Appendix 5 Transmission and Distribution Line Facilities

Transmission Line Detail Inspection Check Point 30/MAR/09 JICA Study Team

Overhead		
Pole Assembly		
General		
Concrete Pole		
	Surroundings	EUMP Staff Easy to access Bucket Car Easy to access Easy to climb No dead animal around No trace of rusty water around No new building is near No new construction work is near
	Pole No.	MV Pole No. is clear LV Pole No. is clear
	Ground	Not flow up Not sink down
	Body of a pole	Not incline Not bent Not cracked Not weathered Not broken
	Stepbar	Not remain
	TV cable	Attached appropriate
Guy Wire		
	Height	Height over road Height over building Height over another place
	Clearance	Clearance to MV Lines, LV Lines OK Clearance to another Transmission equipment OK Clearance to a building OK
	Surroundings	No trace of rusty water around No new building around No new construction work around No vine growing along Not Obstruct Traffic
	Ground	Not flow up Not sink down Anchor is Not shown
	Wire	Elemental wire is Not broken Not too rusty Tension is not too loose Wire End is safe for public
	Coliier	Installed firmly Not too rusty Not broken
	Parallel groove Clamp	Installed firmly Not too rusty Not broken
	Turnbuckle	Installed firmly Not too rusty Not broken
	Guy Insulator	Not cracked Not broken Not dusty No trace of Ark
	Rod	Not bent too much Not cracked too much Not broken Not too rusty
	Guy Wire Cover	Attached at necessary place Not detached Not broken

Overhead			
	Pole Assembly		
		General	
			Cross Arm
			Cross Arm & Arm Tie: Not Incline; Not bent; Not broken; Not too rusty
			Bolt & Nut: Not disappeared; Not broken; Not too rusty; Not loose; Not bent
			Obstacles: No nest of birds; No other obstacles
			Insulator
			Porcelain: Not broken; Not cracked; Not dusty; No trace of Ark
			Bolt & Nut: Not disappeared; Not broken; Not too rusty; Not loose; Not bent
			Earthing Wire
			General / Ground: Earth Resistance Good ※Need to measure; Not flow up; Not sink down; Earthing Rod is Not shown
			Earthing wire: Protected enough by pipe; Pipe not broken; Pipe not cracked; Pipe height enough; Conductor is Not shown; Insulating Cover Not broken; Insulating Cover Not cracked; Insulating Cover Not melt
			Joint to equipment(Transformer etc.): Jointed tightly; Not too rusty; Wire stripping Not too much

Overhead

Pole Assembly

Transformer Assembly

Transformer

Body outside	Height is enough Not incline Not bent Not dent Not bulge Not too rusty No trace of ark No oil leak Spray Coating Not coming off No abnormal noise Not heated too much Fixed tightly
Bolt & Nut	Not disappeared Not broken Not too rusty Not loose Not bent
Insulation Resistance ※If Discharge	Insulation Resistance is enough
Body Inside ※If Open & Discharge	Color of Oil is Clean Tap Position is appropriate Tap tightly fixed
Terminal(Primary/Secondary)	firmly fixed to Lead Wire & Cable Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Porcelain Not broken Porcelain Not cracked Porcelain Not dusty Porcelain No trace of Ark
Lead Wire to FCO	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight Clearance enough to other objectives
Joint of Lead Wire	firmly fixed to Transformer and FCO Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
Earthing Terminal	Jointed tightly to earthing wire Not too rusty Wire stripping Not too much

Overhead		
Pole Assembly		
Transformer Assembly		
Fuse Cutout Switch		
	Primary Cutout Switch	firmly fixed to Cross Arm firmly fixed to Lead Wire Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Porcelain Not broken Porcelain Not cracked Porcelain Not dusty Porcelain No trace of Ark Fuse Size Appropriate
	Lead Wire to MV Line	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight Clearance enough to other objectives
	Joint of Lead Wire	firmly fixed to MV Line and FCO Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much

Overhead		
Pole Assembly		
Transformer Assembly		
Lightning Arrester		
	Body	firmly fixed to Cross Arm firmly fixed to Lead Wire Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Porcelain Not broken Porcelain Not cracked Porcelain Not dusty Porcelain No trace of Ark Fuse Size Appropriate
	Lead Wire to MV Line	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight Clearance enough to other objectives
	Joint of Lead Wire	firmly fixed to MV Line Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
	Earthing Terminal	Jointed tightly to earthing wire Not too rusty Wire stripping Not too much

Overhead		
Pole Assembly		
Transformer Assembly		
LV Distrubution Board		
Body		
	Body	Height is appropreate Easy to access for Reading meters Case is Not Charged Front Glass Not Foggy Front Glass Not Dirty Locked Fixed tightly Not broken Not incline
	Lead Cable to Transformer	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Fixed firmly to the Pole
Watt-Hour Meter		
	Watt-Hour Meter	Fixed firmly to the Box Not broken Not incline Not too rusty Front Glass Not Foggy Front Glass Not Dirty No trace of Ark Not Burned Inside Disk Rotate is smooth No abnormal noise Terminal Cover is Not Charged Terminal Cover is Fixed firmly Wire Fixed to Terminal firmly Terminal Voltage is appropriate Wires connected to correct phase or neutral Not heated too much
	CT	Appropreate Combination to Watt-Hour Meter Fixed firmly to the Box Not broken Not incline Not too rusty Not Burned No trace of Ark No abnormal noise Wire Fixed to Terminal firmly Wires connected to correct phase Not heated too much
MCCB		
	Magneting Switch	Turn On & Off Smoothly Fixed firmly to the Box Not broken Not incline Not too rusty Not Burned No trace of Ark No abnormal noise Wire Fixed to Terminal firmly Wires connected to correct phase Not heated too much

Overhead		
Pole Assembly		
Transformer Assembly		
LV Distrubution Board		
Street Light Control Circuit with Timer		
	Timer	Time Acculate(Yes/No) Switch Turn On & Off smoothly Fixed firmly to the Box Not broken Not incline Not too rusty Not Burned No trace of Ark No abnormal noise Wire Fixed to Terminal firmly Wires connected to correct phase Not heated too much
Wires Inside		
	Wires Inside	No Abnormal Pressure from outside Fixed to the Box firmly Not heated too much Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight
	Joint of Wires	firmly fixed to Watt-Hour Meter etc. Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
	Earthing Terminal	Jointed tightly to earthing wire Not too rusty Wire stripping Not too much

Overhead		
Pole Assembly		
LV Assembly		
Aggregating Meter Box		
Body		
	Body	Height is appropreate Easy to access for Reading meters Case is Not Charged Front Glass Not Foggy Front Glass Not Dirty Locked Fixed tightly Not broken Not incline
Watt-Hour Meter		
	Watt-Hour Meter	Fixed firmly to the Box Not broken Not incline Not too rusty Front Glass Not Foggy Front Glass Not Dirty No trace of Ark Not Burned Inside Disk Rotate is smooth No abnormal noise Terminal Cover is Not Charged Terminal Cover is Fixed firmly Wire Fixed to Terminal firmly Terminal Voltage is appropriate Wires connected to correct phase or neutral Not heated too much
CB		
	CB	Turn On & Off Smoothly Fixed firmly to the Box Not broken Not incline Not too rusty Not Burned No trace of Ark No abnormal noise Wire Fixed to Terminal firmly Wires connected to correct phase Not heated too much

Overhead		
Pole Assembly		
LV Assembly		
Aggregating Meter Box		
Wires Inside		
	Wires Inside	No Abnormal Pressure from outside Fixed to the Box firmly Not heated too much Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight
	Joint of Wires	firmly fixed to Watt-Hour Meter etc. Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
	Earthing Terminal	Jointed tightly to earthing wire Not too rusty Wire stripping Not too much
Street Light		
	Body	Not Incline Not bent Not broken Not too rusty
	Bolt & Nut	Not disappeared Not broken Not too rusty Not loose Not bent
	Circuit	Connection is correct Bulb Not Broken Glow Lamp Not Broken

Overhead

Pole Assembly

LBS Assembly

LBS

Location	Easy to Access Suit Location for Grid's-Operation
Operating Bar	Locked Not Charged Move Smoothly Fixed firmly to the Pole Not broken Not incline Not Bent Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent
Body	No nest of birds No Obstacles Not broken Not incline Not Bent Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Abnormal Noise
Blade	Not broken Not incline Not Bent Not too rusty Not too dirty No trace of Ark
Porcelain	Not broken Not cracked Not dusty No trace of Ark
Lead Wire to MV Line	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight Clearance enough to other objectives
Joint	firmly fixed to MV Line and Body Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
Earthing Terminal	Jointed tightly to earthing wire Not too rusty Wire stripping Not too much

Overhead		
Pole Assembly		
Underground Connecting Assembly		
MV/LV Termination		
	Location	Easy to climb
	Termination	Fixed firmly to the Pole No Compound Leakage Each Termination Not Touched Each Termination Not too close Phase Plate Not Detached No Tracking Winding Tape Not loose Not broken Not cracked Not dusty
	Lead Wire to MV Line	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight Clearance enough to other objectives
	Joint of Lead Wire	firmly fixed to MV Line Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
Cable along the Pole		
	Lead Cable along the Pole	Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Causion: If Finding abnormal condition, Check electric Leakage by MV Voltage Detector AT FIRST before approrching
Pipe along the Pole		
	Pipe along the Pole	Height is appropreate Fixed tightly to the Pole Not broken Not incline

Overhead			
	Pole Assembly		
		Underground Connecting Assembly	
			Lightning Arrester
			Body: firmly fixed to Cross Arm firmly fixed to Lead Wire Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Porcelain Not broken Porcelain Not cracked Porcelain Not dusty Porcelain No trace of Ark Fuse Size Appropriate
			Lead Wire to MV Line: Insulating Cover Not broken Insulating Cover Not cracked Insulating Cover Not melt No trace of Ark Wire Tension is not too loose Wire Tension is not too tight Clearance enough to other objectives
			Joint of Lead Wire: firmly fixed to MV Line Joint Not too rusty Bolt & Nut Not disappeared Bolt & Nut Not broken Bolt & Nut Not loose Bolt & Nut Not bent No Tension to Joint Point Not heated too much Not melt Wire stripping Not too much
			Earthing Terminal: Jointed tightly to earthing wire Not too rusty Wire stripping Not too much

Overhead				
	Line			
		Ground Wire		
			Ground Wire	
				Clearance: Clearance to MV lines is enough.
				Sag: Not Unbalanced Not too loose
				Wire: No Kink Elemental Wire is not Broken No Obstacle on the Wire *Kite, Branch, etc.
				Near the pole: Fixed firmly to the Cross Arm
				Earthing Terminal: Jointed tightly to earthing wire Not too rusty Wire stripping Not too much
		MV Wire		
			MV Wire	
				Clearance: Height is enough. Clearance to other things is enough. Clearance to Construction Work is enough. Public cannot touch easily.
				Neighbor: Burned Trees near a wire Dead Animal by electrical shock No Obstacle near the Wire *Inclined TV Anntena or Tree *Tin Roof easy to fly toward, etc
				Sag: Not Unbalanced Not too loose
				Wire: No Kink Insulating Cover is not Cracked Insulating Cover is not Broken No trace of Ark on the Insulating Cover Insulating Cover is not burned. No Obstacle on the Wire *Kite, Branch, etc.
				Near the pole: Elemental Wire is not Broken Binding Wire to an Insulator is not Detached Binding Wire to an Insulator is not Loose Bare Conductor is not Touched to other things.
		LV Cable		
			LV Cable	
				Clearance: Height is enough. Clearance to other things is enough. Clearance to Construction Work is enough. Public cannot touch easily.
				Neighbor: Burned Trees near a wire Dead Animal by electrical shock No Obstacle near the Wire *Inclined TV Anntena or Tree *Tin Roof easy to fly toward, etc
				Sag: Not Unbalanced Not too loose
				Wire: No Kink Insulating Cover is not Cracked Insulating Cover is not Broken No trace of Ark on the Insulating Cover Insulating Cover is not burned. No Obstacle on the Wire *Kite, Branch, etc.
				Near the pole: Fixed firmly to the Clamp

Underground				
	Cubicle			
		Cubicle		
			Cubicle	
				Location: EUMP Staff Easy to access; No dead animal around; No new building is near; No digging construction work is near
				Foundation: Not sink; Anchor Bolt is not Loose; No Crack; Not Broken; Fixed to the Case; Not incline; Not Slide; Not Collapse
				Case: Not broken; Not Dent; Not bulge; Not bent; Not too rusty; Easy to read Name Plate; Spray Coating Coming Off(Yes/No)
				Door: Locked; Easily Open and Close; Door Stopper works well; Gasket of the Door is good; Ventilation Opening is not Blocked
				Panel: Easy to read Switch Number and symbol; No abnormal noise; No trace of entering water; No trace of animal; No Condensation; Not too dirt
				Earthing wire: Earth Resistance Good ※Need to measure; Insulating Cover Not broken; Insulating Cover Not cracked; Insulating Cover Not melt; Joint is tight; Joint is Not too rusty; Wire stripping Not too much
				Operation: Smooth to turn ON/OFF
				Switch: Blade does not Bent; Blade is not too rusty; Blade is not dirty; Charged part is covered well; Not Broken inside; No trace of Ark
				Terminal: firmly fixed to MV Line; Joint Not too rusty; Bolt & Nut Not disappeared; Bolt & Nut Not broken; Bolt & Nut Not loose; Bolt & Nut Not bent; No Tension to Joint Point; Not heated too much; Not melt; Wire stripping Not too much
	Line			
		Cable		
			Cable	
				Location: No digging construction work is along the route
				Cable: Insulating Resistance Good ※Need to measure

Transmission Line restoration process from Diels power station when MCB at Power Station turns off by over-current

Appendix 5-4

* To find Fault Point of MV Line, we have to charge each of MV-Line Section and detect abnormal indication at Diesel Power Station.

●→ : Order & Confirm the result
→□ : Action & Report

	Responsible Person	T&D team	Diesel P/S team	O'Romis P/S team	O'Moleng P/S team
A) Confirm Safety					
1 To Comfirm that every staff is safe and keeping away from M/V line	●→		→□	→□	→□
B) Separate Each Circuit					
2 To Open Main MCB in Diesel P/S	●→		→□		
3 To Open Main MCB in O'Romis P/S	●→			→□	
4 To Open Main MCB in O'Moleng P/S	●→				→□
5 To Comfirm that LBS-1 is Open	●→	→□			
6 To Open F1 LBS in Hospital S/S	●→	→□			
7 To Open F2 LBS in Hospital S/S	●→	→□			
8 To Open F3 LBS in Hospital S/S	●→	→□			
9 To Open TR1 LBS in Hospital S/S	●→	→□			
10 To Open TR2 LBS in Hospital S/S	●→	→□			
11 To Open F1 LBS in District Office S/S	●→	→□			
12 To Open F2 LBS in District Office S/S	●→	→□			
13 To Open F3 LBS in District Office S/S	●→	→□			
14 To Open TR1 LBS in District Office S/S	●→	→□			
15 To Open TR2 LBS in District Office S/S	●→	→□			
16 To Open LBS-2	●→	→□			
C) Start Diesel P/S					
17 To Stand by Diesel P/S	●→		→□		

Transmission Line restoration process from Diels power station when MCB at Power Station turns off by over-current

Appendix 5-4

* To find Fault Point of MV Line, we have to charge each of MV-Line Section and detect abnormal indication at Diesel Power Station.

●→ : Order & Confirm the result
→□ : Action & Report

	Responsible Person	T&D team	Diesel P/S team	O'Romis P/S team	O'Moleng P/S team
D) Search Fault Circuit					
18 To Close Main MCB in Diesel P/S	●→		→□		
19 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Fault Circuit may be the "C13-DG Link Line"					
20 To Close F3 LBS in Hospital S/S	●→	→□			
21 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Fault Circuit may be the "Bus-Bar in Hospital SS"					
22 To Close F1 LBS in Hospital S/S	●→	→□			
23 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Fault Circuit may be the "C11-O'Romis Line"					
24 To Close F2 LBS in Hospital S/S	●→	→□			
25 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Fault Circuit may be the "C12-North East Line"					
26 To Close TR1 LBS in Hospital S/S	●→	→□			
27 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Fault Circuit may be the "Hospital-TR1"					
28 To Close TR2 LBS in Hospital S/S	●→	→□			
29 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Fault Circuit may be the "Hospital-TR2"					

Transmission Line restoration process from Diels power station when MCB at Power Station turns off by over-current

Appendix 5-4

* To find Fault Point of MV Line, we have to charge each of MV-Line Section and detect abnormal indication at Diesel Power Station.

