saving data.
  - Referring to a software instruction manual, we gave explanations of and hands-on practice in the methods for downloading data saved on the analyzer to a PC, and for checking the data via the software on the PC.
  - Ahead of the above, we also gave explanations of and hands-on practice in the methods for installing the software, so that in future the EUMP staff can themselves install it to other PCs.
- Remarks:
- Repeat guidance using the actual instrument will be necessary in order for the staff to acquire the use methods, and there are additional items for which guidance needs to be given. Also, only a limited amount of such training can be given during the JICA mission's stay. Accordingly, as we took the staff through the operation procedures, we had them refer to the instruction manuals, so that they could use them for practice by themselves when the JICA mission is not there. However, it tended to be difficult for the staff to exactly understand the manual – perhaps because they are in English, which is not the staff's mother tongue. Accordingly, at every future opportunity, we intend to iteratively give guidance to them.
  - The power quality analyzer has a wide diversity of functions, and understanding the meaning of all its display contents – including apparent power, harmonics and so forth – is likely to require the high knowledge levels. It is therefore rather difficult in practical terms for the EUMP staff to understand all these contents. Although the analyzer's sophisticated functions will not be needed for their electricity business operations in the near future, the data associated with such functions nevertheless rouses their interest when it appears on the screen, causing them to neglect acquisition of the fundamental knowledge that they need. The same thing can be said concerning CAD and other PC operations. It seems that in order to bring about more effective technology transfer in the future, attention will have to be paid to stricter functional selection of the equipment to be supplied, and to appropriate innovations in the guidance methods.

(2) Determination of stone crushing plant load data

Date and time: 9:00 to 12:00 AM on Saturday Dec. 5, 2009

Place: Meeting room in Phnom Penh

Attendees: From EUMP: Deputy Director of Technique Chin Sokhun,  
Transmission/Distribution Team Deputy Senior Staff Ret Soksamdy

From JICA: Mission members Hiraga and Okuhara

Contents: In conjunction with the guidance in (1) above, we carried out determination of the load data\* at the stone crushing plant desiring electricity supply (which at present runs its stone crushing machines on self-generated power).

\* Measurements were made using the power quality analyzer at the site on November 18.

The following information was derived from the results.

- A maximum 283.6 kVA (momentary at 8:10:25) of apparent power occurs when the stone crushing machines are started up. This poses risk of excessive load being applied to the power station generators in a system of scale around 400 kW.
- There is severe fluctuation of load between start-up and operation, posing risk of flickering and other problems in other customers' electricity.

Since it would be difficult for EUMP to evaluate the impacts of these and devise countermeasures, it was decided that mission members Hiraga and Okuhara should take the data acquired back with them to Japan, where they would deliberate countermeasures in collaboration with the manufacturers and others.

(3) Consultations on assuring ground height of road-crossing transmission line at roadwork site

Date and time: 11:30 to 12:00 AM on Sunday Dec. 6, 2009

Place: Meeting room in Phnom Penh

Attendees: From EUMP: Deputy Director Chin Sokhun, Transmission/Distribution Team Deputy Senior Staff Ret Soksamdy

From JICA: Mission member Okuhara

Contents: EUMP having communicated a wish for advice concerning its fear that the above-ground elevation of a 22 kV transmission line is insufficient at a point where it crosses over a national highway now undergoing roadwork, we determined the conditions and explained the pertinent Cambodian Technical Standards to EUMP, then held consultations on methods for dealing with such issues in the future.

- Items determined:
  - a. In national highway improvement work near to the 22 kV transmission



line (bare conductor) between electricity poles No. OR-053 and 054, the piling up of embankments along the highway means that the above-ground elevation of the 22 kV transmission line, which crosses over the national highway, may have become insufficient. (Measured by eye, such elevation is 7 to 8 meters or so at its lowest point.)

- b. In the same section, a communication line of the telecom company runs beneath the 22 kV line, suspended from the same poles, and this communication line already shows signs of having been damaged by passing vehicles.
  - c. There were already plans for improvement of this stretch of road when the 22 kV line was constructed, but the road managers had not prepared any planning drawings, and even though interviews were conducted with them, it was not possible to find out by how many meters the road would be raised. At the moment, the road has been raised by roughly 1 meter from its level when the 22 kV line was constructed, and it is possible that the road may be raised further in the future.
- Pertinent Cambodian Electrical Power Technical Standards:  
We determined the prescribed values for the above-ground elevation of the 22 kV line and its separation distance from the communication line, based on the Explanation Sheet of SREPTS (Article 46, 48) in the Electric Power Technical Standards of the Kingdom of Cambodia  
Prescribed values: Minimum height at point where line crosses national highway: 8 m or higher  
Clearance between Medium-voltage Bare Lines and communication lines: 2 m or greater
  - Consultation on future action methods  
We advised EUMP to take action in the future in line with the procedural flow set forth below.
    - a. Ascertain from the roadwork business by how much the road is to be raised further in the future, then estimate the ultimate elevation of the road surface.
    - b. Verify the conditions at the road crossover location, using surveying rods and aerial photography, prepare drawings by hand based on the results, and use such to estimate the ground height. c. As there is concurrent risk that the communication line's ground height may be insufficient, urge the telecom company to study whether the line needs to be relocated. (But have the telecom company study such need and the methods of relocation on its own responsibility.)

If EUMP found as a result of the above measurements that ground height of the transmission line after the roadwork end will be less than 8 m, it should proceed roughly in accordance with the flow set forth below. It was agreed that more detailed procedures would require separate consultations pursuant to reporting of the above measurement results.

- d. Additional work on the transmission facilities will be required. Such work will probably include items of the following kind.
  1. Putting extra-tall poles
  2. Changing the road crossover point to a different location
  3. Burying the line (entails expensive work, however)
- e. Have design drawings prepared.
  - ✧ Have them prepared by a specialist business.
- f. Estimate the cost of the work.
- g. Settle with the road managers the issue of who is to bear the cost of the work.
- h. Have the work carried out.
  - ✧ Have it carried out by a specialist business.
  - ✧ Interrupt the supply in the O'Romis line before the work is carried out.
- i. Carry out payment.
- j. Update the work completion drawings.

c) Investigation of procurement of transmission/distribution related maintenance and management equipment

Date and time: 3:00 to 4:30 PM on Monday Dec. 7, 2009, plus other occasions

Place: Phnom Penh

- Contents:
- We verified stores where ordinary tools such as tape measures can be procured.
  - A few months ago, EUMP procured by itself some low-voltage insulating rubber gloves, but they have become damaged in use and lost their insulating ability. Accordingly, we investigated whether protective leather gloves for the low-voltage insulating rubber gloves, bags for carrying them, and similar items, were procurable.

We found out that although the manufacturer of the low-voltage insulating rubber gloves does not usually keep stocks of its own genuine protective leather gloves and carrying bags for them in Phnom Penh, such articles can be delivered in 40 to 45 days if ordered from a dealer.