●→ : Order & Confirm the result
→□ : Action & Report

		Responsible Person	T&D team	Diesel P/S team	O'Romis P/S team	O'Moleng P/S team
30	To Close F2 LBS in District Office S/S	●→	→□			
31	To Confirm that any indicator is normal in Diesel P/S	●→		→□		
	>>If Not normal, Fault Circuit may be the "Bus-Bar in District Office SS"					
32	To Close F1 LBS in District Office S/S	●→	→□			
33	To Confirm that any indicator is normal in Diesel P/S	●→		→□		
	>>If Not normal, Fault Circuit may be the "C22-O'Moleng Line"					
34	To Close F3 LBS in District Office S/S	●→	→□			
35	To Confirm that any indicator is normal in Diesel P/S	●→		→□		
	>>If Not normal, Fault Circuit may be the "C21-North Line"					
36	To Close TR1 LBS in District Office S/S	●→	→□			
37	To Confirm that any indicator is normal in Diesel P/S	●→		→□		
	>>If Not normal, Fault Circuit may be the "District Office-TR1"					
38	To Close TR2 LBS in District Office S/S	●→	→□			
39	To Confirm that any indicator is normal in Diesel P/S	●→		→□		
	>>If Not normal, Fault Circuit may be the "District Office-TR2"					
40	To Close LBS2	●→	→□			
41	To Confirm that any indicator is normal in Diesel P/S	●→		→□		
	>>If Not normal, Fault Circuit may be the "C23-North West Line"					

Transmission Line restoration process from Diels power station when MCB at Power Station turns off by over-current

Appendix 5-4

* To find Fault Point of MV Line, we have to charge each of MV-Line Section and detect abnormal indication at Diesel Power Station.

●→ : Order & Confirm the result
→□ : Action & Report

	Responsible Person	T&D team	Diesel P/S team	O'Romis P/S team	O'Moleng P/S team
E) Search Fault Range in the Fault Circuit					
42 To Turn ON or OFF of All LBS to normal condition Except the Fault Circuit	●→	→□			
43 To Open All FCOs of every PMT in the Fault Circuit	●→	→□			
44 To Charge 22kV voltage to MV Line Except the Fault Circuit	●→	→□	→□		
45 To Charge 22kV voltage to MV Line Of the Fault Circuit	●→	→□			
46 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Minimized Fault Circuit may be the "MV Line except PMTs in the Fault Circuit"					
47 To Close 3 of FCOs of each PMT sequently in the Fault Circuit	●→	→□			
48 To Confirm that any indicator is normal in Diesel P/S	●→		→□		
>>If Not normal, Minimized Fault Circuit may be the "PMT"					
49 To Close 3 of FCOs of all PMTs except the Minimized Fault Circuit	●→	→□			
F) Supply electricity except the Minimized Fault Range					
50 To Charge 22kV voltage to MV Line Except the Minimized Fault Circuit	●→		→□		
51 To Stand by O' Romis P/S	●→			→□	
52 To Syncronize and Connect O' Romis P/S to the 22kV Grid	●→			→□	
53 To Stand by O' Moleng P/S	●→				→□
54 To Syncronize and Connect O' Moleng P/S to the 22kV Grid	●→				→□
G) Find and Repair the Fault Point					
55 To Find the Fault Point in the Minimized Fault Circuit	●→	→□			
56 To Repair the Fault Point	●→	→□			
H) Supply electricity to all customers					
57 To Charge 22kV voltage to all MV Line	●→	→□			
End					

Appendix 5-5

Basic Rule at the MV-Line Work for Safety

1) To Confirm that all person is keeping away from MV Line.

2) To Open LBS in order to Shutdown Electric Supply to the Working MV-Circuit
   *For Example, open F2 LBS in Hospital S/S for working in C12(North East Line)

3) To Ground the Working MV-Circuit by LBS in S/S
   *This Procedure is impossible in case of LBS-1 and LBS-2 Operation.

4) To Ground Both Sides of Working Place of MV Line
   *Please note using 22kV-insulated equipment for grounding.
   *Reason why Both Sides is
   that Customer's Stand-by Generators might charge MV Line.

5) To Do MV-Line Work

6) To Remove the Ground Both Sides of Working Place of MV Line
   *If forget it, Short Circuit Accident occurs when Re-Charging.

7) To Remove the Grounding by LBS in S/S

8) To Confirm that all person is keeping away from MV Line.

9) To Close LBS in order to Electric Re-Supply to the Working MV-Circuit

End

FAULT OUTAGE RECOVERY LOG SHEET (T&D)

Appendix 5-6

Date	Outage time	Weather
4-Apr-09	15:25	Rain with thunder
Customer Report	Name	-
	Date & Time	-
	Contents	-
P/S Situation (Output before outage)	O'Romis P/S	Scheduled Stopping (0kW)
	Diesel P/S	V0=21kV, V0-Overvoltage (124kW)
	O'Moleng P/S	Scheduled Stopping (0kW)
Responsible Person	Order of Operation	Mr.Kong Piseth
	Transmission	Mr. Savuth Sothea
	DG P/S	Mr. ***

	Procedure		Date	Time	Condition(P/S, Site)
1	Diesel P/S MCB	OFF	4-Apr	15:25	
2	Diesel P/S MCB	ON	4-Apr	15:26	V0=21kV, V0-Overcurrent
3	Diesel P/S MCB	OFF	4-Apr	15:31	
4	District S/S F1,F2,F3	OFF	4-Apr	15:37	
5	Hospital S/S F1,F2,F3	OFF	4-Apr	15:40	
6	Diesel P/S MCB	ON	4-Apr	15:42	Something is wrong
7				15:43	DG P/S Recoverd
8	Hospital S/S F3	ON	4-Apr	15:44	GOOD
9	Hospital S/S F1	ON	4-Apr	15:44	V0-Overcurrent
10	Hospital S/S F1	OFF	4-Apr	15:45	GOOD
11	Hospital S/S F2	ON	4-Apr	15:46	GOOD
12	District S/S F2	ON	4-Apr	15:50	GOOD
13	District S/S F3	ON	4-Apr	15:51	GOOD
14	District S/S F1	ON	4-Apr	15:51	GOOD
15	---Inspection---				
16	---Replacement---				
17	OM-071 DG-side	Earth	4-Apr	16:50	
18	PMT36 LV-MCB	OFF	4-Apr	16:55	GOOD
19	***Insulator Replace at OM-071***				
20	OM-071 DG-side	Remove Earth	4-Apr	17:35	
21	PMT36 LV-MCB	ON	4-Apr	17:40	GOOD
22	Hospital S/S F1	ON	4-Apr	17:54	GOOD

Inspection	Date	From	To	Result
MV Line of O'Romis Side	4-Apr	15:51	16:20	Insulator broken at OR-071

Reason for Fault

Pin-Insulator on OR-071, A-Phase is broken Probably by thunder shock

Comments by JICA advisors team

Hospital S/S F1 should be Earthing before repairing work.
It is desirable that Earthing tools are attached to both sides of OR-071.
PMT36 LV-MCB should be OFF before operator approrch the MV Line.
Parts and Tools should be up and down by using tool bag, not be thrown down.
It is desirable that necessary parts for repairing is prepared enough (such as binding wire).

*EAC Standard : 60% within 6 hours, all case within 24 hours, except MV Cable

Section 2 Annual Report on Activities

Second Period (from April 2010 through March 2011)

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Second Period (from April 2010 through March 2011)

Chapter 1 Overview of Support Services in the 2nd Period

Chapter 2 Management and Administration

Appendix

Chapter 1 Overview of Support Services in the 2nd Period

Chapter 1 Overview of Support Services in the 2nd Period

1.1 Activities and Achievements of the 2nd Period (Overview)

In the 1st period, the activities were concentrated on establishment of the organizational framework of EUMP and technical transfer of basic abilities in a "pulling" way. This final 2nd period focused on strengthening administrative abilities and repeated technical training and guidance to improve the proficiency with a view to attaining self-support of EUMP. In June 2010, EUMP was transferred to EdC, so that consultations were made with EdC for CP to perform their duties without problems. Technical guidance was also provided on the connection with Vietnam planned by EdC.

The sectoral achievements of management, civil structures and power facilities of generation and transmission/distribution are described below.

(1) Management

a) Keeping the collection rate of power tariff

The transfer to EdC brought the modification of the billing system but the collection rate continued to be an average of 97% without problems.

b) Appropriate accounting works in EUMP

As in the previous year, financial documents of revenues and expenses were prepared on a monthly basis and a yea-end financial report was also prepared.

(2) Civil structures

a) Revision of the Manual for EUMP considering experience and actual behavior of EUMP's staff in 2-year trial operation

The first version of O&M Manual prepared in the 1st period (English and Khmer versions) were modified in the 2nd period considering the performance of EUMP's staff in OJT.

b) Bring up staff to such level that they can understand the Manual in a certain degree and perform maintenance tasks of civil structures.

Experience was gained in measurements of water flow of the water channel, clearing works of the intake, repair works of road drainage and other maintenance works. An ability evaluation revealed that almost all of the staff members attained a satisfactory level.

(3) Generation facilities

a) Revision of the Manual for EUMP considering experience and actual behavior of EUMP's staff in 2-year trial operation

The first version of O&M Manual prepared in the 1st period (English and Khmer versions)

were modified in the 2nd period considering the performance of EUMP's staff in OJT.

b) Bring up staff to such level that they can understand the Manual in a certain degree and perform maintenance tasks of generation facilities.

Normal operation method and recording method were learned through actual operation.

4 semi-annual periodical inspection works brought about hands-on learning of the functions and features of the facilities.

(4) Transmission/distribution facilities

a) Revision of the Manual for EUMP considering experience and actual behavior of EUMP's staff in 2-year trial operation

The first version of O&M Manual prepared in the 1st period (English and Khmer versions) were modified in the 2nd period considering the performance of EUMP's staff in OJT.

b) Bring up staff to such level that they can understand the Manual in a certain degree and perform maintenance tasks of transmission/distribution facilities.

It was judged from actual performance that the basic abilities for regular inspection and maintenance works and trouble shootings were acquired through OJT. Understanding level reached over 80% in all of the points of self-evaluation.

As described above, the levels achieved in the 1st period of framework of EUMP for organization and regulations and the minimum learning of operation methods have developed in the 2nd period to the extent that the foundation for operation was firmly established in terms of self-support and technical abilities transplanted through repeated practice and training.

Appendix 1 General

Appendix 1-1： Photo of Activities

Chapter 2 Management and Administration

Chapter 2 Management and Administration

2.1 Achievements in the 2nd Period

2.1.1 Overview

In the 2nd period from May 2010 through March 2011, the experts were dispatched to Cambodia 4 times for organization and management and 2 times for administration, totaling 6 times. They provided technical transfer to their counterpart, EUMP's staff (Electricity Unit of Mondul Kiri Province) regarding management and administration. On June 8, 2010, EUMP, so far an independent body under the jurisdiction of MIME, was merged into EdC, state corporation, which has a firm management bases and has their established regulations for administration including the articles of incorporation. JICA team made consultations with EdC and provided guidance to them in such a way to realize a smooth transfer of administrative works within EdC. The procedures for administrative matters such as billing system are basically common with other power utilities, so that the transfer was smoothly carried out with EUMP's staff having learned and becoming familiar with the procedures in the 1st period.

As for management, in 2010, the entire Mekong basin area suffered from the severest drought since 1998, resulting in such a lowered profit as 5% compared with 2009. However, EUMP did not undergo fund shortage and continued sound management.

In order to meet future increase in power demand, EdC is pushing forward with their plan of power import by connecting with Vietnam. The current power tariff, based on the hybrid power system of hydropower and diesel power, will be revised after the connection with Vietnam because most of the power demand currently satisfied by the diesel power will be met by electricity imported from Vietnam. JICA team made a trial calculation for a prospect of power tariff after the connection and explained it to JCC.

The achievements and activities in the 2nd period are described below.

2.1.2 Achievements by PDM Achievements

(1) Preparation of a mid- and long-term plan and a financial plan

With the transfer to EdC of EUMP, the management and administration matters were decided to be carried out by EdC. As for the civil structures and the facilities of power generation and transmission/distribution, JICA team, in the 2nd period, prepared a revised version of the Manual since EdC had few experiences in hydropower and the power facilities of EUMP were peculiar to them.

Regarding financial plan, a revision was made monthly according to the method suggested in the 1st period.

(2) Establishment of billing system

The billing system established in the 1st period was being operated but modified to fit into EdC system after the transfer to EdC. As mentioned above, the system itself is basically same, so that EUMP staff, already familiar with such system, were able to perform their tasks without problems, keeping an average collection rate of 97%.

As for power tariff after the connection with Vietnam, which is being planned by EdC, JICA team explained a prospect of power tariff to EdC, to whom the generation mix (imported power, hydropower and diesel power) is new.

(3) Preparation of a manual for management and administration (submitted in February 2010 and approved in the 3rd JCC meeting)

As for the manual for management and administration, similar to the said billing system, the regulations and the manual of EdC have come to be operated after the transfer to EdC.

(4) Control of operation of the power facilities through OJT

In the 1st period, training by OJT was provided for the administrative section including work procedures for labor and procurement of equipment and materials. In the 2nd period, they became able to do those tasks by themselves.

(5) Record and consolidation of the relevant data (customer data, sales of electricity, revenue and expenses)

Such necessary forms for management and administration were prepared as customer book, monthly sales of electricity by customer, power tariff table, accounting book, assets and equipment/materials book. In the 2nd period, data accumulation and control were continued with the donated computers.

2.2 EUMP's Organization

EUMP was transferred to EdC on June 8, 2010, while the organization (former EUMP) supplying power to Sen Monorom city was being kept as it had been. Keo Seyma area, also in Mondul Kiri province, had already been supplied with electricity since 2006 with distribution lines from Vietnam and was incorporated into EUMP, bringing a total of 39 staff members as Electricite de Mondul Kiri of EdC.

Electricite de Mondul Kiri has two managerial posts: Chief and Deputy Chief. Before the transfer to EdC, the director of EUMP was held concurrently by the director of DIME, who voluntarily retired from EUMP's post and the then deputy director of EUMP was promoted to the Chief of Electricite de Mondul Kiri. The post of the deputy chief was taken by the then technical deputy director of EUMP. Most of EUMP's staff were transferred to EdC, causing no problems in operation.

Organization of EDC Mondul Kiri(EUMP) in Feb. 2011

2.3 Summary of the Activities

Field activities	Duration	Activities performed
Koji Mishima		Leader/management
6th field activities	From May 26 through June 9, 2010 (15 days)	Explanation of the 2nd period plan to MIME, EAC and EdC, preparations for the transfer to EdC and consultations
7th field activities	From September 19 through October 8, 2010 (20 days)	4th JCC meeting, support to the terminal evaluation mission of JICA and self-evaluation of EUMP's administrative staff
8th field activities	From December 4 through December 18 (15 days)	Examination and consultations of a prospect of power tariff after connection with Vietnam
9th field activities	From February 15 through February 27, 2011 (13 days)	5th JCC meeting, submission of the revised O&M Manual and mid- and long-term plan, ending the field activities
Tetsuro Tanaka		Administration
7th field activities	From September 7 through 16, 2010 (10 days)	Consultations relevant to the transfer to EdC for administrative matters
9th field activities	From February 17 through February 26, 2011 (10 days)	5th JCC meeting, submission of the revised O&M Manual and mid- and long-term plan, ending the field activities

2.4 6th Activities in Cambodia (Management: May 26 through June 9, 2010)

2.4.1 Outline

This was the first activities in Cambodia in the 2nd year of the project. The 2nd year Plan prepared in the activities in home country was explained and submitted to Cambodia office of JICA.

The unexpected transfer to EdC of EUMP was decided in January this year by MIME and EdC, making it important to make due coordination with the relevant authorities. So, the planned activities were explained and request for cooperation was made not only to EUMP, project counterpart, and MIME, supervisory organization, but also to EdC.

At the above request, MIME, EAC and EdC confirmed their willingness of cooperation for this project after the transfer to EdC of EUMP.

2.4.2 Explanation and Consultation with Relevant Authorities

(1) MIME (supervisory organization)

1) Date and time: 3 p.m., May 28, 2010
2) Place: Conference room in Department of Energy of MIME
3) Attended by

MIME Dr.Bun Narith Deputy General Director, General Department of Energy

	Mr. Nong Sareth, Deputy Director, Hydropower Dept. and other 3 people
EUMP	Mr. Kong Pisith, Dirwctor of EUMP
	Mr.Chin Sokn, Deputy Director of EUMP and other 3 people
JICA office	Mr. Shinoda and Mr. Heng Salpiseth
JICA team	Mr. Koji Mishima (Chief and management),
	Ryuji Oikawa (civil), Yukitaka Hiraga (generation)
	Junya Shinohara (transmission and distribution)
	Ms.Eong Sodavy(local coordinator)
Assistant cum interpreter	Mr.Kry Meng Ang (Khmer)

4) Handouts

- 2nd year's Plan of activities of the project (English version)
- Material for trial calculation of future power tariff

5) Key points discussed

a) 2nd year's schedule

It was conveyed that this year was the last year of the project and that JICA would dispatch an evaluation mission in around September.

b) Key points of this year

① Improvement of abilities of EUMP's individual staff members

It was conveyed that efforts in last year were centered mainly on preparing the framework for organization and manuals, while in this year various programs would be conducted to improve the abilities of individual staff members. (Refer to the plan of self-evaluation of CP in Appendix to the Plan of Activities)
MIME replied as follows:

- They recognized the improvement of EUMP as compared with the past.
- They expressed their expectation that the self-evaluation program would bring good results and they willingness to support it totally.

② Revision of the manual and coordination of operation works on account of the transfer to EdC

MIME replied as follows:

- Official transfer to EdC would be on June 8, 2010.
- The manual would be revised mainly by EUMP and EdC.
- They considered that there would be no problems in administration section, while they requested for cooperation from JICA regarding hydropower section because of the lack of technical ability.

- JCC would remain as it was with MIME, supervisory organization, as organizer but specific matters should be directly consulted with EdC.

c) Trend of power tariff after connecting with Vietnam

Explanation was made on trial rough calculation of generation costs and power tariff as for the current time and after connection with Vietnam. It was pointed out that, although specific figures may vary and cannot be fixed, there is a sure tendency of hydropower generation costs to decrease.