## **Appendix 5 Transmission and Distribution Line Facilities**

**Appendix 5-1 : Inspection Check list for T/D**

**Appendix 5-2 : Transmission Line restoration process**

**Appendix 5-3 : Basic Rule at the MV-Line Work for Safety**

**Appendix 5-4 : Fault Outage Recovery Log Sheet (T&D)**

# **Appendix 1 General**

**Appendix 1-1 : Photo of Activities**

**Appendix 1-2 : List of Supply Equipments (Office Equipment)**

**Appendix 1-3 : List of Supply Equipments (Electric mechanical)**

**Appendix 1-4 : Presentation Material for 3rd JCC by Administration  
division of EUMP**

**Appendix 1-5 : Presentation Material for 3rd JCC by Technical  
division of EUMP**

Appendix 1-1

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Public Hearing for Billing and  
Tariff System**

**Opening address of Chairman  
by Vice Governor of Mondul  
Kiri state at Government  
meeting room.**

2009/1/29



**Public Hearing for Billing and  
Tariff System**

**EAC explained Tariff and  
Billing system for public, JICA  
mission made only for technical  
advice of it.  
(Approx. 80 persons attended)**

2009/1/29



**Study meeting for EUMP's  
Tasks and Work procedure at  
site office**

2009/2/2

Appendix 1-1

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**1st. JCC Meeting**

**Meeting for Inception Report attendance with MIME(Chairman), EAC, EDC, JICA Cambodia, EUMP and JICA Study Team ( 25 persons)**

2008/12/18



**3rd. JCC Meeting**

2010年2月23日

**Meeting for Annual Report, 2009 and O&M Manual, Plan of 2010 attendance with MIME(Chairman), EAC, EDC, JICA Cambodia, EUMP and JICA Study Team (30 persons)**

2010/2/23



**Hearing for Billing and Tariff System**

**EAC,EUMP, JICA expert and JICA Study Team discussed for Tariff and Billing System at EAC office.**

**The tariff of EUMP was basically agreed by the meeting members.**

2009/3/16

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Defect Liability Test Inspection  
of Document and Drawings by  
MIME/DIME and Contractor**

2009/12/11



**Management of Spare Parts  
provided shelf by EUMP**

2009/3/19

Appendix 1-1

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**OJT of Finance and Accounting**

**Training of Financial Report in  
consultation of MIME**

2009/2/4~2/11



**OJT of Billing System**

**Study and Training of Billing  
System for EUMP staff at site  
office**

2009/3/1



**Study of O&M Manual**

**Study meeting of Administration  
Section at site office**

2009/6/11



Appendix 1-1

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Measuring of Water flow at  
waterway, O'Romis Hydropower  
Station**

2009/2/10



**Training of water level(cm) -  
Output (kW) in stable operation  
at O'Moleng Hydropower Station**

2009/1/14



**Defect Liability Test at O'Romis  
Hydropower Dam site by  
MIME/DIME and Contractor**

2009/11/11

Appendix 1-1

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Cleaning Work at Intake,  
O'Romis Hydropower Station**

2009/6/15



**OJT of water flow measuring at  
Sedimentation pond, O'Romis  
Hydropower Station**

2009/12/14



**Measuring of water level at Head  
tank, O'Romis Hydropower  
Station**

2009/12/14

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Periodic Inspection and OJT  
for Diesel engine  
(Disassembly of Engine  
body)**

2009/6/10



**OJT for Weekly Inspection by  
Japanese Supervisor**



**Trial Operation after Periodic  
Inspection**

2009/6/12

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Periodic Inspection and OJT  
for Turbine Cover at  
O'Moleng Hydropower  
Station**

2009/6/1



**Periodic Inspection and OJT  
for Turbine inside Runner at  
O'Moleng Hydropower  
Station**

2009/6/1



**Defect Liability Test at  
O'Romis Hydropower Station  
by MIME/DIME and  
Contractor**

2009/11/11

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Reading a Wh-meter**

2009/10/20



**Operation of Switchgear at  
Scheduled Outage**

2009年11月27日



**Training of Supplied Tool and  
Equipment**

**Power Quality Analyzer**

2009/10/14

Appendix 1-1

**Project for Operation and Maintenance of the Rural Electrification on Micro-hydropower  
in Mondul Kiri, Cambodia (1st.Period Work: 2008/12 to 2010/3)**



**Repairing Work of Insulator  
on Concrete Pole**

2009/6/25



**Training of low voltage  
distribution lines (400/230V)  
by Elevated work vehicle**

2009/4/5



**Trimming Work for Trees**

2009年10月13日

**The Project for Operation and Maintenance of The Rural Electrification  
on Micro-Hydropower in Modul Kiri, Cambodia  
List of Supply Tool and Equipment (Office Equipment)**

No.	Name (Manufacture)	Type	Number	Delivery date
1	Personal Computer Portage M800-E367 (Toshiba)	CPU : Intel Core 2 DUO (2.26GHz) HDD : 320GB, Memory : 4GB Display : 13.3" WXGA, Optical Drive : DVD-RW OS : Microsoft Office Vista Business Wireless LAN inside	7	2009/1/15
2	Personal Computer Desktop NEC Power Mate P6000 (NEC)	CPU : Intel Core 2 DUO (2.26GHz) HDD : 500GB, Memory : 2GB Display : 19" WXGA, Optical Drive : DVD-RW OS : Microsoft Office Vista Business	1	2009/1/15
3	Laser Printer HP 5550 (H.P)	Size: A4-A3 Speed: 28ppm (A4) OS : Vista	2	2009/1/15
4	Color Printer HP K7100, (H.P)	Size: A4-A3	2	2009/1/15
5	Copy Machine IR2022n, (Canon)	Size: A4-A3 Facsimile	1	2009/1/15
6	Projector LCD Projector TLP-X2500A, (Toshiba)	PC and color projection	1	2009/1/15
7	Cabinet	Steel	2	2008/12/22
8	Chair	Steel	4	2008/12/22
9	Desk	Steel	4	2008/12/22

**The Project for Operation and Maintenance of The Rural Electrification  
on Micro-Hydropower in Modul Kiri, Cambodia**

**Supply of Tools and Equipment**

No.	Name	Manufacture	Type	Unit	Number	Delivery date	Application
1	Power High-tester	Hioki Denki	(Main Item) 3331 (Accessories) Carrying Case, Test records	set	1	2009/6/5	For Gen, T&D
2	Clump-type Power High-tester	Hioki Denki	(Main Item) 3169-21 (Accessories) Sensprs, PC cards, PC soft, Carrying Case, Test records	set	1	2009/6/5	For Gen, T&D
3	Digital insulation tester	Yokogawa Denki	(Main Item) MY40-01 (Accessories) Sensprs, PC cards, PC soft, Carrying Case : 93015	set	2	2009/6/29	For Gen, T&D
4	Digital multimeter	Yokogawa Denki	(Main Item) TY720 (Accessories) Carrying Case : 93029	set	2	2009/6/29	For Gen, T&D
5	Pole safety belt	Fujii Denko	(Main Item) TD-27 (Accessories) Sub Rope : T-21 Plier Case : P252, P255 Working Bag : P288	set	7	2009/6/29	For T&D
6	Earthing tool	Hasegawa Denki	(Main Item) S Type for 6.6~22kV	set	1	2009/6/29	For T&D
7	Power quality analyzer	Hioki Denki	(Main Item) 3197 (Accessories) Clump-On Sensor : 9669	set	1	2009/6/29	For T&D
				set	3		



 **គម្រោងវារីអគ្គិសនី**

ការប្រតិបត្តិការដំបូង ដោយវារីអគ្គិសនី

ខ្នាតតូចនៅតំបន់ដាច់ស្រយាង ខេត្តមណ្ឌលគិរី

ក្រោមជំនួយឥតសំណង រវាងរដ្ឋាភិបាលជប៉ុន តាមរយៈអង្គការ JICA

គម្រោងនេះចាប់ផ្តើមនៅថ្ងៃទី ០៣ ខែ វិច្ឆិកា ឆ្នាំ ២០០៧

ហើយបញ្ចប់ជាស្ថាពរនៅថ្ងៃទី ១៥ ខែ វិច្ឆិកា ឆ្នាំ ២០០៨

នឹងបានសម្រេចនូវអោយប្រើប្រាស់ នៅថ្ងៃទី ២៣ ខែ កុម្ភៈ ឆ្នាំ២០០៩

 1

**ស្ថានភាពវិស័យថាមពល**

**ក្នុងក្រុងស្រែមមោរម្យ**

មន្ទីរទេសចរណ៍កម្ពុជា វិស័យថាមពលខេត្តមណ្ឌលគិរី

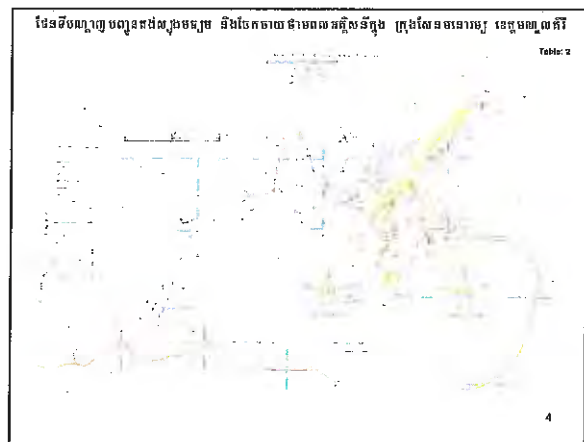
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ប្រទេសជប៉ុន លោក សាម៉ា អារិស៊ី

អង្គការអន្តរជាតិជប៉ុន រដ្ឋបាល វិស័យថាមពល

ក្រុង ស្រែមមោរម្យ ថ្ងៃទី ២៣ ខែ ០២ ឆ្នាំ ២០១០

2



- មាតិកា**
- ក. រចនាសម្ព័ន្ធនៃការគ្រប់គ្រងនិងចរន្តការងារ
  - ខ. ស្ថានភាពថាមពលអគ្គិសនីនៅទីក្រុងមណ្ឌលគិរី
  - គ. អង្គការអន្តរជាតិជប៉ុន ឆ្នាំ ២០០៧
  - ឃ. គម្រោងវារីអគ្គិសនី ឆ្នាំ ២០១១
  - ង. វិស័យថាមពលខេត្តមណ្ឌលគិរី ឆ្នាំដំបូង
- 5

**ក. រចនាសម្ព័ន្ធនៃការគ្រប់គ្រងនិងចរន្តការងារ**

6

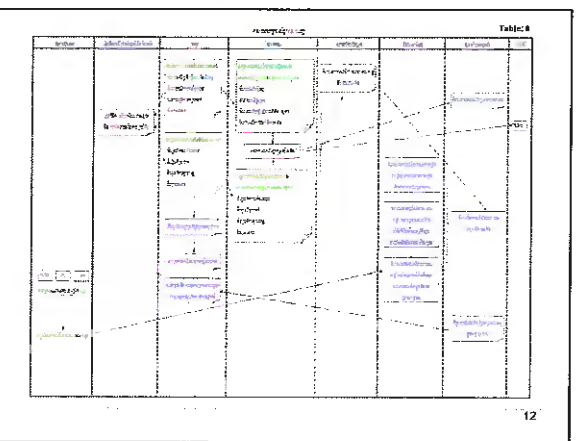
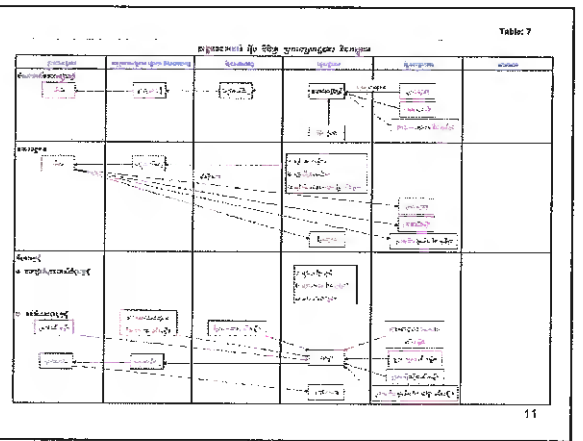
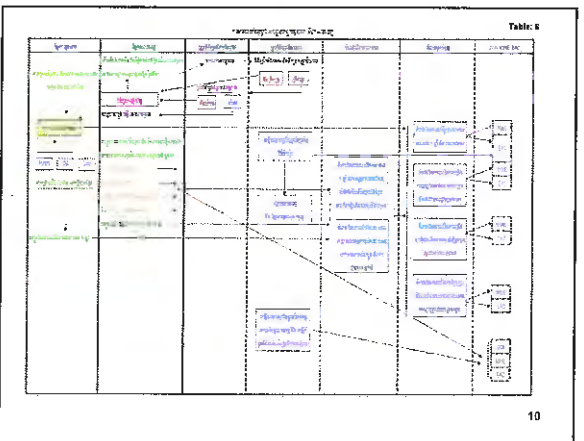
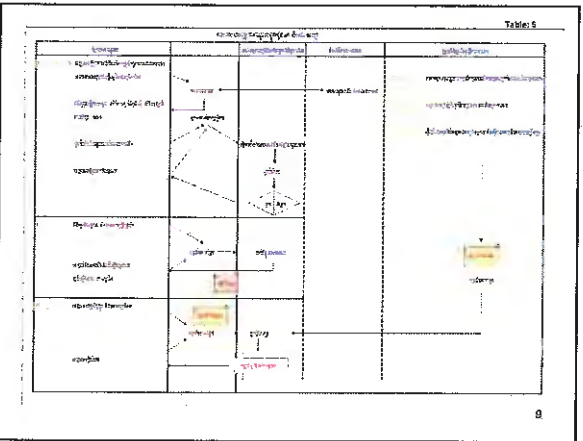
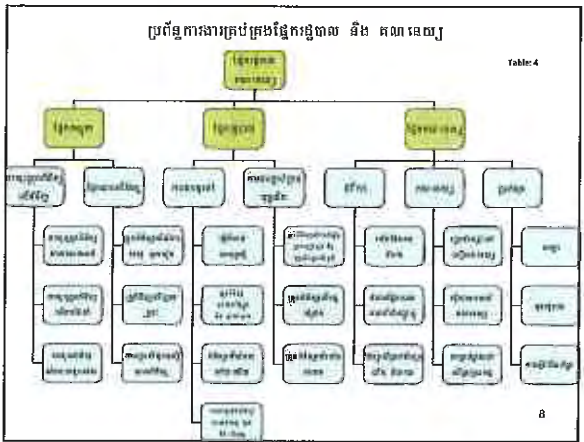
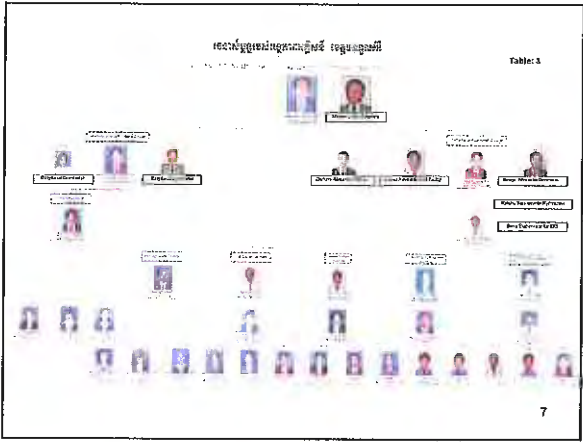