MIME and EUMP made the following statements:

- The staff of Keo Seyma would be transferred to EUMP.
- Keo Seyma suffers from power outage 2 or 3 times a week during dry season, lasting 12 hours at the longest.

Comment:

JICA project team pointed out that the diesel power plant would be useful as emergency standby because power supply from Vietnam is not always stable according the above information.

(2) EAC (regulatory body)

1) Date and time: 9 a.m. May 28, 2010
2) Place: General Manager's room of EAC
3) Attended by

EAC	Dr.Ty Norin (General Manager)
EUMP	Mr. Kong Pisith, Dirwctor of EUMP Mr.Chin Sokn, Deputy Director of EUMP and other 3 people
JICA office	Mr. Shinoda and Mr. Heng Salpiseth
JICA team	Koji Misima (Chief and management), Y Ryuji Oikawa (civil), Yukitaka Hiraga (generation) ukitaka Hiraga (generation)、 Junya Shinohara (transmission and distribution) Ms.Eong Sodavy (local coordinator)

Assistant cum interpreter Mr.Kry Meng Ang (Khmer)

4) Handouts
   - 2nd year's Plan (English version)
   - Trial calculation of future power tariff

5) Main points discussed
After explanation of the 2nd year's plan, discussion was made on future power tariff.

EAC understood the decreasing tendency of hydropower generation costs and the total costs resulting from the trial calculation.

a) Remarks from the General Manager of EAC

- They understood the decreasing tendency of the generation cost but expected to lower the power tariff gradually instead of drastic drop.
- It was their policy to keep the regional tariff as it was after the transition to EdC and to maintain the independent financial stand.
- The current organization and staff will remain as they are even under EdC, while as for the payroll and work regulations should follow those of EdC.

Regarding the trial calculation of future power tariff, the following 2 points were made.

i) When connecting with Vietnam in the future, the diesel power plant was counted out as emergency. There will occur power supply suspension from Vietnam as seen in Keo Seyma because of power stringency during dry season.
ii) Power import tariff will have such tax addition as 7% of import duty and 10% of excise tax.

(3) General meeting of EDC (Organization to merge EUMP)

1) Date and time: 10 a.m., May 31, 2010
2) Place: Meeting room of the planning department of EDC
3) Attended by

EDC	Mr.Chan Sodavath (Deputy General Manager: in charge of planning), Mr. Ros Chenda (Manager of Generation), Mr. Mr.Chea Sinhel (Manager of Distribution) Ms. Ms.Duong Vannay (Manager of Finance), Mr. Chan Chetra (Deputy Chief of International Cooperation Office: in charge of ODA) Mr. Chulasa Plaing (Manager of Planning) Ms.Ngin Kanida (Cief of Planing division: in charge of liaison), Mr. Hirokatsu Yamakawa, senior volunteer of JICA(EDC distribution section)
EUMP	Mr.Chin Sokn, Deputy Director of EUMP and other 3 people
JICA office	Mr. Shinoda and Mr. Heng Salpiseth
JICA team	Mr. Koji Mishima (Chief and management),

Ryuji Oikawa (civil), Yukitaka Hiraga (generation)
Junya Shinohara (transmission and distribution)

Ms.Eong Sodavy (local coordinator)

Assistant cum interpreter Mr.Kry Meng Ang (Khmer)

4) Handouts
   - 2nd year's Plan (English version)
   - Trial calculation for future power tariff (Appendix 2-2)

5) Outline

EdC had been attending JCC meetings as a member of JCC and once EUMP has been transferred to EdC (scheduled for June 8), they would become the operator of the donated power facilities or the counterpart of the project. That transfer motivated this 1st meeting was held to discuss how to cope with various matters requiring coordination.

JICA project team made a request for cooperation from EdC in that it was necessary to tailor the regulations and manuals so far prepared to EdC, although JICA team would continue to provide guidance to improve the abilities of EUMP's staff.

At the above request, EdC would organize a working team for transition to EdC in order to proceed to transition works with close communications with JICA team.

The deputy General Manger of EdC made a general statement as follows:

- He expressed deep appreciation, from the General Manager as well, for JICA's cooperation and recognition of the situation of Mondul Kiri.
- He expressed their willingness to basically keep the current system in order to make use of the results of technical transfer so far made after the transition as well.
- He stated that there would be no worry about the general direction and management of Mondul Kiri by guiding and controlling from the headquarters.
- The transfer to EdC of EUMP was to be on June 8 and the ceremony would be held at Mondul Kiri. (attended by Mr. Hiraga from JICA team)
- The members of the working group were already almost appointed and the working group would be formally established on the transfer.

6) Cooperation for revision of the guidelines and manuals

JICA project team requested EdC and EUMP to propose the points to be revised of the manuals, which JICA team was to finish the draft of the revised manuals by September.

- Regarding administration matters, it was requested to make modifications mainly by EdC including EUMP.
- As for technical matters, it was requested that technical staff of EdC take part in training at the times of technical guidance to be provided to the staff of Mondul Kiri.

EdC stated that the safety regulation was already prepared and that O&M manual would be tailored to EdC's needs.

7) Guidance and training on administration

JICA team requested EdC to send some experts in administration to Mondul Kiri 2 times for 1 week each time with travel expenses to be borne by JICA team.

First time: Those administrative matters that should be addressed without delay due to the transfer to EdC

Second time: Training related with revised guidelines and manuals (after completion of the draft of the revised version)

8) Planned connection with Vietnam

EdC has plans of importing power from Vietnam to Mondul Kiri via 22kV medium-volt transmission line.

- Timing of construction: the plans are currently under preliminary investigations and will not be implemented this year.

  Note 1: Collection of information and reconnaissance were later conducted at site together with EdC's staff. It was revealed that EdC just started concrete surveys from conceptual stage.
- Construction cost will be budgeted by EdC, not from financial aid.
- To meet increasing demand, EdC considers the use of the diesel power plant. (remark made by the deputy general manager of EdC after the meeting)

9) Power tariff

EdC's tariff is different by regions. The cost of expansion of transmission lines is planned to be covered by EUMP. The power tariff will be calculated by EdC's method of tariff calculation, including taxes.

In the personal view of the deputy general manager of EdC, he is not optimistic about negotiation with Vietnam for power import tariff, which is getting tougher.

10) Conformity with JCC

Asked by EdC about JCC after the transfer of EUMP, JICA team explained as follows:

JCC has so far had 2 functions: coordination committee for JICA project and joint steering committee (JSC) and, however, the transfer to EdC of EUMP will discard the function as JSC because the former will be in charge of management of the latter. At the same time, the function of JCC as coordination committee for JICA project will remain unchanged with Ith Praing, secretary of MIME as chairperson.

11) Future liaison or point of contact

EdC will forthwith establish a working team after the official transfer to EdC. A list of

communications line will be prepared by the coordinator to be sent to relevant persons.

Liaison : coordinator

EDC : planning department Ms.Ngin Kanida

JICA team : Mrs. Oung Sodavy

- Official letters should all be addressed to the General Manager
- All letters should be sent with cc to the coordinator

12) JICA Cambodia Office

Comments by JICA Office

i) Spare parts should be secured for future maintenance

ii) Tariff should not be lowered abruptly but step by step.

iii) JICA's largest concern is shutdown of the donated power facilities, expecting continued stable supply.

(4) Consultation with administrative section of EDC and liaison

1) Date and time: 10 a.m. June 2

2) Place: meeting room of the planning department of EDC

3) Attended by

EDC Ms. Ms.Duong Vannay (Director of Finance)
Mr. Chan Chetra (Deputy Chief of International Cooperation Office: in charge of ODA)
Ms.Ngin Kanida (Cief of Planing division: liaison),

JICA team Mr. Koji Mishima (Chief and management), Mr.Kry Meng Ang(assistant cum interpreter)

4) Presentation of the list of contact persons (entative)

JICA team presented the list of relevant persons for confirmation by EdC on their part.

At present, EdC has not given a concrete instruction to the person in charge. The members of the working team will be determined after the official transfer on June 8, then, they will complete the list. JICA team consented to it.(See Material 4)

Note: despite the statement by the deputy general manger on the establishment of the working team, it seems that it will take longer time to get to the working level.

5) Revision of guidelines and manual for administrative section

JICA team explained and requested as follows:

As explained at the general meeting on May 31, EdC has their own regulations for

administration, although it may be necessary to make some adjustments or modifications to parts peculiar to Mondul Kiri with the rest in common to be simply replaced. Such works were requested to be done mainly by EdC.

EDC: Director of Finance and staff in charge of ODA

Understood the explanation and request. Those works requested will be proceeded on appointment of the persons in charge.

Note: A digital file of the guidelines and manuals was sent to the liaison of EdC by the local coordinator of JICA team.

(5) Interview with the Deputy General Manager of EDC in charge of administration

1) Date and time: 3 p.m. June 2, 2010
2) Place: room of the deputy general manager of EDC
3) Attended by

EDC	Mr.Eng Kunthea (Deputy General Manager, Administration),
JICA team	Mr. Koji Mishima (Chief and management),
	Mr.Kry Meng Ang (assistant cum interpreter)

4) Key points discussed

JICA team explained the outline of JICA project, requesting coordination and cooperation for administrative matters due to the transfer.

EdC recognized that matter, stating that the current organization will be kept unchanged as much as possible. As for treatment of EUMP's staff, the regulations of EdC must be followed. They knew that the current level of salary is a little higher than the counterpart of EdC. The salary has been increasing recently by 20% yearly, so that it will reach the same level in one or two years. As for bonus, there is no such provision but some form of health-care allowance is given twice a year in the amount of half of the salary.

JICA team expressed their understanding about the observance of EdC's regulation for personnel treatment after the transfer and, at the same time, requested such consideration that personnel evaluation be made fairly.

2.4.3 Guidance on EUMP Administration

An explanation was made to 11 members of administration section about the 2nd year schedule and self-evaluation of CP on June 4. In doing the first self-evaluation, an instruction was given to fill in the evaluation sheet by June 5 after confirming their respective tasks in charge. An individual interview was conducted with each member on June 5 and discussions were held about points or skills to be improved to prepare an action plan, of which the original has been kept by each member and the

copy by JICA team and will be checked to see advancement.

2.4.4 Of the Entrance to National Route 76 at O'Romis Access Path

A site reconnaissance on June 3 revealed that the heavy rain of several days ago made the transit difficult because of erosion of the road. The outlet of drainage works of the National Road was collapsed by the erosion. The road was narrowly transitable with an 4WD vehicle but not with a vehicle with a high platform. Having consulted with Mr. Chin Sokhun, Deputy Director in charge of technical matters, it was decided that EUMP should make a request to the Road Department for repair, which JICA team would attend as an observer.

Consultation with the Road Department of Mondul Kiri Province (RD

Attended by Mr.Mau Thonnearak, Director of RD

RD understood that the repair already made satisfied EUMP, so that they were not going to do further repair.

JICA team alleged that shutdown of O'Romis power plant would cause power outage to Sen Monorom city, insisting that the erosion of the road was caused by construction works of the national road and it was necessary to secure the transit to the power plant.

RD appealed the difficulties in coping with this matter through repeated negotiations with a Chinese contractor, citing such a case that the contractor would not even submit drawings to RD and pleaded to EUMP for handling the matter.

RD added that, once the road construction has been completed and become under their jurisdiction, it may be possible to do something as they did for other roads. Having discussed the actual situation, both parties agreed to a practical way in such that RD would make repair of the roadbed with heavy equipment and that EUMP would provide bottoming.

June 5: RD made restoration works for roadbed with heavy equipment and dump trucks. A full-scale repair works were conducted in October.

2.5 The 7th Field Activities of Administration lasted for 10 days from September 7 through 16, 2010.

2.5.1 Outline

With the transfer to EdC, it was considered to be desirable that the internal bylaws and regulations should be based on those of EdC, so that this matter was conveyed to EdC headquarters and a consultation was made regarding a smooth way of transition for administration matters in such a form as not to hinder daily operations.

2.5.2 Situation of Transfer to EdC of Administrative Matters

(1) Consultation with Administrative Staff of EdC

Some hearings were made with Ms. Duong Vannay, Director of Finance, and Mr. Suon Chhuob,

Director of Administration regarding the following matters.

Attended by: Ms. Duong Vannay, Director of Finance
Mr. Suon Chhuob, Director of Administration
Ms. Sin Sovanny Deputy Director of Finance
Mr. Van Hra, Chief Accountant
Mr. Ly Sophalrith, Staff member of Administration

1) Internal bylaws and regulations

With the merger into EdC, Electricite de Mondul Kiri (former EUMP) follows the internal bylaws and regulations of EdC. There are a lot of matters in common with the regulations prepared by JICA team, so that the transition is going smoothly without any problems.

It was decided that the representative of Electricite de Mondul Kiri shall be Chief, to whom 2 Deputy Chiefs of technical matters and administrative matters shall report. Actually, there is a vacancy for Deputy Chief of administration, who will be appointed by the Managing Director of EdC sometime later.

2) Situation of Transfer of Adminstrative Matters

a) Accounting

Accounting works are being performed according to EdC's accounting rules. There were so far 2 times of accounting training, one time at Phnom Penh and the other time at Mondul Kiri.

The transfer was done not long ago, so that the balance sheet and income statement as of the end of 2010 for EdC including Electricite de Mondul Kiri have not been prepared yet, although the accounting documents prepared by Electricite de Mondul Kiri are sent to Phnom Penh monthly to be checked by the headquarters.

At the request from the administrative staff of Electricite de Mondul Kiri, JICA project team made a request for accounting training for not only accounting staff but also all the administrative staff because they should have basic accounting knowledge and skills. The headquarters replied to the effect that they would consider such a request.

b) Labor and General Affairs

As for labor and general affairs as well as equipment and warehouse control, such control works are being performed according to EdC's rules.

Regarding the salary, as a temporary measure, its level is being maintained at the same level as before the transfer to EdC, which has not caused any complaints from Mondul Kiri. EdC has a rule that pay raise is made every other year, so that such a temporary measure will be faded out

in 4 years.

2.5.3 Hearings about Self-evaluation Sheets

Hearings were done about self-evaluation sheets from the administrative staff of Electricite de Mondul Kiri (the former EUMP), also attended by its Chief.

i) Mr. Im Vichet: in charge of general affairs and procurement

A hearing was not done this time because of his business trip to Phnom Penh.

The Chief said that he was willing to attend accounting training and acquire accounting knowledge.

ii) Ms. Chres Malout: Chief Accountant in charge of accounting and cash/deposit control

She has acquired a basic understanding of accounting rules but its level of understanding was 79-80% although she attended accounting training, so that she expressed her hope to receive more training.

Asked about the outstanding balance of cash and bank deposits, she made a quick reply, improving as compared with the time of her predecessor.

As chief accountant, she is in a position to check accounting records prepared by her subordinate, but it seemed that she could not fulfill such a role partly because of her inadequate accounting knowledge. She was previously in charge of cashier and has not long been in the current position, so that it is advisable to make her give more efforts for advancing her accounting skills.

A chief accountant must fulfill his or her duties giving due consideration to the budget. In that regard, she did not do so adequately yet. At the beginning of this year (2010), JICA project team asked to prepare a simple budget on a trial basis. Now that the budget of Mondul Kiri has been incorporated into the budget of EdC. It is necessary that she should have more budget awareness and gain budget practice.

iii) Ms. Ty Soyatra: in charge of accounting

She is considered to play a central role in accounting works of Electricite de Mondul Kiri as in the past. She continued doing accounting woks without problems after the transition to EdC and she herself said that she was confident in her works. After the transition, new accounting processes have been involved for such matters as tax and headquarter's decision matters for fuel and the like, for which she felt it necessary to become familiar with such processes.

Regarding the budget, the same can be said as the chief accountant.

The income statement are sent monthly to EdC's headquarters for check and the accounting documents are inspected at Mondul Kiri by headquarter's staff in every 3 months.

iv) Ms. Tieng Pisey: cashier

She was so far an accounting assistant but now becomes in charge of cashier. Her main duties are to check the payment of customer's bills on receiving money against the customer's book and to issue receipts. Having little accounting knowledge, it is desirable for her to gain accounting knowledge and skills.

v) Ms. Ny Sopor: cashier

She is in charge of receiving money from customers regarding electricity bills and connection fee and deposit money. She was once an assistant to Ms. Malout, currently chief accountant, and has become cashier together with Ms. Pisey. Likewise, she needs to gain accounting knowledge and skills.

vi) Mr. Kong Botrachhany: in charge of electricity bill

He continues to be in charge of billing as in the past. With the transition to EdC, the computer program for billing has been renewed but he has already become familiar with the new software without problems.

According to the Chief of Electricite de Modnul Kiri, a new Business Section was to be established to handle billing and customer management, so that they are applying for approval to EdC. That Business Section will also be in charge of Keo Seyma as well as Mondul Kiri. They have already started to do so.

Regarding the matter previously pointed by JICA project team about power supply suspension measure against non-payment customer, they said that they are doing strict operation of such a rule. There have so far been 4 or 5 cases of supply suspension.

vii) Mr. Soth Saroem: in charge of billing

He was once in charge of diesel power plant and has become in charge of billing. He has already become familiar with the billing program and is now doing his works for Keo Seyma together with Mr. Botrachhany.

viii) Ms. Mey Champey: assistant to billing works

As assistant to Mr. Botrachhanny, she is in charge of checking bills with the customer book.