Table 9

ប្រភេទការងារ	សំណង់	សំណង់	សំណង់	សំណង់
ការងារសាងសង់	ការងារសាងសង់	ការងារសាងសង់	ការងារសាងសង់	ការងារសាងសង់
ការងារថែទាំ	ការងារថែទាំ	ការងារថែទាំ	ការងារថែទាំ	ការងារថែទាំ
ការងារបណ្តុះបណ្តាល	ការងារបណ្តុះបណ្តាល	ការងារបណ្តុះបណ្តាល	ការងារបណ្តុះបណ្តាល	ការងារបណ្តុះបណ្តាល
ការងារផ្សេងៗ	ការងារផ្សេងៗ	ការងារផ្សេងៗ	ការងារផ្សេងៗ	ការងារផ្សេងៗ

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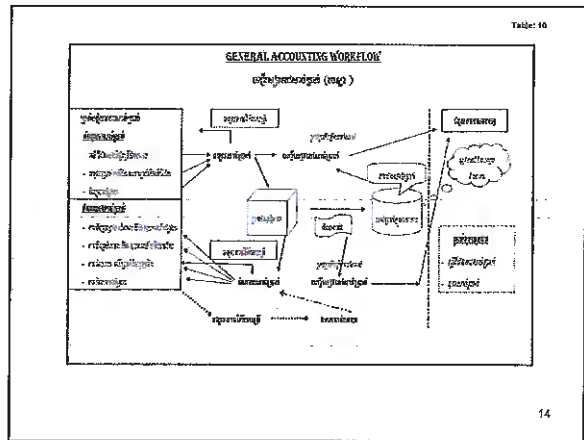


Table 11

ឈ្មោះ	សំណង់	សំណង់	សំណង់	សំណង់
ឈ្មោះ	សំណង់	សំណង់	សំណង់	សំណង់
ឈ្មោះ	សំណង់	សំណង់	សំណង់	សំណង់
ឈ្មោះ	សំណង់	សំណង់	សំណង់	សំណង់

15

Table 12

**ក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ**  
Ministry of Economy and Finance (EMFP)

ក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ  
Ministry of Economy and Finance

លេខសំណុំ :  
លេខសំណុំ :

សំណុំរៀបរយ :  
សំណុំរៀបរយ :

សំណុំរៀបរយ :  
សំណុំរៀបរយ :

**ក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ**  
Ministry of Economy and Finance (EMFP)

ក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ  
Ministry of Economy and Finance

លេខសំណុំ :  
លេខសំណុំ :

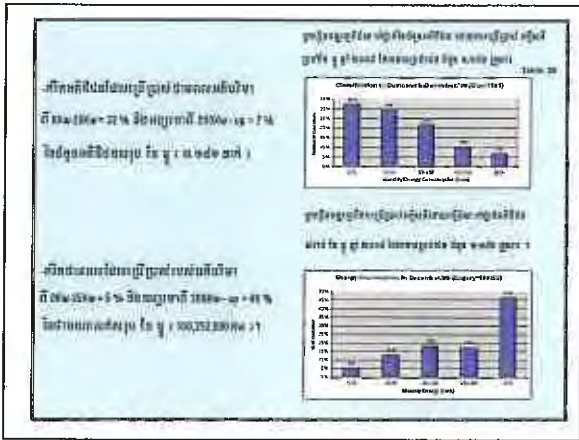
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សំណុំរៀបរយ :

សំណុំរៀបរយ :  
សំណុំរៀបរយ :

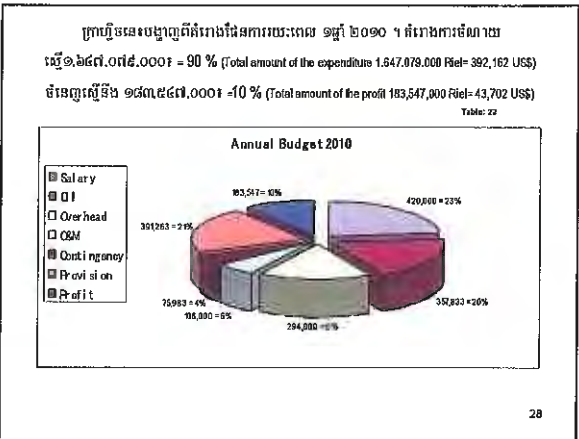
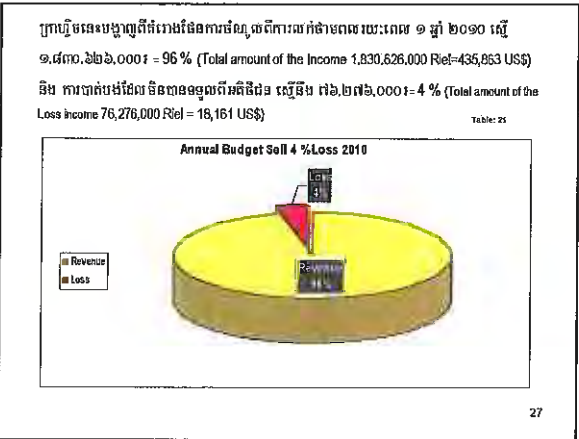
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៣. គំរោងវិនិយោគអនុវត្ត ឆ្នាំ ២០១០