She maintains the customer book by registering new customers, change in power supply conditions of existing customers and elimination of customers.

Although she is not involved in the billing program, it is desirable for her to get engaged in billing works and to acquire practical skills.

2.5.4 Expert's Observations

1) With the transfer to EdC, the bylaws and regulations prepared by JICA project team will not be used as they are, but it is considered that such matters will basically be followed as organization and command line as well as task assignments of Mondul Kiri's internal sections. At the time of establishment of the former EUMP, they started their business without no internal regulations and almost all of their staff had very little experience in working with a company. The expert considers that a smooth transition to EdC is going on, which resulted from having trained the staff, although for a not long period, by making them prepare workflows of their tasks, making them aware of not only their own tasks but also those of other staff and carrying out their tasks according to the regulations and rules prepared by JICA project team.

2) EdC recognizes that the ability level of the administrative staff of Electricite de Mondul Kiri is lower than those of the Phnom Penh headquarters with respect to academic background, experience, skill and knowledge. EdC understands such situation that the former EUMP, a power utility of a small underdeveloped resort town, remote from the capital city, had no choice but to recruit their staff from local people. It seems that EdC adopts such a temporary measure as not to lower the current level of salary in order not to cause complaints about the salary and to keep the current staff as much as possible.
   Nevertheless, EdC explains that at the time of pay raise in every other year, they will make personnel evaluation, based on which 40% of the staff will be determined to get a pay raise and such staff members that will continue to be evaluated low may be fired. So, the administrative staff of Mondul Kiri must give more efforts for improving their ability. JICA project team urged them to acquire more knowledge and skills, not resting on the sense of security of being a member of the large company.

3) It seemed that the administrative staff of Electricite de Mondul Kiri feels assured because of the transfer to EdC of Mondul Kiri. So far, the former EUMP used to be a small company with a familylike atmosphere and was like a school while they were receiving technical transfer from JICA. Nonetheless, the transfer to EdC means that the former EUMP has become a part of a large company of Cambodia and that evaluation of Mondul Kiri staff by the headquarters will become more severe. Their current level of ability allows them to perform their tasks without problems, and, however, the administrative staff of the headquarters have far higher levels of knowledge, experience and academic ground. The staff of Mondul Kiri will be evaluated as compared to their counterpart of the headquarters, so that it was advised that they should do more capacity building.

4) With the transfer to EdC, Keo Seyma has become under Electricite de Mondul Kiri, so that they take over the tasks of accounting and billing, which has made the staff in charge of those tasks busier. It is considered to be necessary to make such arrangements not to concentrate works on certain staff members by making other staff members acquire accounting knowledge.

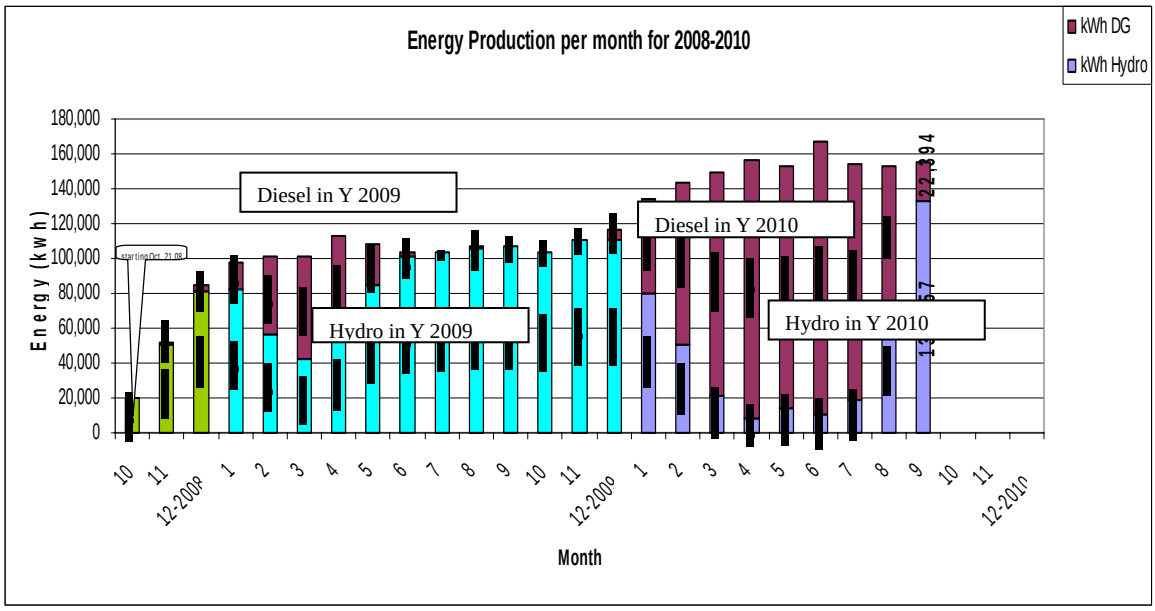
2.6 Activities in Cambodia (Management: September 19 through October 8, 2010)

2.6.1 Outline

In having the evaluation mission for the project at site, the following points were confirmed beside the usual technical guidance in order to show them concrete figures related with the operation situation of EUMP.

2.6.2 Supportive evidence for unusual drought（reason for decrease in generation by hydropower and increase in generation by diesel power）

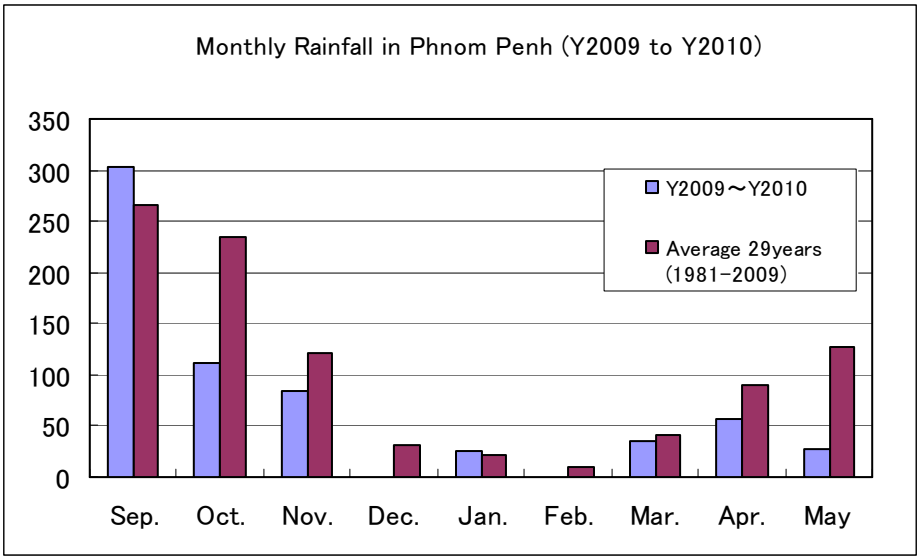
River discharge did not increase even in April and May this year and the dry season continued to July, so that hydropower operation decreased drastically as shown in the graph below against expectations.



Collection of data was made to verify if that climatic conditions were peculiar to Mondul Kiri or prevailed in middle reaches of Mekong river.

1) Trend of monthly rainfall at Phnom Penh

Data of monthly rainfall from 1981 to the present of Phnom Penh meteorological station were gathered. The figure below shows monthly rainfall for the period of rainy season to dry season to rainy season.



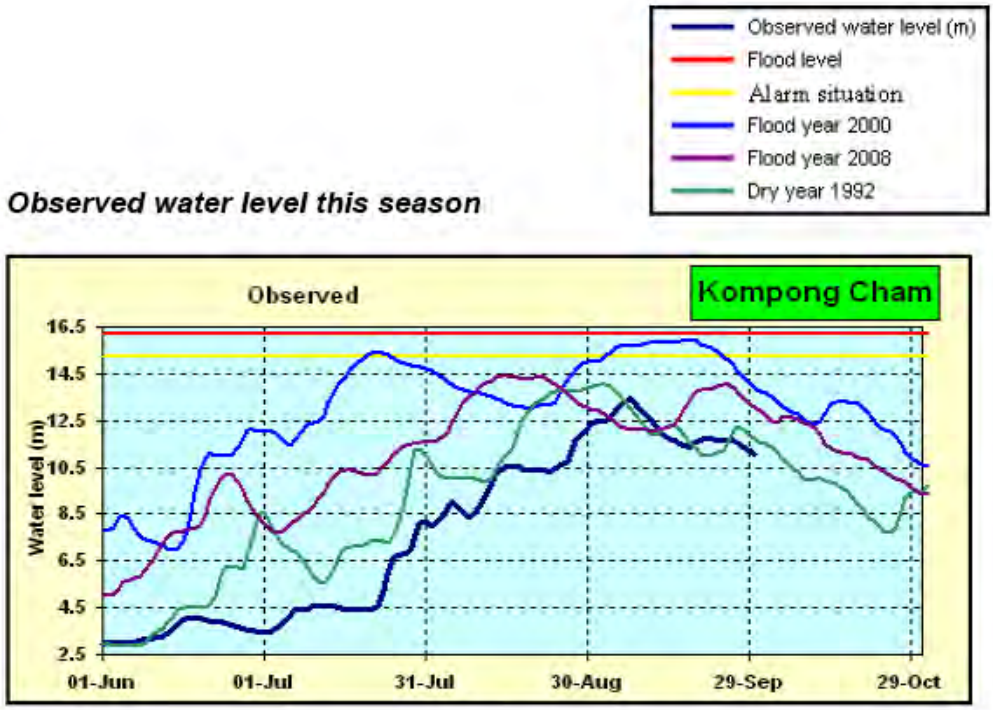
In usual years, rainfall gradually decreases from September, peak month of the rainy season, to reach the bottom in January or February of the next year and to increase little by little from March, which is the usual pattern of rainfall. Contrary to that pattern, from 2009 to 2010 (shown in light-blue line), rainfall drastically decreased from October to almost none from December through February. Usual years see rainfall from April but no rainfall until May this year.

That graph illustrates a delay of commencement of the rainy season this year.

2) Trend of water level of Mekong river

The graph below shows the water level at Kampong Cham during the rainy season (source: webpage of Mekong River Committee)

Usual years have such a trend that the water level rises from around June to reach the peak in August. This year (shown in blue line), however, the water level was slightly less than 3 meters as of June 1, similar level to 1992, a drought year. It was 6 meters in July 1, 1992, while it was as low as 3.5 meters this year. Those records prove that this year was the severest drought in the past 20 years in basin areas of Mekong river.



From the above, it was confirmed that the drought conditions during the dry season from last year to this year were not peculiar to Mondul Kiri but a meteorological phenomenon prevailing in middle and lower reaches of Mekong river.

2.6.3 Situation of Revenues and Expenses and rate of Tariff Collection

With the transfer to EdC, their billing system and accounting processes were adopted. Presented here was the result of calculation of revenues and expenses and the collection rate in the previous way.

Basic assumptions:

- Depreciation costs are counted out because of the donated power facilities.
- Connection fee and security deposit paid by customers at the time of contract are counted out.
- The rate of tariff collection was the ratio of the amounts received to those billed from January through June 2010, with nonpayment or delayed payment as of the due date of June treated as arrears.

The table below shows the past records and the projection from September.

Annual Operation Recor 2010

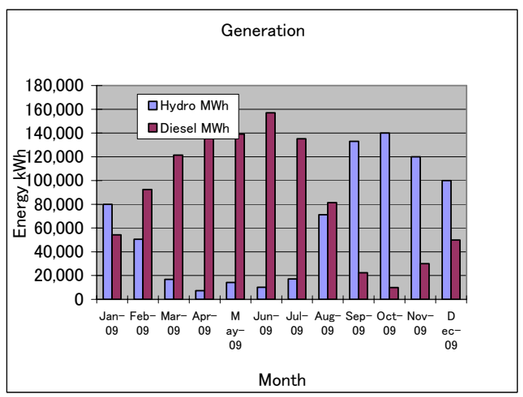
Tariff 1,580 Riel/kWh
Profit 0.8%

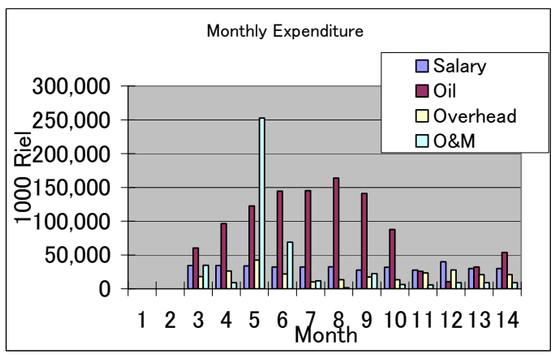
4,150 Riel/US$
3,480 Riel/Litter
0.31 Litter/kWh
70%

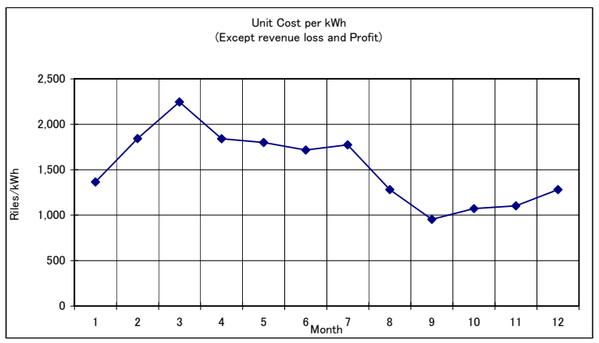
0.839 US$/Litter

Contingency 10%

	Date	Generation Hydro MWh	Diesel MWh	Total MWh	Oil Spend Litter	Consumption E MWh	Loss 1	Tariff Riel/kWh	Invoice M Riels	%	Revenue Total M Riels	Salary M Riels	Oil M Riels	Overhead M Riels	O&M M Riels	Contingency M Riels	Sub-total M Riels	Provision (Deposit for Future) Hydro M Riels	O&M M Riels	Total M Riels	Cost Total M Riels	kWh/Cost (Invoice) Riels	Profit M Riels	%	Note Appropriated Sources	Item of Expenditure
	2009	1,078,201	210,675	1,288,876	65,848	1,048,552	19%	1633	1,711,984	3.00%	1,661,647	323,833	165,158	314,925	116,341		920,257	100,283	405,000	505,272	1,425,530	1,360	236,118	14%		
1	20-Jan	80,034	54,310	134,344	17,379	112,095	17%	1570	175,980	2.81%	171,037	34,341	60,480	18,106	34,822	−25,822	121,927	8,634	22,500	31,134	153,061	1,365	17,976	11%	Carry over profit from previous year	Moving Pole due to Road construction
2	20-Feb	50,569	92,427	142,996	27,728	105,456	26%	1569	165,416	−0.44%	166,136	34,459	96,494	26,319	9,077	0	166,348	5,455	22,500	27,955	194,303	1,843	−28,167	−18%		
3	20-Mar	16,822	121,319	138,141	35,183	118,276	14%	1568	185,458	1.84%	182,047	33,811	122,435	42,453	252,786	−210,296	241,190	1,815	22,500	24,315	265,504	2,245	−83,458	−47%	Carry over profit from previous year	Moving Pole due to Road construction
4	20-Apr	7,238	148,293	155,531	41,522	125,417	19%	1570	196,854	4.44%	188,106	32,150	144,497	21,865	68,799	−59,799	207,511	781	22,500	23,281	230,792	1,840	−42,686	−23%	Draught provision	Warehouse and parking house
5	20-May	14,153	139,035	153,188	41,711	123,807	19%	1568	194,079	1.61%	190,949	32,150	145,153	9,994	11,626	0	198,922	1,527	22,500	24,027	222,949	1,801	−31,999	−17%		
6	20-Jun	10,126	156,904	167,030	47,071	136,939	18%	1569	214,874	4.89%	204,371	32,616	163,808	13,318	1,655	0	211,396	1,092	22,500	23,592	234,989	1,716	−30,618	−15%		
7	20-Jul	17,057	135,136	152,193	40,541	123,665	19%	1569	194,030	2.65%	188,889	27,581	141,082	17,442	22,395	−13,395	195,105	1,840	22,500	24,340	219,445	1,775	−30,556	−16%	Draught provision	Office equipments
8	20-Aug	71,277	81,332	152,609	25,213	132,277	13%	1569	207,543	2.65%	202,043	32,118	87,741	13,332	6,222		139,413	7,689	22,500	30,189	169,602	1,282	32,441	16%		
9	20-Sep	132,957	22,394	155,351	7,480	125,834	19%	1580	198,818	2.65%	193,550	27,739	26,029	23,639	5,735	0	83,143	14,343	22,500	36,843	119,986	954	73,563	38%		
10	20-Oct	140,000	10,000	150,000	3,100	121,500	19%	1580	191,970	2.65%	186,883	40,000	10,788	28,000	9,000	4,779	92,567	15,103	22,500	37,603	130,170	1,071	56,713	30%		
11	20-Nov	120,000	30,000	150,000	9,300	121,500	19%	1580	191,970	2.65%	186,883	30,000	32,364	21,000	9,000	6,236	98,600	12,946	22,500	35,446	134,046	1,103	52,837	28%		
12	20-Dec	100,000	50,000	150,000	15,500	121,500	19%	1580	191,970	2.65%	186,883	30,000	53,940	21,000	9,000	8,394	122,334	10,788	22,500	33,288	155,622	1,281	31,261	17%		
	"Y2010	760,233	1,041,150	1,801,383	311,727	1,468,266	18%		2,308,961		2,247,775	386,965	1,084,809	256,467	440,116	−289,903	1,878,455	82,014	270,000	352,014	2,230,469	1,519	17,306	0.8%		
	Adjustment																	−73,194					−236,118		Appropriated from previous year	
	Y2009+'10										3,909,422						2,798,712	109,103	675,000	857,286	3,655,999	2,879	17,306		Accumulating total	
									1,132,660	2.65%	1,102,645															







1) Rate of tariff collection

The ratio of the revenues from tariff collection as of the due date of June to the billed amounts from January to June 20 was 97.35%. The collection rate is to be determined by a long-term accumulated amounts because there occurs not only nonpayment but also delayed payment in the actual tariff payment. This calculation here excludes delayed payments that occur as of the final month of the calculation. EUMP estimated the collection rate at 99%.

2) Profit rate

As mentioned before, the severest drought in the past 20 years, combined with the demand increase, caused an unexpected increase in power generation by the diesel power plant. That situation put the monthly balance in red from February through July because of fuel costs piling up.

The months of January, March, April and July recorded larger amounts of O&M costs than usual. That happened because of investments made on the warehouse, the garage and the office facilities. Those costs were recognized to be appropriated from last year's profit and part of drought reserves.

From the above, it is expected to strike a balance in the bottom line, so that reserves for overhaul will be accumulated without being used.

2.6.4 Ratio of electrification

The ratio of electrification, one of the parameters targeted by the project, was not determined in the 1st JCC meeting. The table below shows the inferred ratio of electrification with reference to the assumed ones at the time of the Basic Design.

	Plan of Basic Design			Record			
	Total household	**Electrified**	**Electrification Rate (%)**	**Total household**	**Electrified**	**Electrification Rate (%)**	**Note**
Before Project	1,264	448	35%	Same as left value			Dec. 2004
Ditto				1,560	465	30%	Sep. 2008
After 1 year electrification	1,327	928	70%	1,645	1,180	72%	Nov. 2009
After 2 years	1,383	996	72%	1,710	1,275	75%	Aug. 2010
After 3 years	1,410	1,043	74%				

Note: Total household in the column of Record is estimated based on 5.5% per year as an existing increasing rate.

2.6.5 Self-evaluation of the Administrative Staff

JICA team instructed 9 members of the administration section of EUMP to fill in their advancement as of September in their self-evaluation sheets prepared in June. The comments of JICA team will be conveyed later through the local coordinator because of the limited time at the site.

2.6.6 Cooperation for JICA's Evaluation Mission

JICA project team provided cooperation to the evaluation mission as needed from September 21 through October 4.

2.6.7 4th JCC Meeting

The 4th JCC meeting was held at MIME on October 4, 2010.

Besides the ordinary meeting of JCC, the evaluation results by the evaluation mission were reported and the minutes were signed between JICA, MIME and EDC.

(1) Progress report

The progress of the activities was reported by JICA team as follows.

1) Operation

Since the start of power supply in November 2008, 1 year and 10 months have passed, leaving about half a year for the project. The start was from a group of absolute laymen but they have been dedicating themselves to supply electricity tirelessly to residents of Sen Monorom for 24 hours with support by the advisory team of JICA.

2) Management

This year saw a decrease in power production by hydropower due to unusual drought. Meanwhile, the power production by diesel more than tripled as compared with last year to cover the decrease of hydropower and the increased power demand. Nevertheless, the management went well without running out of money. This was because of the accumulated drought reserves counted into the power tariff in case of such an unexpected situation.

3) Working situation of EUMP's staff

In the 3rd JCC meeting held in February, it was announced that EUMP would be transferred to EdC. The transfer was officially made in June 8 to newly start Electricite de Mondul Kiri, a branch of EdC. Although at the time of the transfer, some of C/P dispatched by DIME left EUMP, most of the staff remained in EUMP to become staff of EdC, continuing to work today.

4) Transfer to EdC

One of the largest advantages is that such a system has been consolidated as to meet increasing power demand, which JICA team welcome. It was learned that power import from Vietnam was

targeted for July next year, for which EdC was currently making preparations. JICA team, especially Mr. Hiraga, now at the site, and Mr. Shinohara, distribution expert, was providing assistance for that regarding the relevant technical matters to engineers at the site and at the headquarters in order for the hydropower plants and other donated power facilities to be operated smoothly after the connection.

(2) Partial modification to the activities

The following 2 points are to be modified on account of the transfer to EdC.

1) Mid- and long- term plan

The first version was prepared by JICA advisory team with a view to guiding how to prepare. The previous JCC meeting confirmed that that plan would be prepared by C/P with some guidance by JICA team. The transfer to EdC made the management part, particularly the mid- and long-term plan of Mondul Kiri proper, useless to prepare.

The reason for the above was that the plan so far prepared was based on the precondition that EUMP was an autonomous managing body. But now EUMP has become part of EdC, so that Electricite de Mondul Kiri has been incorporated into management plan of the headquarters of EdC. JICA team considers such a treatment to be the best.

JICA team thinks that EdC does not have know-how about cost calculation by kWh of hydropower, a basis for tariff setting. JICA team will present a trial calculation for future tariff, attached to the Final Report.

Regarding the technical parts such as civil, generation and distribution, the purpose of the mid- and long-term plan is to establish maintenance and repair plans for stable use of the power facilities without troubles. There are a lot of parts which cannot be found except at the site as well as operating conditions of the machinery and equipment.

A plan of inspection and replacement of parts will be indispensable regardless of the transfer to EdC. So, it must be prepared by C/P as in the past. JICA team will provide advice as needed.

2) O&M Manual

Regarding administration part, as the mid- and long-term plan mentioned above, the unified system and regulations have already been established, so that the manual in that part will cease to serve considering that administrative works are going almost well despite some confusions.

As for technical parts, C/P themselves are to make modifications to necessary parts after the first version.

The list of attendants and the handouts are attached as Appendix.

2.7 8th Field Activities (Management: December 4 through December 18)

2.7.1 Outline of the Activities Performed

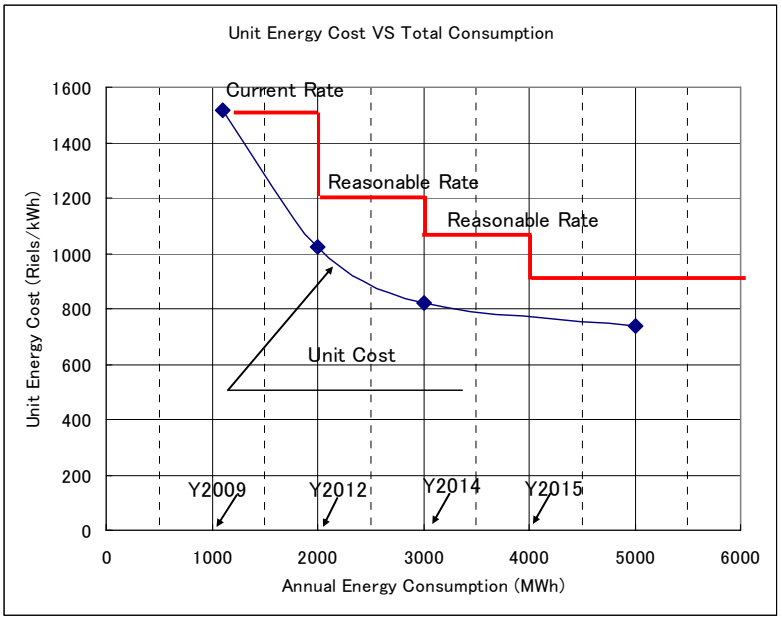
JICA team demonstrated to EdC a prospect of power tariff based on the most appropriate combined operation of the hydropower and the diesel power after the connection with Vietnam. The same was explained to EAC, approving body of power tariff, who confirmed it as reasonable.

2.7.2 Operation Mode of the Small Hydropower Plants after Connecting with Vietnam

The most distinct feature of hydropower is that the total cost remains almost constant regardless of how much power is generated. In the case of the small hydropower of Mondul Kiri, of which the power facilities were donated by Japan, the main operation costs are personnel costs and repairs. The more the available water flow, the unit generation cost per kWh will become the less. Contrary to that, the combined generation costs of the diesel power and the power import from Vietnam will increase proportionately to power demand because of increased fuel costs and increased power import with the agreed power price.

In the case of Mondul Kiri, the demand in daytime and midnight of the rainy season will become less than the generation capacity, so that the water will be released without being turbined. In the future, however, such unturbined water will also be utilized for power generation as the demand will increase, bringing an increase in revenue without incremental costs.

In summary, the most economical operation is that hydropower should be given priority in meeting the power demand. JICA team explained it not only to EUMP's staff but also to EdC and EAC.



Case 2012 Assumed Tariff Rate after connection with Viet Nam (Simplified and Approximate calculation)

: Input data

Item	Unit	Basic Model : Isolated net work using D/G Energy Demand Level : Year 2009		Future Condition : Connected with Vietnam Energy Demand Level : **2,000MWh**	
Ⅰ.O&M Cost (Depreciation of construction is not included)					
1. Total (Annual)					
a Ration supply energy		100%		100%	
b Energy sold	MWh/year	1,200	year 2009 level	2,000	Assumed maximum peak demand is 1000kW
c Salary and overhead cost	US$/year	175,000	nearly actual record	220,000	plus additional T/D cost
d Fuel Cost for D/G	US$/year	96,000	(p*m): coefficient 0.35 kWh/litter	32,000	emergency use only
d' Provision for Overhaul of Grant facility	US$/year	120,000	Instead of depreciation cost of Grant facility	120,000	Instead of depreciation cost of Grant facility
e Import energy cost	US$/year		N.A	76,456	(x*s): from Vietnam to Mondul kiri
f Sub-total	US$/year	391,000	(c+d+e): excluding depreciation cost	448,456	(c+d+e): excluding depreciation cost
2. Hydropower					
h Ration supply energy	%	75%	Conservative side	60%	
i Energy by hydropower	MWh/year	900	(b*h): About 60% of Energy is no used caused by energy demand pattern, Surplus energy	1,200	Base supply operation: surplus energy become to be used. Potential energy may be about 2,000 MWh/ year
j Salary and overhead	US$/year	131,250	(c*h): Cost allocation in line with amount of each energy source	132,000	(c*h): Cost allocation in line with amount of each energy source
k Generation Cost of Hydropower	US$/kWh	**0.15**	(j/i): ⟶	**0.11**	(j/i) :
3. D/G					
l Ration supply energy	%	25%	(a-h):	5%	Use to be stable HZ and Voltage at Peak time
m Energy by D/G	MWh/year	300	(b-i): Auxiliary power source	100	(b*l): Auxiliary power source
n Salary and overhead	US$/year	43,750	(c*l): Cost allocation in line with amount of each energy source	11,000	(c*l): Cost allocation in line with amount of each energy source
o Generation Cost excluding Fuel cost	US$/year	0.15	(n/m): nearly same value of hydropower	0.11	(n/m): nearly same value of hydropower
p Fuel Cost	US$/kWh	0.32	1US$ per litter	0.32	1US$ per litter
q Generation Cost of D/G	US$/kWh	0.47	(o+p):	0.43	(o+p):
4. Import Energy from Viet Num					
r Ration supply energy			N.A.	35%	
s Energy imported from Viet Num	MWh/year		N.A.	805	(b-i): Auxiliary power source
t Salary and overhead	US$/year		N.A.	88,000	(c*r): Cost allocation in line with amount of each energy source
u O&M cost for T/D	US$/kWh		N.A.	0.11	(t/s): O&M cost for additional T/D
Construction Cost of T/D	US$			650,000.00	
Annual Depreciation Cost	US$/year			32,500.00	20 Year
Depreciation Cost per kWh	US$/kWh			0.006	
v Electric price at the border	US$/kWh	0.069	FOB price from Vietnam in 2008 base	0.069	FOB price from Vietnam in 2008 base
v2 Import tax and VAT		0.012	7% of import, 10% of VAT	0.012	7% of import, 10% of VAT
w Transmission loss	%		N.A.	15%	Loss ratio: shall be analyzed in detail
x Electric Cost including T/D loss	US$/kWh		N.A.	0.095	(v2*1/(1-w)):
y Energy Cost of imported at demand point	US$/kWh		N.A.	0.21	(u+x):
5. Combined Energy Generation Unit Cost					
g Energy Generation Cost	US$/kWh	0.33	(f/b): including **Provision(d')**	0.22	(f/b): including **Provision(d')**
Ⅱ. Revenue					
z Income (considering commercial loss and including provision and profit)	US$/kWh	0.37	3% revenue loss and 10% of profit	0.25	3% revenue loss and 10% of profit
	Riel/kWh	**1,510**		**1,039**	

Remind !

1. Unit Cost of Energy is **not Constant**. It's depend on amount of energy sold.
2. This sheet shows that **unit cost of hydropower will decrees after connection with Vietnam**

Table-7 Case 2014 Assumed Tariff Rate after connection with Viet Nam (Simplified and Approximate calculation)

Item	Unit	Basic Model : Isolated net work using D/G Energy Demand Level : Year 2009		Future Condition : Connected with Vietnam Energy Demand Level : 3,000MWh	
Ⅰ.O&M Cost (Depreciation of construction is not included)					
1. Total (Annual)					
a Ration supply energy		100%		100%	
b Energy sold	MWh/year	1,200	year 2009 level	3,000	Assumed maximum peak demand is 1000kW
c Salary and overhead cost	US$/year	175,000	nearly actual record	220,000	plus additional T/D cost
d Fuel Cost for D/G	US$/year	96,000	(p*m): coefficient 0.35 kWh/litter	48,000	emergency use only
d' Provision for Overhaul of Grant facility	US$/year	120,000	Instead of depreciation cost of Grant facility	120,000	Instead of depreciation cost of Grant facility
e Import energy cost	US$/year		N.A	147,451	(x*s): from Vietnam to Mondul kiri
f Sub-total	US$/year	391,000	(c+d+e): excluding depreciation cost	535,451	(c+d+e): excluding depreciation cost
2. Hydropower					
h Ration supply energy	%	75%	Conservative side	50%	
i Energy by hydropower	MWh/year	900	(b*h): About 60% of Energy is no used caused by energy demand pattern, Surplus energy	1,500	Base supply operation: surplus energy become to be used. Potential energy may be about 2,000 MWh/ year
j Salary and overhead	US$/year	131,250	(c*h): Cost allocation in line with amount of each energy source	110,000	(c*h): Cost allocation in line with amount of each energy source
k Generation Cost of Hydropower	US$/kWh	**0.15**	(j/i): →	**0.07**	(j/i) :
3. D/G					
l Ration supply energy	%	25%	(a−h):	5%	Use to be stable HZ and Voltage at Peak time
m Energy by D/G	MWh/year	300	(b−i): Auxiliary power source	150	(b*l): Auxiliary power source
n Salary and overhead	US$/year	43,750	(c*l): Cost allocation in line with amount of each energy source	11,000	(c*l): Cost allocation in line with amount of each energy source
o Generation Cost excluding Fuel cost	US$/year	0.15	(n/m): nearly same value of hydropower	0.07	(n/m): nearly same value of hydropower
p Fuel Cost	US$/kWh	0.32	1US$ per litter	0.32	1US$ per litter
q Generation Cost of D/G	US$/kWh	0.47	(o+p):	0.39	(o+p):
4. Import Energy from Viet Num					
r Ration supply energy			N.A.	45%	
s Energy imported from Viet Num	MWh/year		N.A.	1,553	(b−i): Auxiliary power source
t Salary and overhead	US$/year		N.A.	110,000	(c*r): Cost allocation in line with amount of each energy source
u O&M cost for T/D	US$/kWh		N.A.	0.07	(t/s): O&M cost for additional T/D
Construction Cost of T/D	US$			650,000.00	
Annual Depreciation Cost	US$/year			32,500.00	20 Year
Depreciation Cost per kWh	US$/kWh			0.005	
v Electric price at the border	US$/kWh	0.069	FOB price from Vietnam in 2008 base	0.069	FOB price from Vietnam in 2008 base
v2 Import tax and VAT		0.012	7% of import, 10% of VAT	0.012	7% of import, 10% of VAT
w Transmission loss	%		N.A.	15%	Loss ratio: shall be analyzed in detail
x Electric Cost including T/D loss	US$/kWh		N.A.	0.095	(v2*1/(1−w)):
y Energy Cost of imported at demand point	US$/kWh		N.A.	0.17	(u+x):
5. Combined Energy Generation Unit Cost					
g Energy Generation Cost	US$/kWh	0.33	(f/b): including **Provision(d')**	0.18	(f/b): including **Provision(d')**
Ⅱ. Revenue					
z Income (considering commercial loss and including provision and profit)	US$/kWh	0.37	3% revenue loss and 10% of profit	0.20	3% revenue loss and 10% of profit
	Riel/kWh	**1,510**		**827**	

Case 2016 Assumed Tariff Rate after connection with Viet Nam (Simplified and Approximate calculation)