៣. ម៉ឺន ដើម្បីឧត្តរកម្រិត គុណភាព
- គួរតែផ្តល់ការគាំទ្រ និង ជំនួយ ក្នុងការកែលម្អ និង គុណភាព ផលិតផល ឱ្យបានល្អប្រសើរ ។
  - បង្កើនការគាំទ្រ និង ជំនួយ ក្នុងការកែលម្អ និង គុណភាព ផលិតផល ឱ្យបានល្អប្រសើរ ។
  - ធានាឱ្យបានការគាំទ្រ និង ជំនួយ ក្នុងការកែលម្អ និង គុណភាព ផលិតផល ឱ្យបានល្អប្រសើរ ។
  - ធានាឱ្យបានការគាំទ្រ និង ជំនួយ ក្នុងការកែលម្អ និង គុណភាព ផលិតផល ឱ្យបានល្អប្រសើរ ។
- Table 23

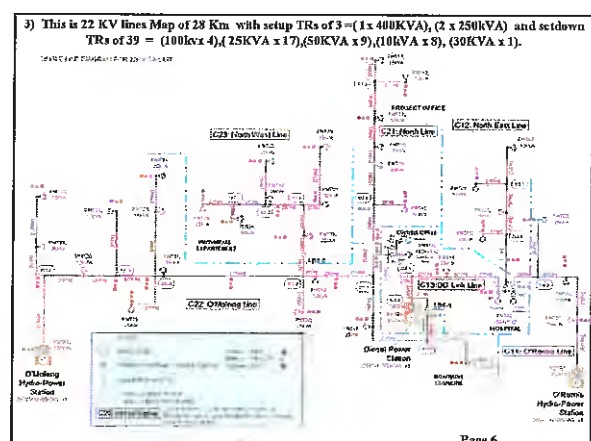
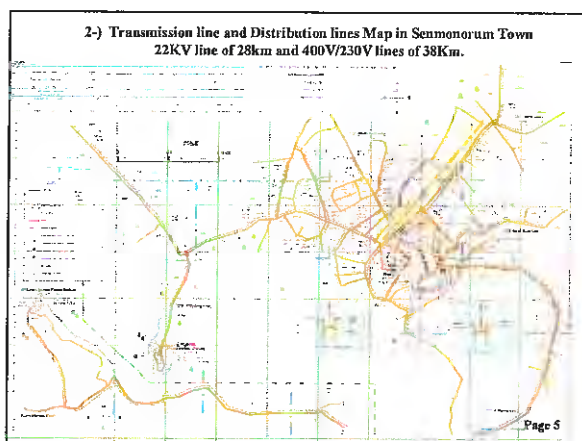
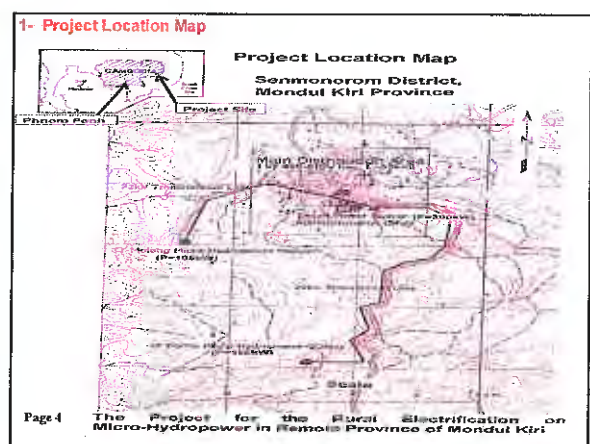




**Contents**

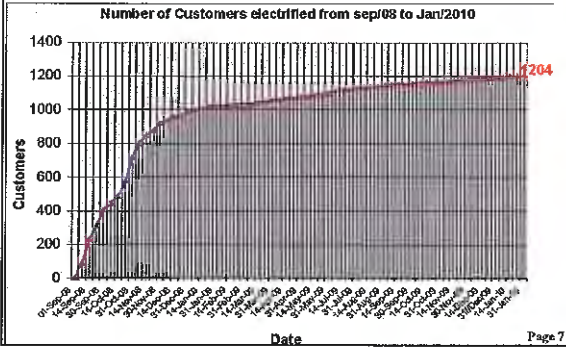
- 1- Location Map
- 2- Technical and Distribution Line Map
- 3- Power Map
- 4- Basic Status of MIMP's power supply performance
- 5- Summary and Rationale of Town and Milk farm Plan
- 6- Demand Forecast
- 6.1 Actual Demand
- 7- Supply and Demand Balance
- 7.1 Generating Capacity (existing and future)
- 7.2 Balance of supply and demand (existing)
- 7.3 Medium term forecast
- 7.4 Long term forecast
- 8- Power rate policy

Page 1

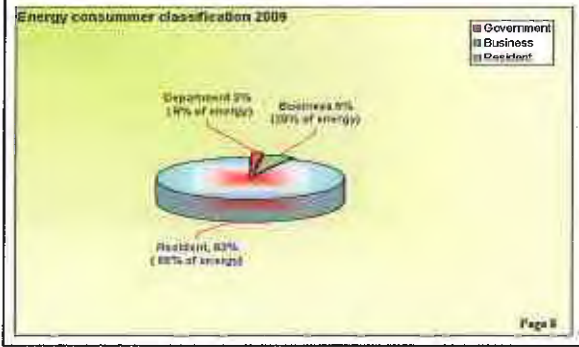


4 - Present status of EUMIP's power sector performance

4-1 Current situation of Energy demand is to depend on the increasing number of customers electrified from sep/08 to Dec/09 is 1191 and to Jan/2010 is 1204.



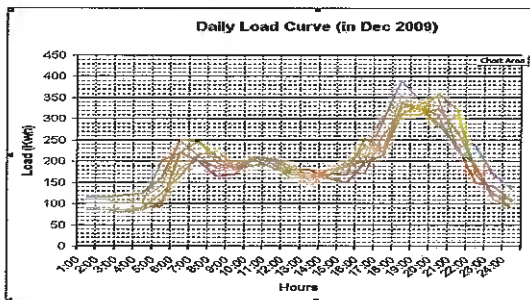
4.2 Total of Energy consumers 1191 electrified for 2009 is divided into three categories .



4.3 Daily Load Curve

At the present, Typical Daily Load Curve increases highly in Dec/ 2009, is shown below.