Item	Unit	Basic Model : Isolated net work using D/G Energy Demand Level : Year 2009		Future Condition : Connected with Vietnam Energy Demand Level : **5,000MWh**	
Ⅰ.O&M Cost (Depreciation of construction is not included)					
1. Total (Annual)					
a Ration supply energy		100%		100%	
b Energy sold	MWh/year	1,200	year 2009 level	5,000	Assumed maximum peak demand is 1000kW
c Salary and overhead cost	US$/year	175,000	nearly actual record	220,000	plus additional T/D cost
d Fuel Cost for D/G	US$/year	96,000	(p*m): coefficient 0.35 kWh/litter	80,000	emergency use only
d' Provision for Overhaul of Grant facility	US$/year	120,000	Instead of depreciation cost of Grant facility	120,000	Instead of depreciation cost of Grant facility
e Import energy cost	US$/year		N.A	354,975	(x*s): from Vietnam to Mondul kiri
f Sub-total	US$/year	391,000	(c+d+e): excluding depreciation cost	774,975	(c+d+e): excluding depreciation cost
2. Hydropower					
h Ration supply energy	%	75%	Conservative side	30%	
i Energy by hydropower	MWh/year	900	(b*h): About 60% of Energy is no used caused by energy demand pattern, Surplus energy	1,500	Base supply operation: surplus energy become to be used. Potential energy may be about 2,000 MWh/ year
j Salary and overhead	US$/year	131,250	(c*h): Cost allocation in line with amount of each energy source	66,000	(c*h): Cost allocation in line with amount of each energy source
k Generation Cost of Hydropower	US$/kWh	**0.15**	(j/i): ⟶	**0.04**	(j/i) :
3. D/G					
l Ration supply energy	%	25%	(a−h):	5%	Use to be stable HZ and Voltage at Peak time
m Energy by D/G	MWh/year	300	(b−i): Auxiliary power source	250	(b*l): Auxiliary power source
n Salary and overhead	US$/year	43,750	(c*l): Cost allocation in line with amount of each energy source	11,000	(c*l): Cost allocation in line with amount of each energy source
o Generation Cost excluding Fuel cost	US$/year	0.15	(n/m): nearly same value of hydropower	0.04	(n/m): nearly same value of hydropower
p Fuel Cost	US$/kWh	0.32	1US$ per litter	0.32	1US$ per litter
q Generation Cost of D/G	US$/kWh	0.47	(o+p):	0.36	(o+p):
4. Import Energy from Viet Num					
r Ration supply energy			N.A.	65%	
s Energy imported from Viet Num	MWh/year		N.A.	3,738	(b−i): Auxiliary power source
t Salary and overhead	US$/year		N.A.	154,000	(c*r): Cost allocation in line with amount of each energy source
u O&M cost for T/D	US$/kWh		N.A.	0.04	(t/s): O&M cost for additional T/D
Construction Cost of T/D	US$			650,000.00	
Annual Depreciation Cost	US$/year			32,500.00	20 Year
Depreciation Cost per kWh	US$/kWh			0.004	
v Electric price at the border	US$/kWh	0.069	FOB price from Vietnam in 2008 base	0.069	FOB price from Vietnam in 2008 base
v2 Import tax and VAT		0.012	7% of import, 10% of VAT	0.012	7% of import, 10% of VAT
w Transmission loss	%		N.A.	15%	Loss ratio: shall be analyzed in detail
x Electric Cost including T/D loss	US$/kWh		N.A.	0.095	(v2*1/(1−w)):
y Energy Cost of imported at demand point	US$/kWh		N.A.	0.14	(u+x):
5. Combined Energy Generation Unit Cost					
g Energy Generation Cost	US$/kWh	0.33	(f/b): including **Provision(d')**	0.15	(f/b): including **Provision(d')**
Ⅱ. Revenue					
z Income (considering commercial loss and including provision and profit)	US$/kWh	0.37	3% revenue loss and 10% of profit	0.18	3% revenue loss and 10% of profit
	Riel/kWh	**1,510**		**718**	

Remind !

1. Unit Cost of Energy is **not Constant**. It's depend on amount of energy sold.
2. This sheet shows that **unit cost of hydropower will decrees after connection with Vietnam**

2.8 9th Activities in Cambodia (Administration 17 February through 26 February 2011)

2.8.1 Outline

This evaluation was a final one, so that an overall evaluation was made on the administrative ability of Electricite de Mondul Kiri (former EUMP) based on hearings from key members of the administrative staff.

2.8.2 Result of Hearings from Key Staff Members

i) Mr. Im Vichet: General affairs and procurement

He is in charge of general affairs and also plays a role of assistant to the Chief of Mondul Kiri, although he is still young. JICA team evaluates him as having much advanced, considering that he prepared the material for the presentation made by the Chief at the JCC meeting. However, he lacks accounting knowledge so that JICA team considers him not to having reached the expected level in the tasks of procurement and inventory control closely related with accounting.

By becoming more familiar with accounting and relevant regulations of EdC, he will be able to deal with the above tasks with more confidence, so it is advisable for him to learn those matters.

ii) Ms. Chres Malout: Chief accountant (accounting/cash and deposit control)

Less than half a year having passed since the previous evaluation, she has not made good progress. Her attitude towards her tasks has been sincere and responsible without change and in this respect JICA team highly evaluates her. Although she is in such a position as to supervise her subordinate in charge of accounting, lacking a positive attitude and accounting knowledge, she has not yet played such a role, as pointed in the previous evaluation.

Therefore, it is advisable for her to positively learn more accounting knowledge and to take part in the accounting works which are performed by the accountant mentioned below.

iii) Ms. Ty Soyatra: accounting

The evaluation result is the same as the previous one. That is, she is confident in her tasks and has been performing her tasks without problems even after merging into EdC. It is expected that she will continue to play a central role in accounting for Electricite de Mondul Kiri. Moreover, most of the data used in the presentation by the Chief of Mondul Kiri were prepared by her, who collaborated with the key staff member in charge of general affairs in preparing the presentation material.

iv) Mr. Kong Botrachhany: billing

Being well familiar with preparation of electricity bills of EdC, he has been performing the billing task without problems. The joint collaboration with the section of transmission/distribution has brought a very good result as more than 90% of bill collection rate.

He is expected to continue playing a central role in this task. Nevertheless, it is advisable that he should not be content with the present situation and that he should be able to grow more by learning knowledge of accounting and other tasks than his own.

2.8.3 Overall Evaluation

JICA team evaluates that in Electricite de Mondul Kiri the administrative ability has attained the necessary level to fulfill the required tasks. However, Electricite de Mondul Kiri is a very small organization and has a limited number of administration staff. There is some concern over whether they can continue to smoothly perform the required tasks if some of the said key staff members become absent or leaves the company. So, JICA team considers it to be desirable that EdC should provide opportune guidance in administrative works and accounting training and make periodical internal transfer of administrative staff to make each member of the administrative staff experience different tasks and give other considerations with a view to raise the ability level of all the administrative staff.

Furthermore, in personnel evaluation, it is advisable not to make a simple comparison with the counterpart in the headquarters but to have a long-tem view of evaluation and treatment, considering that their startup was made in such a remote place as Mondul Kiri and that they have been brought up in a small power utility established there.

2.9 9th Field Activities (Management: February 15 through February 27, 2011)

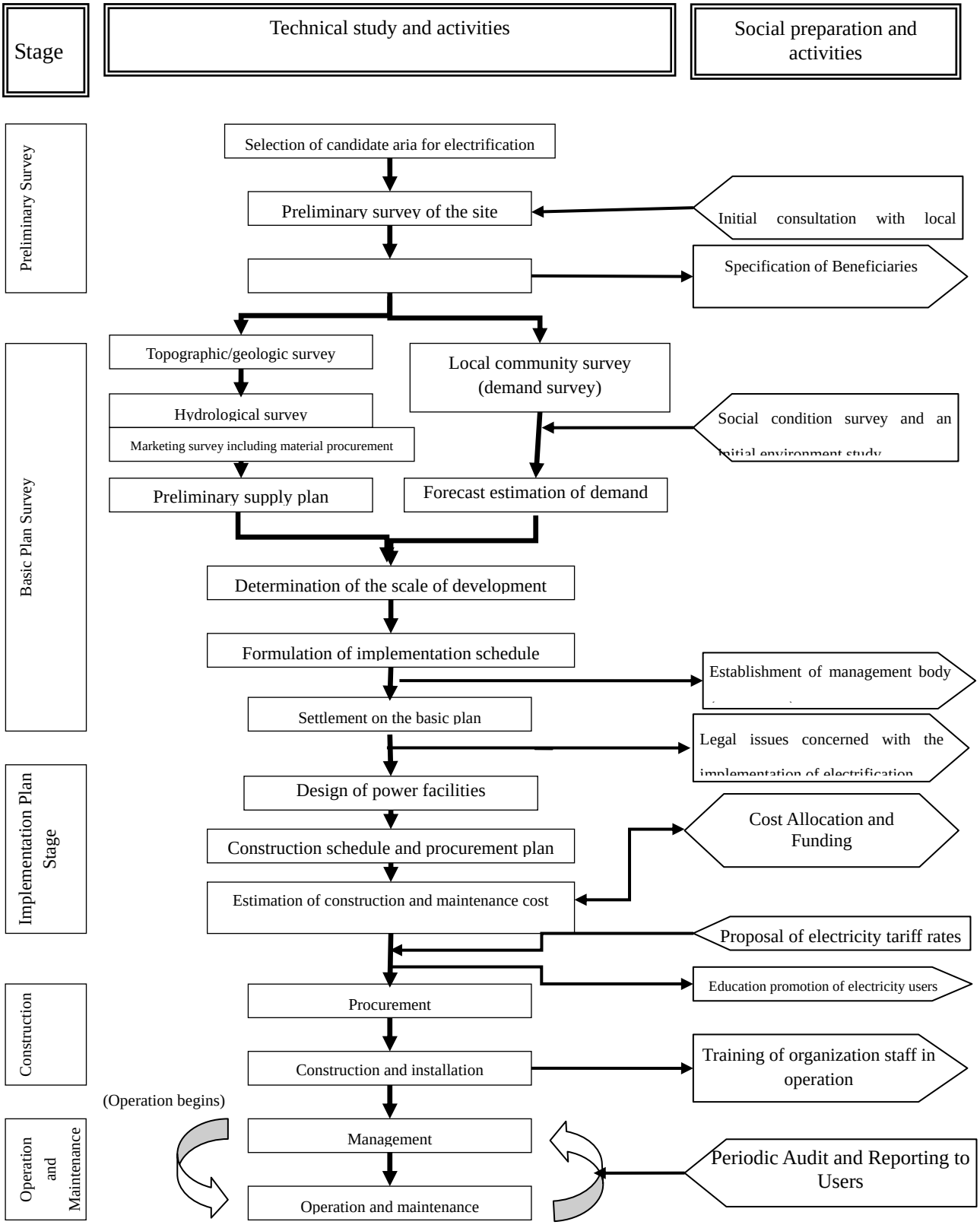
2.9.1 Outline of the Activities Performed

This time was the final field activities of the project. A revised O&M Manual and a revised mid- and long-term plan were prepared and explained and approved in the 5th JCC meeting. A seminar was held on small hydropower in JICA office prior to the JCC meeting, considering that such knowledge will be useful to the staff of EdC headquarters as well.

2.9.2 Seminar on Small Hydropower

On February 22, 2011 at a conference room of JICA Cambodia office, a seminar was held on small hydropower for technical staff of EdC's headquarters. Technical matters were lectured by Mr. Hiraga, who is in charge of power generation. Taking that opportunity, the expert in charge of management

lectured a workflow for small hydropower development as shown in the figure below with reference to Mondul Kiri small hydropower.



Standard Process of The Rural Electrification Project by Small-Scale Hydropower

2.9.3 5th JCC Meeting

The 5th JCC meeting was held in MIME Phnom Penh on February 23 from 10：00 to 12：00.

The meeting was attended by MIME, EAC, EDC, JICA Cambodia, EUMP and JICA project team,totaling 38 people.

(1) Report from EUMP

Mr.Chin Sokun, chief of Electricite de Mondul Kiri, reported its business performance of 2010.

Organization

- EUMP was transferred to EdC in June 8, 2010 with a new name of Electricite de Mondul Kiri of EdC. At the time of the transfer, Keo Seyma, receiving power from Vietnam and so far under the jurisdiction of DIME,was incorporated into Electricite de Mondul Kiri. The actual number of the staff is 39 including that of Keo Seyma.

Power facilities

- In addition to the power facilities donated by Japan, a warehouse and a parking lot were built with the funds from EUMP's profit.

Power demand and supply

- The number of customers was increasing to reach over 1,300 as of 2010.
- The power production was also increasing by 22% in 2010 with respect to 2009. However, the unusual drought made the share of power production of the diesel power larger in 2010.
- The daily maximum demand exceeded 400kW on consecutive days, forcing the diesel power plant to operate continuously.

Maintenance

- The power loss steadily decreased as compared with the 1st period. The acutual rate of loss is between 10% and 12%.
- Observations continued to be conducted of the water discharge and water level, basic factors for hydropower,
- Records were surely taken of trouble shootings for use of future improvements.

Share of the customers

- Out of some 1,300 customers, the number of the customers using 50kWh or less monthly account for half of the total, translated into the power consumed at only 15%. In the meantime, the number of the customers using 200kWh or more monthly account for 9%, translated into the power consumed at 55%. Financially, more than half of the revenue comes from the customers consuming more electricity.
- The collection rate of power tariff continues to be 97%.
- As of 2009, the profit was 14%, while 2010 saw an unusual drought, bringing a profit of 5%

by using part of the reserves.

In summary, EUMP continued sound management as reported by EUMP.

(2) Report from JICA team

1) Explanation of the mid- and long-term plan

Explanation was made of the mid- and long-term plan for operation and maintenance of the power facilities of Mondul Kiri. JICA team conveyed the necessity that such plan should be revised yearly by EdC for budgeting purposes.

2) Explanation of a prospect of power tariff after connecting with Vietnam

The trial calculation of power tariff made in the previous 8th field activities was explained. The managing director of EdC gave such a comment that the result of such trial calculation should not be disclosed publicly. In response to that, JICA team argued that that calculation was only a trial one and that power tariff should be set on a cost recovery basis.

(3) Comments from JCC members

1) MIME secretary（Dr.Ith Praing）

- This project was a successful one and the operation and maintenance has been well conducted.
- Overall, the project has been contributing to Cambodia, EdC as well as Sen Monorom residents
- EdC/EUMP will continue to make the most of the donated power facilities, adequately conducting maintenance works.
- It was requested that supply of spare parts for O&M and technical support be provided.
- It was hoped to develop new sites for small hydropower in Mondul Kiri and North-west areas (Latanakiri)

2) Comments fromJICA

- JICA considers that EUMP has much grown through this project for the past 24 months.
- As pointed out in the previous JCC meeting, this project fully attained the project goal.
- JICA appreciates the efforts of EdC/EUMP to take care of the donated power facilities and to supply power for 24 hours daily, expecting further efforts for improvement.
- JICA realizes that a lot of citizens were satisfied as investigated by JICA terminal evaluation mission.
- JICA wishes that the voices from local people be responded regarding power tariff.
- JICA hopes that the donated power facilities be appropriately operated with a connected line with Vietnam, the first experience in hydropower.

- JICA would like to appeal this successful project to the world, thanking to all people involved for their support.

With the above, the field activities of the project was finalized and JCC was dissolved.

The list of participants and the handouts are shown in Appendix.

2.10 Others

JICA Terminal Evaluation Mission has recommended 4 items as a **"5-2 Activities to be taken by the completion of this project"** in their report

The JICA project team and EUMP were recommended to take activities of the above mentioned 4 items during 6 months as follows.

(1) Further up-grading of know-how, technologies and skills

（Issues）

There are a lot of things which EUMP hasn't experienced yet to become "self-reliant" as an electric power supplier in actual term. Considering this point, additional technologies and skills should be transferred to EUMP staff.

In addition, existing know-how, technologies and skills should be further shared and upgraded for EUMP to select and apply most suitable one, i.e. know-how, technologies and skills, into each actual situation on its own.

（Action plan）

JICA project team will teach EUMP to improve electrical literacy such as sequence diagram and block diagram as well as drawings and operation and maintenance manual.

Simulation training for an emergency accident in hydropower station may be considered.

（Target period and activities performed）

1) EUMP provided such an action plan as a "study of electrical theory and sequence numbers and symbols" and performed it by December 2010.

JICA project team held a seminar as follows:

(1) JICA Senior Volunteer (JSV): Lecture on electrical theory
(2) JICA project team:Understanding of sequence and block diagram, etc.
(3) Participants : EUMP 15 staff members, JICA project team 2, JSV 1, totaling 18
(4) Place: Mondul Kiri project site

2) JICA project team provided accident prevention plans for Mondul Kiri and EDC, instead of simulation training of emergency accident before the project completion. Refer to Appendix 4-11.

(2) Grid connection

(Issues)

The grid extension from Vietnam to this project area is planned by EDC. That is reasonable to meet increasing power demand in this project area. If it is realized, the system operation has to be changed, and it is necessary to be properly shared by EUMP and EDC.

(Action plan)

JICA project team considers that, although this issue was not expected in this project, it is better to give EUMP/EDC some advice on the connection with Vietnam.

(Target period and activities performed)

JICA project team had meeting and site survey as follows.

(1) June 11 2010: 1st meeting on interconnection plan at EDC

(2) June 21 2010: 2nd meeting on technical points

(3) August 12 2010: 3rd meeting on specifications and cost estimation

Refer to the Memoranda No.1 through 3 in Appendixes 4-11 & 12.