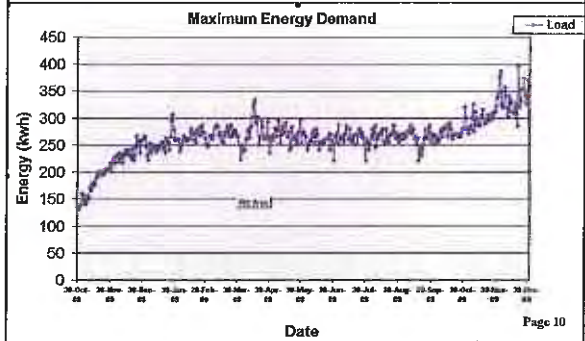
Daily Load Curve on 31<sup>st</sup> Dec, 2009



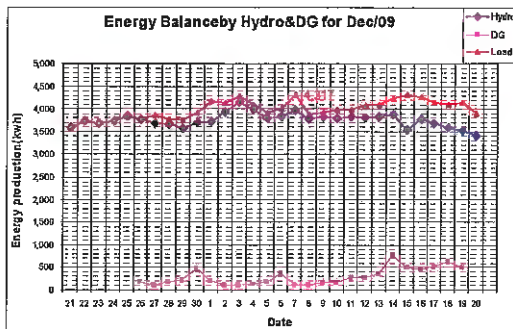
This value includes transmission loss, that is total value of all power output.  
Daily Load Factor is approximately 50%.

4.4 Maximum Energy Demand per day

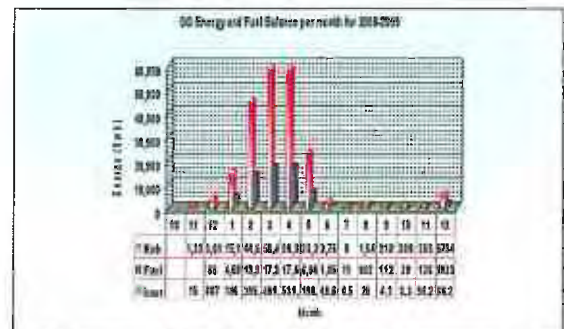
Maximum demand occurs at around 7 PM  
For recent maximum demand record during three months late 2009 from 280 kw to 300 kw, and Over 300 Kw to 395 kw is mostly recorded in festival days only for 2009. The maximum power demand is defined as the total of the maximum load recorded at 3 powerhouses at the same hour.



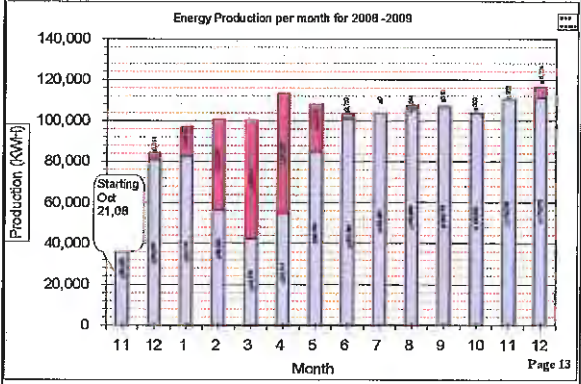
4- 5) Energy Consumption of Mondukkir Power system Dec/09



4-6 ) DG energy production and Fuel consumption for per month from 2008 - 2009



4.7 This is the comparison table of Energy produced by Hydropower (70%) and DG (30%) for 2009, including Transmission and distribution loss.



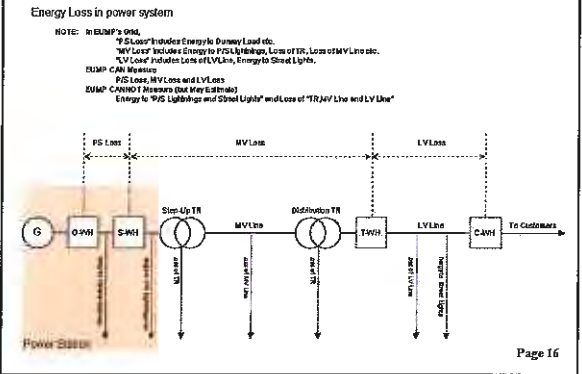
4.8 This is the record table of generation data of the three plants from 20/Sep/2008 to 20/ Dec/2009 as shown below.

Condition Total										Night Total																
Time	Day	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	
20	20-Sep-08	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

4.8 The below table is recorded with energy loss through MV Line, LV Line, other losses and total energy loss per month from 21/Oct/2008 to 20/Dec/2009.

Date	To	Day	Energy Loss				% of Load (at 70%)				
			MV Line	LV Line	TOTAL	MV Loss	LV Loss	TOTAL			
21-Oct-08	20-Oct-08	30									
21-Nov-08	20-Nov-08	31									

4-9) Energy loss in Power system



4-10) Loss of TR Estimation

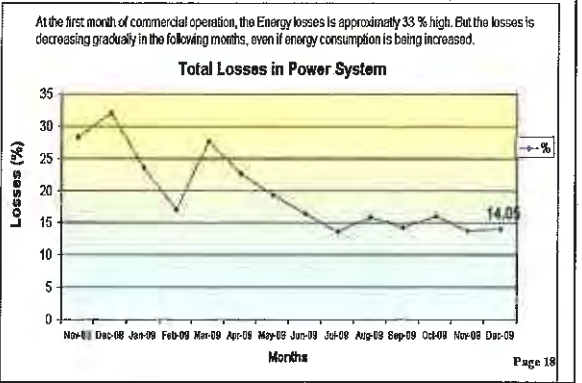
NOTE: % Load Loss means Loss for Rated Capacity of Transformer  
 ex: One of 10MVA Transformer takes 500MW (operating power) is 500/10=50%  
 The Load Loss means Loss for No Load.  
 ex: Even if there is no customer for a 10MVA Transformer, there is 10%.

Capacity/MVA	Load Loss at 75 °C	No Load Loss/MW
10	500	120
25	725	168
50	1,210	263
100	2,150	389
250	4,100	720
400	6,038	1,163

Capacity/MVA	Number	Load Loss/MW	No Load Loss/MW
10	8	4.6	1.0
25	17	12.5	2.8
50	9	11.8	2.4
100	4	8.6	1.6
250	2	8.2	1.4
400	1	6.0	1.1

4-11) Total losses per month in Power system







**របៀបប្រតិបត្តិការ តំបន់ ១/៣ ដំបូង ឆ្នាំ ២០០៩**

- ១- ឯកសារដោះស្រាយ ប្រតិបត្តិការ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ២- ប្រតិបត្តិការ Turbine បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៣- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៤- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៥- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៦- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៧- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៨- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ៩- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ១០- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ១១- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ១២- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )
- ១៣- ប្រតិបត្តិការ បិទបញ្ជីការងារ ( បញ្ជីការងារត្រួតពិនិត្យការងារ )

4-14) This is the switching procedure for guide vane which is very necessary to change for dry season when water level is low to 45 - 48 cm (operate guide vane 1/3), and water level decrease to 65 cm (operate guide vane 2/3) so change turbine performance curve below

Turbine type : HC-1R2G

Rating	Eff. head = 18.70 m Max Output = 215 kW	Max discharge = 1.45 m <sup>3</sup> /s Rotating speed = 253 min <sup>-1</sup>			
Guide vane	1/3+2/3				
Discharge [%]	100	80	60	40	Max eff. 84
Discharge [m <sup>3</sup> /s]	1.45	1.16	0.87	0.58	1.22
Efficiency [%]	81.0	82.8	78.3	67.6	83.0
Output [kW]	215	176	125	72	185

Rating	Eff. head = 18.70 m Max Output = 138 kW	Max discharge = 0.97 m <sup>3</sup> /s Rotating speed = 253 min <sup>-1</sup>			
Guide vane	2/3				
Discharge [%]	67	57	31		Max eff. 57
Discharge [m <sup>3</sup> /s]	0.97	0.83	0.45		0.83
Efficiency [%]	77.6	79.7	70.1		79.7
Output [kW]	138	121	58		121

Rating	Eff. head = 18.70 m Max Output = 64 kW	Max discharge = 0.48 m <sup>3</sup> /s Rotating speed = 253 min <sup>-1</sup>			
Guide vane	1/3				
Discharge [%]	33	28	15		Max eff. 28
Discharge [m <sup>3</sup> /s]	0.48	0.41	0.22		0.41
Efficiency [%]	73.2	76.4	64.9		76.4
Output [kW]	64	57	26		57

**Switching Procedure for Guide Vane at 1/3 Zone**  
The figure below shows 1/3 GV operation and 2/3 GV Locking. In case of generator output is to be approx. less 60kW operation.

Take off the Pin

Turn the lever and to connect the Locking Arm

Locking Arm

**Switching procedure for Guide Vane at 2/3 Zone**  
The figure below shows 2/3 GV operation. 1/3 GV is no locking device and always free position.

Step 1: Take off the Pin ( ← 2/3 GV same as procedure of 1/3 GV changing.

Step 2: Turn the lever ( ← ) and free position (but not connect to the Locking arm)

Caution: inlet valve open when turbine starting, the turbine speed may be increased more than setting value (450rpm) due to water leakage from 1/3 GV. Then starting condition is incomplete.

Measure: Speed relay (meter setting) LL must be changed more than 450rpm by manual.

4-17) This is a new method for starting hydropower plant operation by using battery energy source, when DG plant stops or is overhauled. As mentioned in operation instruction below.

**Black Start Operation Procedure for O'Moleng PS**

- I. Preparation for Black start
- 1) To confirm the all LSB off in 22kV/400V Hospital and District Substations
- Outdoor DG starting for powerhouse lighting : ON
- Control Panel
- Confirmation of all MCCB breakers: OFF
- MCCB 1 and 1A: Control source
- MCCB 2: PS Lighting
- MCCB 3: SERVO MOTOR
- MCCB 4: AVR source
- MCCB RCP 1: Receptacle source
- MCCB Z 1: Aux. source
- MCCB TC 1: TR Primary
- MCCB CPC 2: Control source (Black Start)
- MCCB Battery (Black Start DC 24 V)

**II. Black Start for Turbine**

- 1) To change 4:3BS: ON (Black start Switch)
- 2) To confirm 5 2 - 1 : OFF
- 3) MCCB TC1 TR Primary: ON  
MCCB CPC2 Control source (Black start): ON
- 4) MCCB 4 AVR source : ON
- 5) Start of Panel Indicators and Targets
- 6) To insert a handle into Servomotor unit
- 7) BATTERY breaker: ON

3) To confirm to do the check for 2 times.  
To charging Motor Spring by handle 02 → 2 (indication "Red")  
To operate 02 → 2: OFF (indication "Green")  
To charging Motor Spring by handle 02 → 2 (indication "Green")

5) 02 → 1 MCB-ON and to send power (kW) to the 22kV line





**ii. Operation**

- 1) Inlet valve : OPEN
- 2) Be sure "PREPARATION" lamp is ON
- 3) START, confirmation lamp on "OPERATION"

4) Turn the handle and turn Servomotor handle to "OPEN" position.  
Turn the handle slowly until it reaches the mark 100 to 150kW load and to set the lock in the Servomotor handle.  
Turn the handle and confirm meters 40kV, 50kV, 1000 rpm.

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Breaker MCCB 1 and 1A: Control source : ON



**Shutdown**

- 1) # 1 : STOP
- 2) Turn Servomotor handle in "CLOSE" direction.
- 3) Close the Inlet valve.
- 4) To confirm STOP
- 5) To take out a handle from Servomotor unit
- 6) BATTERY breaker: OFF
- 7) 43BS : OFF
- 8) All MCCB breakers: OFF

To start normal operation procedure.

- 1) Battery NFB : OFF
- 2) 43BS : OFF
- 3) Preparation of normal operation

8) To confirm Breaker MCCB 3: SERVO MOTOR : OFF  
9) To increase the load into 22kV/400V lines, one by one. (increase the load at every 20% of the power generated.)  
10) To start O'Romis PIS and Parallel with O'Woleng PIS

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## 5- Assumptions and Relevance of Long and Mid-term Plan

EUMP started its operations in August 2008 and has been supplying electricity from November 2008 up to the present. This long and mid-term plan is aimed to

serve for stable business operations of EUMP for the foreseeable future. In the future, demand will grow to require addition of power supplying capacity.

This plan suggests an outlook of such necessity for later consideration by the relevant authorities of Cambodia as well as EUMP.

The time horizon of this long and mid-term is set at: 3 years for power supply with the existing capacity as mid-term and 10 years at maximum onward.

This long and mid-term plan is a rolling plan to be revised yearly taking into account the actual performance and future forecast.

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## 6- Demand Forecast

### 6.1 Actual Demand

The power grid of EUMP covers an area with some 1,550 households. In August 2008, before electrification of the micro-hydropower rural electrification project, but the number of current customers is 1151 as of December 2009, translating into some 76% of coefficient of electrification. The basic design of the project assumed 70% of coefficient of electrification with 930 customers. Although the coefficient of electrification was slightly higher, the number of customers exceeded the assumed number of the basic design.

Table-1 shows the actual demands between October and December 2009.

Item	Unit	Oct.	Nov.	Dec.	Remarks
Maximum Demand	KW	230	326	395	Demand at generation end (average of the highest 5)
Power Consumption	kWh	87,221	98,335	100,282	Total sales of kWh meters
Number of Customers	Customer	1,348	1,324	1,091	Number of kWh meters
Average Power Consumption per Customer	kWh/month	76.4	84.2	84	Converted in 30 days

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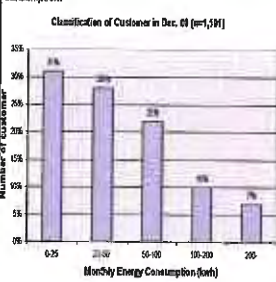
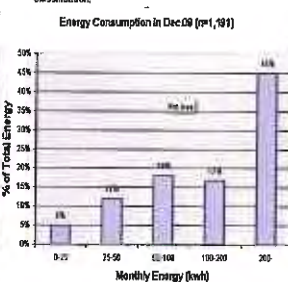
6-2) Power consumption trended by customer classification

Graph-1 shows the ratio of the number of customers by monthly consumption and Graph-2 the ratio of power consumption by customer classification, both as of the closing of 2009.

Those graphs have revealed that 31% of the total customers use electricity of 25kwh or under, equivalent to only 5% of the total electricity supplied by EUMP. In the meantime, the upper 7% of the customers (mainly hotels and guesthouses) consume 45% of the total.