(3) Dissemination of the Project

(Issues)

This project would be a good example both as "rural electrification with micro-hydropower" and as "rural development through rural electrification", seeing some positive impacts, although indirect, of electrification on rural development. It is recommended to publicly disseminate the project information from those two perspectives.

Besides, there is quite few technology and skills about hydropower in Cambodia. Therefore, EdC should take advantage of the technologies and skills provided by the Project to further disseminate them and fully utilize them in other geographical areas in Cambodia.

(Action plan)

JICA project team plans to have a seminar for EDC, The seminar theme will be on small hydropower engineering drawn from Japanese technology and experiences.

Existing operation and administration records may be used for hydropower engineering and plans in the future.

(Target period and activities performed)

On 22nd February 2011, from 9:30 to 11:30, JICA project team held a seminar at JICA Cambodia office as follows.

Theme

Small hydropower (Plan)

Small hydropower (Design)

Mondul Kiri Electrification Project (Construction)

Participants

EDC 10, EUMP 8 staff members, JICA project team 5, JSV 1,

JICA Cambodia office 2, totaling 26 persons

(4) Internal dissemination of learned technologies

(Issues)

The technologies and skills which transferred to EUMP should be transferred properly to newly recruited staff to ensure the sustainability. Such a system for internal technology transfer among staff should be recommended by Japanese experts within the Project term.

(Action plan)

JICA project team has been providing instructions of operation and maintenance management during the past 2 years. EUMP has a lot of data and information collected from the project commencement and up to the present. EUMP makes a mid- and long-term plan including cost estimation, periodic inspection and spare parts allocation plan.

(Target period and activities performed)

Engineers of EDC headquarters attended the 4th periodic inspection as part of technical transfer regarding overhaul works for both hydropower and diesel power stations.

JICA project team provided technical documents translated into Khmer as much as possible.

JICA project team recommended to the Cambodian side at 5th JCC meeting to have a public affair and announcement in the future.

Appendix 2 Management and Administration

Appendix 2-1 : Organization Chart of EUMP

Appendix 2-2 : Example of Assumed Tariff Rate after connection with Viet Nam (Second version)

Appendix 2-3 : 4th JCC Meeting

1) Agenda
2) Attendants list
3) Information
4) Presentation Material for 4th JCC by EUMP

Appendix 2-4 : Self-evaluation sheets for Administration division

Appendix 2-5 : 5th JCC Meeting

1) Agenda
2) Attendants list
3) Information
4) Presentation Material for 5th JCC by EUMP

Chapter 3　Electric Power Civil Engineering

Chapter 3 Electric Power Civil Engineering

3.1 Activities and Achievements of 2nd Period

3.1.1 General

Electric power civil engineers carried out field guidance by a total of four times and work in Japan by a total of three times in the second year (April 2010 to March 2011).

In the first year, the Electric Power Engineering Division performed technical guidance so that “the maintenance skill guidance of civil engineering structures including the gate, screen and penstock would be established and functioning", 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 Mundul Kiri Province (EUMP)” which is set forth in the Project Design Matrix. In the second year, the Division first of all evaluated each individual’s abilities as of the ending of the first year, using the attached OJT sheet, and gave OJT guidance concentrating on the aspects that the individuals felt to be weak points. Alongside that, it implemented operational support such as guidance for manual creation and for preparation of mid- and long-term plans.

The results and evaluations of the second year’s work are set forth below.

3.1.2 Activities and Achievements of the 2nd Period

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

Revision of Long and mid-term maintenance plan that was approved at 2nd JCC meeting was made.

In most case, we can revise it with enough actual performance record, but there were no referable data during this project because not so long time passed after completion and there are few maintenance records. It is assumed that the cost for replacement of consumable goods or repairing work due to the deterioration will be rising with the passage of time. So it is risky choice to decrease the maintenance cost judging from the maintenance record only two years from 2009 to 2010. Our recommendation is that if EDC Mondul Kiri can estimate the probable data with at least 5 to 10 years actual performance records, the Plan should be revised.

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

Operation and maintenance manual that was approved at the 3rd JCC meeting was revised to meet the standard of EdC or to be practical one.

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

Civil expert conducted the OJT guidance through the daily patrol in the same manner as 1st year. It

is confirmed that the skill of every staff was improved to the level that they can make a periodical patrol by himself.

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

Part of staffs did not acquire how to do a water measurement well, therefore civil expert make an intense guidance at the beginning of 2nd year. Judging from their manner of water measurement or data collection after our assistance, it is assumed that almost all the staff understands how to do them.

3.2 Outline of the 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^2

(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, L: 63 m
Power station building	Total floor area: 56 m2

(3) Diesel Power Station

Power station building	Total floor area: 144 m^2

(4) Administration Office

Office building	Total floor area: 189 m^2

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 Aide (in charge of O'Moleng Station)	Mr. Eng Rithy
Chief Aide (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 Station)	Mr. Thim Seanghai, Mr. Sin Siemeng, Mr. Toch Phally

[JICA Project Team]

Takahito Oikawa (The Chugoku Electric Power Co.,Inc.)

(2) Outline of the Guidance

Phase	Period	Items	Description
1	May 18 to June 1, 2010 (15 days)	Guidance in maintenance and control of civil engineering equipment before rainy season	Entrench skills via repeated instruction in regular maintenance and control work. During patrols, give OJT guidance concerning main points of pre-rainy season inspection of civil engineering equipment.
		Self-assessment checks	Assess skill/proficiency levels using the checksheet. (First assessment)
2	September 20 to October 6, 2010 (17 days)	Guidance in maintenance and control of civil engineering equipment during rainy season	Entrench skills via repeated instruction in regular maintenance and control work. During patrols, give OJT guidance concerning main points of in-rainy season inspection of civil engineering equipment.
		Self-assessment checks	Assess skill/proficiency levels using the checksheet. (Second assessment)
3	December 3 to 15, 2010	Guidance in maintenance and control of civil	Entrench skills via repeated instruction in regular maintenance and control

	(13 days)	engineering equipment before dry season	work. During patrols, give OJT guidance concerning main points of pre-dry season inspection of civil engineering equipment.
4	February 13 to 27, 2011 (15 days)	Guidance in drawing up mid- and long-term plans	Give guidance in drafting amendments in places where necessary.
		Final self-assessment checks	Assess skill/proficiency levels using the checksheet. (Third assessment)

3.3.2 Field Activities Report

3.3.2.1 First field survey

(1) Duration of engagement in the field work

Total of 15 days: Tuesday, May 18 to Tuesday June 1, 2010
(Duration of stay in the field: total of 7 days: Thursday, May 20 to Wednesday, May 26, 2010)

(2) Contents of work implemented

1) Guidance regarding removal of mud accumulated in O'Romis Power Station reservoir

Due to the effects of roadworks that China is implementing upstream of the O'Romis Power Station, earth and sand flow into the Station's reservoir. Since this power station is of the river run-off type, there will be no problems from this so long as there is no impact on water intake (such as mud accumulating in front of the intake and blocking it). Nevertheless, EUMP had, on its own judgment, constructed a temporary road into the reservoir, and was using it to remove mud from the reservoir bottom in order to secure reservoir capacity. We convinced them that in the present state of things, these measures taken to date were unnecessary and a wasted outlay.

However, the accumulated mud removal work had stopped in a part-way stage. When we questioned the staff as to the reason, it transpired that EUMP had been neglectful with the proper procurement methods (had only obtained an estimate from one company, instead of from three companies as normally), and so MIME had put a stop to the work.

Despite being a burden in terms of costs, the accumulated mud removal work is not itself a problem in terms of operation, and thus there has been no adverse impact from implementation of the work. The problem is rather that when the work was stopped part-way, the temporary road was left in place in the reservoir. The road is directly upstream from the intake, and so there could be adverse impacts from alteration of the river's water currents, or accumulation of loosened earth and sand around the intake, etc.

Accordingly, we advised them to hold negotiations with MIME at an early date, and rectify the procurement procedures and restart the work, so as to complete removal of the road before the

rainy season.

For reference, we gauged the amount of sand accumulated in front of the intake, but found it to be negligible.

2) Renewal of O'Romis Power Station maintenance road entrance

Having first consulted with the public projects and Ministry of Transport, EUMP carried out reworking of the entrance to the O'Romis Power Station maintenance road, in line with road improvement work carried out by a Chinese business. Near the entrance, the road has a certain abrupt gradient because it brushes against the roadbed of the National Route, but this has been settled with the public projects and Ministry of Transport, on the condition that drainage measures such as creation of a drainage ditch are taken and crushed stone is spread over the surface layer. It seems that provided these measures are taken according to plan, there will be no hindrance to the power station maintenance and control operations.

3) Skills assessment

In this year, the plan was to implement assessment and education using checksheets, in order to verify and raise the EUMP staff's skill levels (outcomes of the guidance thus far). The details are set forth in the work implementation plan for the second year.

The plans for the education needed for determining the staff's skill levels and overcoming their weak points were formulated via self-checks by the staff and interviews with the JICA advisors.

When they started out, the EUMP staff had been hired in an almost lay person-like state and some of them had all received the same education in a group, so that their self-assessments were almost the same. In this connection, they themselves explain that they are all alike because they have learned and acted in a group, and do things such as learning from each other when they don't understand things.

As the civil engineering guidance in the first year, we gave guidance mainly in the knowledge and operations necessary for operation of the power station, and partly because of that, almost all the staff confidently answered "I can do it" concerning operations such as gate control, foreign material removal, and water level (flow rate) measurement.

But as for their skills levels concerning patrols and inspection, despite being able to go to a site, discover an irregularity, and take minor countermeasures for it, they did not understand about the methods for systematic patrolling and inspection using checksheets. The cause of this was that the contents of the revisions that were made to the manuals last year had not been made widely known to all the power station's staff.

We explained that early discovery of irregularities and implementation of countermeasures is necessary in order to maintain civil engineering facilities in a sound condition and prolong their lives, and that implementing (habitualizing) periodic patrols (daily, weekly and monthly) in

accordance with the manual will lead to early discovery of faults. As it was felt indispensable for them to be familiar with the inspection contents (items, frequency and so forth), we set them the task of reading the manuals thoroughly by the time of the next survey (end of September).

4) Other matters

Concerning the repair of the slopes along the O'Romis Power Station access paths, which was carried out as part of the construction work repair operations, the unstable parts were cut away and shored up with crushed stone, in accordance with the JICA advisors' recommendations.

In the present state, no other parts in danger of collapsing were found.

Temporary road left in the reservoir
(Looking upstream from the diversion weir)

Same as above
(Looking toward the diversion weir from the road)

Measuring the thickness of the mud accumulated in front of the intake

Staff's reading: 3.45 m
Elevation of sand removal gate front face: EL 644.5 m
Elevation of intake top line: EL 648.0 m
Thickness of accumulated sand: 5 cm

O'Romis Power Station entrance

Same as above

A water drain is scheduled to be constructed, and crushed stone to be laid, on the mountain side of the road in the future.

Interviewing the EUMP staff

Repaired slope alongside the O'Romis Power Station access path

[For reference]
State of the slope before the repair (December 2009)

3.3.2.2 Second field survey

(1) Duration of engagement in the field work

Total of 17 days: Monday, September 20 to Wednesday, October 6, 2010

(Duration of stay in the field: total of 9 days: Tuesday September 21 to Wednesday, September 29, 2010.)

(2) Contents of work implemented

1) Patrol guidance

During the last field survey we had given guidance in performing patrols and inspections using checksheets in accordance with the O&M manuals. This time we verified such situation and carried out necessary guidance.

The contents were as set forth below.

a) O'Moleng Power Station (implemented Thursday, September 23)

- A check of the past records revealed that on the weekly patrol days, patrol was implemented using only the weekly patrol checksheets, without leaving a daily patrol checksheet as a record. We gave guidance to leave both a daily patrol checksheet and a weekly patrol checksheet as records on the weekly inspection implementation days.
- The buildings and structures had no strength problems, but a certain number of small cracks had developed in them. We were asked whether it was alright not to take records if there were no problems, but we instructed them that records were necessary because small cracks might expand and become problems, and in order to continue monitoring (hand on details of the situation).
- Regarding the ruts in the access paths, repairs such as filling with crushed stone are carried out whenever the situation became serious.
- Weeding work is performed along the access paths twice per month. This is a more than adequate frequency, and so we advised them that there was no problem so long as the weeding work did not detract from other work, but if it did, they could reduce the frequency to, say, once per month. (In the current state of things, it does not detract from other work in any major way.)
- Since the access path is also used for purposes such as checking the reservoir level in the nighttime, streetlamps needed to be installed along the path in consideration of work safety. (This wish had been communicated to EDC but was not accepted; EOM had installed fluorescent lights on its own initiative.)
- Regarding measures to prevent entry to the facility, some persons had been scaling over the fence and getting inside even though it was locked. We advised the staff that, as the facility's managers, it was necessary for them to take the minimum preventive measures (such as

putting up “KEEP OUT” signs).

- They carried out sand removal from the sand basin every three months and from the diversion weir every two months. The frequency for the sand basin seems to be no problem, as a large amount of sand is removed each time. But with the sand removal from the diversion weir, the force of flood water currents is utilized to expel the sand, which means that in the dry season it is not possible to remove the sand efficiently, and no significant amounts of sand emerge during the (once-per-two-months) sand removal operations. Accordingly, we advised them that it might be sufficient to carry out just two sand removal operations in the year – say half-way through the flood season and at the end of it (although, as we had not seen the amounts of sand expelled, we could not be very sure).

b) O’Romis Power Station (implemented Friday, September 24)

- A check of the past records revealed that on the weekly patrol days, patrol was implemented using only the weekly patrol checksheets, without leaving a daily patrol cheeksheet as a record. We gave guidance to leave both a daily patrol checksheet and a weekly patrol checksheet as records on the weekly inspection implementation days.
- Regarding weeds along the access path, it seemed that weeding was done frequently. But the vegetation grows quickly and the access path has a long extent, so that even if time is taken to weed the whole of it, it immediately becomes overgrown again. We advised the staff to do periodic weeding only of the portions, such as those which vehicles pass along, where overgrowth is an impediment for maintenance and control, and that for the road shoulder and so forth it would suffice to do weeding whenever the overgrowth became serious.
- In the “Notes” column in the sheets, there were almost no entries opposite the items where “OK” had been checked. We gave guidance that although it was alright to check “OK” for small cracks, etc., which would not affect the structures, an entry to the effect that cracks were present should be left in the “Notes” column (because it could be used as data on when the cracks occurred).
- Dwellings for the power station personnel had been built on the river directly upstream of the power station. As this was not desirable in terms of safety, we advised shifting the dwellings elsewhere.
- Tourists sometimes entered the premises as far as the diversion weir, but for reasons of control, entry beyond the weir toward the power station was restricted.
- The sand removal gate is opened with a frequency of around once per month to expel mud accumulated in front of the intake. By the guidance day, almost one month had passed since the last opening, and so the gate was opened (for several minutes, expelling mud) on that day. We gave guidance that during the dry season, expelling sand when the river flow rate was small was inefficient and a waste of power generation water, because little mud accumulated in that season as there was no flooding, and so they should stop operating the gate in the dry season and implement sand expulsion in the rainy season when there was

overflow from the diversion weir. However, we also advised them to conduct inspection of the gate every month in order to verify its working.

2) Interim assessment of OJT

a) O'Moleng Power Station staff (implemented Thursday, September 23)

- The O&M manuals had been carefully read by all the staff.
- Patrols using the checksheets were being implemented almost in accordance with the manuals, and the results were being filed.
- The staff still lacked confidence concerning minor repair work.
- We advised the staff that one cannot acquire expertise and skills in civil engineering work unless one actually experiences it, and that a way to learn would be to "watch while thinking about" the work implemented in the locality by other companies.
- The task that we had set them in May (to be able, by the end of September, to perform on their own efforts the periodic patrols set forth in the manual) may be deemed to have been achieved.
- As their next task, we told them to "become able, by the end of December, to establish on their own efforts plans for minor repair work" – as they had all responded that they were not confident about such work.

b) O'Romis Power Station staff (implemented Friday, September 24)

- The O&M manuals had been carefully read by all the staff.
- Patrols using the checksheets were being implemented almost in accordance with the manuals, and the results were being filed.
- Unlike the O'Moleng Power Station staff, those at the O'Romis Power Station had experienced construction work a few times – slope repair work, drainage equipment work, and work to join the access path to the National Route, etc. – and therefore almost all of them responded that they were able to plan and implement repair work.
- The task that we had set them in May (to be able, by the end of September, to perform on their own efforts the periodic patrols set forth in the manual) may be deemed to have been achieved.
- As their next task, we told them to "become able, by the end of December, to establish on their own efforts plans for minor repair work" – as it had emerged from a consultation with them all that they wished to further raise their work planning abilities.

3) Other matters

We questioned the staff about the work near the junction of the National Route with the O'Romis Power Station's maintenance road, part of which had collapsed due to heavy rains after the last survey. We learned the following about the situation:

- The order placement procedures for the work had been performed at the EDC Head Office.
- The work start date was Monday, 27 September and the work duration one month (both specified contractually).
- The work itself was expected to finish in two weeks if there was no rain or other adverse weather.
- There was a warranty for six months after completion.