Graph-1 Ratio of the number of customers by monthly consumption.

Graph-2 Ratio of the power consumption by customer classification.

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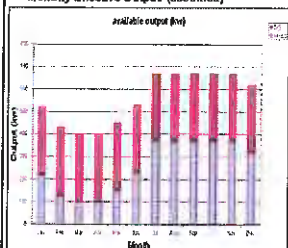
7) Supply and Demand Balance

7-1 Generating Capacity (Effective Output)

EUMP currently owns 2 hydro-power plants with a total installed capacity of 370kW and 1 diesel power plant with an installed capacity of 300kW, totaling 670kW. The diesel power can be operated at maximum output at all time as needed except times of inspection and repair. Meanwhile, hydro-power is limited in output by fluctuation of river flow. The past record shows that the firm flow for generation decrease from December to reach the dust point between February to March. The hydro-power output is about 100kWh in this period. The stable output for 24 hours through the year is about 400kW at the generation end. So during February to April we can generate power of 50% by hydro-power.

The table below shows the expected output by season.

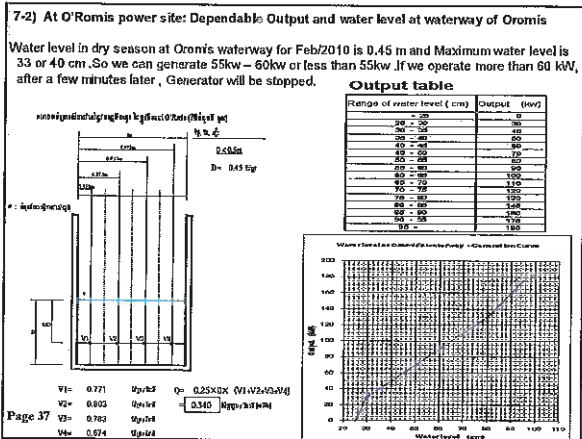
Monthly Effective Output (assumed)



Generating Capacity and Effective Output

Period	Generating Capacity (kW)			Effective output (kW)		
	Hydro-power	Diesel	Total	Hydro-power	Diesel	Total
Wet season (June to Sep)	370	300	670	370	300	670
Normal season (Oct to Dec)	370	300	670	100-150	300	400-450
Dry season (Jan to May)	370	300	670	100	300	400

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**7.3 Mid-term Forecast (supply and demand balance with the existing capacity)**

As mentioned above, the existing installed capacity by Japanese donation is 670kW and, however, the effective output decreases to about 400kW due to drop of river flow during dry season from February to March.

The demand forecast predicts that the demand would exceed 400kW a few years later or between the early of 2011 and 2013.

The basic design of the project assumed that power supply would start in 2007 and that the demand would reach the supply capacity 5 years later or 2012. The start of power supply delayed for a year but it is quite probable that the power demand would reach the supply capacity as originally assumed because of the rapid increase of the number of households of Semnonorum.

During that period, the generating portion of diesel power ranges from 10% to 60% by season about 30% of the annual total generation.

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**7.4 Long-term Forecast**

When the maximum demand at generation end exceeds 400kW, the existing installed capacity would not be sufficient during dry season.

If no addition of generating capacity is made, there would occur supply deficit (outage) during peak hours for 2 months from February to April for the first one or two years. The hour and period of power outage would become longer year by year and power shortage would become constant around 2015.

The following countermeasures are conceivable: ① Addition of generating capacity ② Connection with the grid ③ Planned outage.

1) Possibility of addition of generating capacity

Generally, it is necessary to take a period for design, procurement and construction for a new supply capacity, requiring several years at the shortest. Incorporation of such addition into the long and mid-term plan would require investigation and examination.

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2) Connection with the grid

This project is an isolated power system with 2 hydropower and 1 auxiliary diesel power supplying power to the urban area of Semnonorum city, provincial capital of Mondul Kiri province.

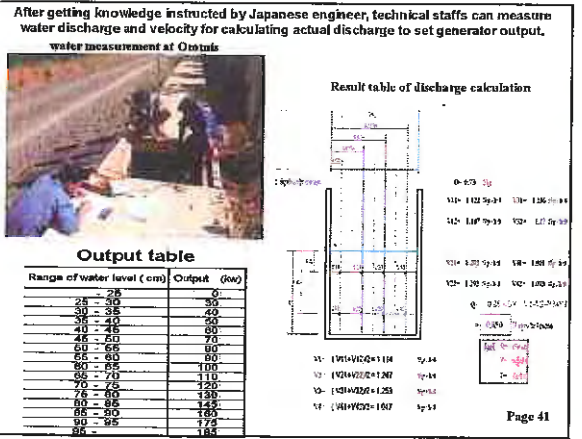
The transmission plan of MIMÉ has a plan of transmission from Kratie to Semnonorum but does not have any concrete plan for construction up to 2020.

As for extension of transmission/distribution lines from Vietnam, Keo Sema in Mondul Kiri province has been supplied with electricity from direct connection with Vietnam (10km) since the end of 2006. Similar power supply is being made in Snom (20km) along the national highway 7. Other towns along that highway such as Menot Ponnea Krak are supplied by EdC's grid, actually receiving electricity from Vietnam. Those cases show geographical advantage of transmission from Vietnam.

In transmitting from Vietnam, there would be 2 routes: about 65km from Keo Sema and about 40km from the border. Both cases are expected to have considerable loss of transmission due to long extension of lines if the lines are of similar specifications, which leads to think that it is not technically reasonable to make such an extension for a low demand level of this project (400kW).

In future, when power demand increases, e.g. 1,000kW or over, it would be feasible to install transmission lines of higher voltage (efficient but expensive). Here is again a financial issue as kwon.

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After blackout for 10 minutes , line staffs found VTs at Cronis broken with current flow to earthing wire, and starting repaling .



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Activity of repairing speed meter of hydro generator by technical staffs of EUMP at Cronis power plant.



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Maintenance of MV lines and distribution line has to be patrolled every weeks and out tree branches once a month by line staffs.



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After training by Japanese engineer, EUMP technical staffs repaired a guide wire at pole No P 32-108 caused by strong wind on 4/Jan/2010.



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### 8) Power rate policy

#### - Basic Policy

Power rate will be set in conformity with the relevant law for power rate setting established by Electricity Authority for Cambodia (EAC) and in line with the following policies.

- 1- All the customers shall bear the power rate without exception and EUMP shall be operated with the income from them,
- 2- Priority shall be given to maintaining the financial balance of the corporate operation for stable management ,
- 3- The recovery cost of the power facilities , being donated by Japanese aid, shall not be included in the operation cost and, however, the expenses for inspection, maintenance and repair shall be secured in order to maintain the functions of the power facilities;
- 4- Capital accumulation shall be made in preparation for future demand increase; and ,
- 5- Promotion of electrification of low-income group shall be made to the extent to satisfy the above conditions.

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Thank you for your attentions