The staff were advised by the JICA team to secure an access way to the power station at all times, by for example constructing a detour road during the excavation work for drainage pipe installation. (They responded that they would not implement whole-surface excavation, but rather would be sure to leave a part unexcavated so as to ensure access.)

○ O'Moleng Power Station
Giving guidance in patrolling (at the water discharge outlet)

○ O'Romis Power Station
Giving guidance in patrolling (at the headrace)

○ Guidance in sand removal
Instructing staff how to operate the sand removal gate at the O'Romis Power Station

○ Sand removal
Situation immediately after opening of sand removal gate

○ House on the river
Advice was given to relocate the house, as it is in danger of being washed away when the river foods.

○ Cabling for access path streetlamps
The clearance above the road is small.

3.3.2.3 Third field survey

(1) Duration of engagement in the field work

Total of 13 days: Friday, December 3 to Wednesday, December 15, 2010
(Duration of stay in the field: total of 9 days: Saturday, December 4 to Sunday, December 12, 2010.)

(2) Contents of work implemented

1) Patrol results (implemented December 6, 2010)

(1) O'Moleng Power Station

- It was reported that a wild boar had run into the rockfall protection fence along the access path, causing damage to its posts. Repair was being requested.
- There were no other matters worthy of particular attention.

(2) O'Romis Power Station

- The improvement work on the access path near to the O'Romis Power Station entrance had already been completed. The path's mountain side had been reinforced with a stone-pitched side ditch and road-crossing waterway, and its valley side with piled-up sandbags, etc. The total cost of the work was around 14,000 U.S. dollars (including 10% VAT). As there was a possibility that despite such firm reinforcement, the path might be eroded by rainwater flooding onto its surface during the rainy season, rendering passage difficult, we advised the staff to soundly carry out maintenance such as removal of mud accumulated in the ditch, so that rainwater would not overflow from it onto the path surface.
- The slopes repaired last year appear to be practically stable, perhaps partly due to the comparatively small amount of rain in this year.
- The dwellings erected in the river beside the O'Romis Power Station, which we pointed out as a concern in the last survey, had been removed.

2) Patrol guidance

(Implemented December 8, 2010 for O' Moleng Power Station, December 9, 2010 for O' Romis Power Station)

(1) O'Moleng Power Station

- Water was observed to be seeping from the joint portions of the diversion weir. We commented that if it had been a gushing leak, countermeasures would have been necessary, but as it involved the joint portion and only a small amount of water, there was no problem. We also instructed the staff that if leakage should occur in any of the concrete portions other than the joint, they should report it to Head Office and devise countermeasures.

- There was a small quantity of water leakage from the sand removal gate portion. This seemed to be due to foreign material having been trapped in the gate the last time it was closed. As the quantity of water was not such as to constitute a problem for operation, and as it was not desirable to open/close the gate during the current rainy season (when the river flow rate was low and its traction force small, so that the sand that had accumulated on the river bottom might get left in the gate grooves and stop the gate from closing), we instructed them to leave adjustment until open/closing during the next rainy season.
- The bases of some posts in the rockfall protection fence along the access path had been eroded by rainwater. We advised upgrading to a stone-pitched or concrete-lined side ditch (this has already been reported to Head Office and action is being deliberated).
- The inspection lamp cables along the access path had been trailed over the ground surface alongside the rockfall protection net, and so we instructed that the cables should be shifted to above the net.

(2) O'Romis Power Station

- The doorknob on the rear entrance to the power station building had been damaged. A request for repair had been submitted to Head Office.
- When the output is in the region of 40 kW, the hydraulic pressure iron pipe vibrates. There is no vibration at other outputs. This may probably be because the generator and the hydraulic pressure iron pipe resonate, causing vibration, when the output is 40 kW. We instructed the staff to accumulate data for a while until the vibration was verified, then describe the situation in as much detail as possible in the patrol records.
- Some posts in the rockfall protection fence along the access path had been broken by a falling tree. A request for repair had been submitted to Head Office.
- The padlock on the intake gate's wheel had disappeared. A request for repair had been sent a year before, but there had been no response at all from Head Office. Because a long time had passed, we instructed the staff to issue a repeat request together with the other requests. It appears that they make requests in written form.

3) OJT assessment

(Implemented December 8, 2010 for O'Moleng Power Station, December 9, 2010 for O'Romis Power Station)

(1) O'Moleng Power Station

All the staff scored B or higher for all the items entered in the self-assessment sheet. We accompanied the staff in their actual patrolling and maintenance/control work, giving them guidance in those operations, and we observed improvement not only in their skills but also in their attitude compared to two years previously. One could sense that they were engaging in their duties with a sense of responsibility.

The matters about which we gave advice were as follows.

- The staff were able to conduct patrols according to the manuals, and were issuing the necessary reports and requests to Head Office. We advised them to continue to perform their duties without neglecting to make efforts for skills improvement.
- Major repairs, of from the waterways for example leakage, are implemented by a construction company, not by the power station staff, and those staff are unlikely to manage such repairs directly. However, we believe that, in order to render operation of the power station sustainable, the power station staff have a duty to discover early any irregularities that will require repair, and promptly issue a repair request to EDC before any fatal trouble occurs. We advised them to acknowledge the foregoing and strive for early discovery of irregularities.

(2) O'Romis Power Station

All the staff, except one man hired at the time of the transfer of control to EDC, scored A for almost all the items concerning operation, maintenance and patrolling. We accompanied the staff in their actual patrolling and maintenance/control work, giving them guidance in those operations, and we observed improvement not only in their skills but also in their attitude compared to two years previously. One could sense that they were engaging in their duties with a sense of responsibility. We also requested the other staff to assist the recently recruited man. If they can give him OJT, they should be able to hand their skills on to him.

Many of the staff lacked confidence concerning repairs, but since they have themselves been able to implement minor repairs such as road improvement at the power station entrance and improvement of the drainage side ditch, there is probably no problem.

The matters about which we gave advice were as follows.

- Regarding the new-recruit staff member, we advised that the experienced staff should give him OJT and strive to raise his overall level.
- Major repairs, of from the waterways for example leakage, are implemented by a construction company, not by the power station staff, and those staff are unlikely to manage such repairs directly. However, we believe that, in order to render operation of the power station sustainable, the power station staff have a duty to discover early any irregularities that will require repair, and promptly issue a repair request to EDC before any fatal trouble occurs. We advised them to acknowledge the foregoing and strive for early discovery of irregularities.

(3) Other matters

1) Large-scale repairs

Civil engineering structures have a long lifespan, and no event that would have necessitated large-scale repair work has occurred with such structures during the period of the present project.

Concerning repair of civil engineering structures, it is often the case that effective repair measures cannot be taken unless the actual facts of the situation are verified and the causes analyzed. Moreover, since the EOM staff will not be able to cope with cases where large-scale repair is actually necessary (it appears that design and implementation of such repair are outsourced), we advised the power station staff that they should list up the kinds of cases (phenomena) that might lead to serious situations, and if they discovered such phenomena, should report them to Head Office, consult the experts, and deliberate the suitability or otherwise of countermeasures.

2) Flow rate measurement

Measurement of the flow rate at the O'Romis Power Station is carried out with a frequency of once per week, and from what we saw of the data that had been recorded, it seemed that the measurements were being performed with good accuracy.

○ O'Moleng Power Station
Present state of the power station

○ O'Moleng Power Station
Present state of the diversion weir. There was no overflow from the weir.
Hydropower when photograph taken: 100 kW.

○ O'Moleng Power Station
Posts that a boar had run into

○ O'Romis Power Station
Present state of O'Romis Power Station

○ O'Romis Power Station
Dwelling that had been erected on the river had been removed (leaving only the foundations).

○ O'Romis Power Station
Present state of water tank. There was no overflow into the effluent outlet.
Hydropower when photograph taken: 140 kW.

○ O'Romis Power Station
Improved access path near entrance.
Stone-pitched side ditch that was newly constructed for dealing with rainwater from the mountain side.

○ O'Romis Power Station
Same as above.

○ O'Romis Power Station
Slope repaired last year.
Currently stable.

○ Guidance in patrolling
(O'Moleng Power Station)
Seepage at the diversion weir joint portion.

○ Guidance in patrolling
(O'Moleng Power Station)
Leakage from the sand removal gate

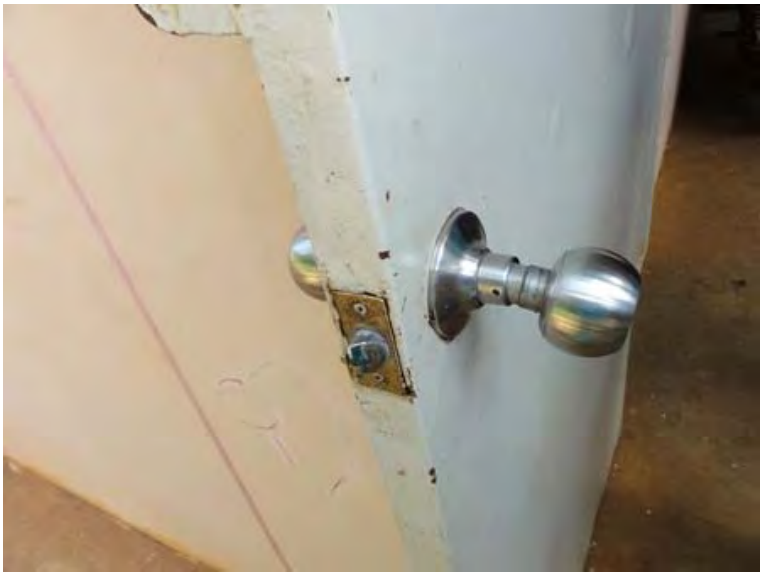
○ Guidance in patrolling
(O'Moleng Power Station)
Base portions of posts in rockfall protection fence along access path

○ Patrol in progress
(O'Moleng Power Station)
Inspecting a manhole for the hydraulic pressure iron pipe

○ Patrol in progress
(O'Moleng Power Station)
Inspecting a joint portion of the hydraulic pressure iron pipe

○ Patrol in progress
(O'Moleng Power Station)
Inspecting the bases of machinery inside the building

○ Patrol in progress
(O'Romis Power Station)
A patrol starting up



○Patrol in progress
(O'Romis Power Station)
Damaged doorknob of power station building

○ Patrol in progress
(O'Romis Power Station)
Inspecting the hydraulic pressure iron pipe

○ Patrol in progress
(O'Romis Power Station)
Fallen posts of rockfall protection fence

○ Skills assessment
Interviewing the O'Moleng Power Station staff

○ Skills assessment
Interviewing the O'Romis Power Station staff

3.3.2.4 Fourth field survey

(1) Duration of engagement in the field work

Total of 15 days: Sunday, February 13 to Sunday, February 27, 2011

(Duration of stay in the field: total of 7 days: Monday, February 14 to Sunday, February 20, 2011.)

(2) Contents of work implemented

1) Site Patrol

We checked the condition of facilities at O'Moleng and O'Romis power station. The site was well maintenance and no aberration was detected on the civil facilities.

Nothing special question was made by the staff.

2) Performance of Edc Mondul Kiri

Periodical patrol was surely conducted as stipulated in O&M manual and the record was also surely kept. Measuring of water level at O'Romis water way and water measuring was conducted three times a day and every week respectively and recorded surely.

We explained again the importance of keeping the record.

3) Revise of long and mid-term strategy

We studied the necessity of revision of the budget for civil structures in the long and mid-term strategy that was made up on April 2009.

The long and mid-term strategy should be revised with enough performance record but it passed not so long time after starting operation and this site had few repairing record so we couldn't acquire referable data. Generally, civil structure will need repairing caused by its age as years pass. The budget should be kept even if there was no record from 2009FY to 2010FY. At least, 5 − 10 years record is necessary and estimation of the average annual cost for civil structure repairing and after that the long and mid-term strategy should be revised.

4) Post evaluation by JICA

We assisted the activities of post evaluation survey conducted by JICA Cambodia office. We visited the site with JICA, accompanied with JICA interview to the customer and gave some comments to JICA for the future.

EUMP seemed to acquire the basic technical and to be able to make operation under the normal condition. In order to continue to supply electricity stably, it is necessary for EUMP to make efforts to improve their skill by more experience. Because of the lack of hydropower technical abilities in Cambodia, follow-up project such as training or technical assistance is necessary to improve their skill, which we recommended.

○ Status around O'Moleng intake Weir

○ Status around O'Moleng powerhouse

○Status around O'Romis powerhouse

○ Record of patrol
Every day records since May 2010 when the content of O&M manual was explained is filled.

○Status of the survey by JICA
Interview to the people in province

3.3.3 Work in Japan

Round	Period	Description
1	6th,7th,10th May, 2010 (3 days)	Making a work plan for 2nd year and OJT sheet to evaluate the skill of counterpart
2	8th 20th 22nd October, 2010 (3 days)	Making an interim report of 2nd year and revising a long and mid-term plan
3	2nd 3rd 4th March, 2011 (3 days)	Making a final report

3.3.4 Results and evaluations of the second year

In the first field survey of the second year, we used the attached Ability Checksheet to carry out ability evaluation of the members in order to verify each member's abilities as of the ending of the first year.

The results were as follows.

- Almost all the members were sufficiently confident concerning the basic work (gate operation, foreign material removal and water level (flow rate) measurement and so forth) to be able to check the "I can do it" response.
- They are not well able to understand the contents of the manual (Khmer version) created during the first year.

The manual contains matters pertaining to implementation of patrols. Early discovery of irregularities and implementation of countermeasures is necessary in order to maintain civil engineering facilities in a sound condition and prolong their lives, and implementing (habitualizing) periodic patrols (daily, weekly and monthly) in accordance with the manual will lead to early discovery of faults. Believing it necessary that they first of all understand the manual's contents and the importance of patrols, so as to be able to conduct periodic patrols reliably based on the manual, we elected to give guidance with emphasis on patrols.

In the course of four rounds of guidance, the members came to understand the purposes of implementing patrols, namely:

- Civil engineering structures have to be kept in sound condition in order to render power generation sustainable, and visual inspections via day-to-day patrols are an effective means to that end.
- Besides implementing patrols properly, it is also important to leave proper records of them so as to capture changes over time.
- If cracks or the like develop and water leakage, etc., is observed, action must be promptly taken.

Thus, explanations were given not only of the purposes of implementing patrols, but also of how to

utilize their results. As a result, all the members came to engage earnestly in patrols.

If civil engineering structures deteriorate over time, they are likely to require repair based on the patrol results, and in such cases it will be necessary to draw up and implement appropriate repair plans. Although no particular irregularity was observed in the diversion weirs, waterways or other major structures during the guidance periods, we believe we were able to give a fair amount of guidance concerning repair of the accessory equipment, for example, repair of slopes that had collapsed in the rainy season, reinforcement of access paths, and addition of road-crossing drainage equipment. Moreover, in the second year the members were able to repair almost entirely by their own abilities the access path near the O'Romis Power Station entrance, and so it is believed that they will be able to implement minor repairs by themselves without any problem.

Thus, it seems that as a result of the two years and four months of technical guidance that have been given, they have become able to carry out by themselves the basic operation, irregularity discovery via patrols, and minor repair work.

The following may be cited as tasks for rendering this project sustainable – besides the proper implementation of maintenance and control according to the manual.

- Maintenance and raising of technical skills (implementation of periodic external training, handing on skills within EUMP, etc.)
- Formulation of appropriate repair plans and mid-and long-term funding plans that take account of the situation regarding deterioration of civil engineering structures over time, and use of such plans for implementation of maintenance and control.

Appendix 3 Civil Work Structures

Appendix 3-1： Self-evaluation sheets for civil section

Appendix 3-2： Action plan sheets for civil section

Appendix 3-3： Example of the patrol record

Chapter 4 Operation and Maintenance of Generating Facilities

Chapter 4 Operation and Maintenance of Generating Facilities

4.1 Activities and Achievements of the 2nd year

4.1.1 General

The first period work in both Japan and Cambodia completed during December 2008 to March 2010, and the second period work was carried out to dispatch the advisor with 5 times during this period, then they transferred the technology of operation and maintenance in generating facilities to EUMP(（Electricity Unit of Mondulkiri Province） staff as a counterpart of the project.

EUMP was able to supply the power to the customers for 24hours 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 1st and 2nd period work.

The result of 2nd 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 (MLTP) of power generation (first version) provided in April 2009 was approved by the 2nd JCC meeting in June 2009.

JICA project team provided final version of MLTP in February 2011 considering the situation of transferring to EDC, generating facilities condition, management system and technical level of EUMP staff, etc. At the time of preparation of the plan (first version), generation facilities was operating only 6 months and not enough for data accumulation, so 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, the MLTP was reviewed by the EUMP and JICA project team during 7th site survey in July to September 2010. It is necessary to review the plan taking future plan of EUMP management and verification of the content into consideration after 2 years.

During the preparation of the revised plan, JICA project team suggested to EUMP to suggest it and the plan was provided in consultation with EUMP staff and JICA project team considering the 2 year experience in the operation and maintenance period.

Especially, in the 2nd period work, JICA project team considered to level up the EUMP staff for planning capability and making a budget.

(2) To review the operation & maintenance manuals regarding hydropower generation both in English and Khmer

The reviewed O & M Manual of the 2nd version in Khmer and English were completed in September 2010 in consideration of the transfer to EDC, management system, ability of the staff and site training. The manual was approved by 4th JCC meeting in 4th September 2010 with an official letter from EDC headquarter.

The final version of the manual was prepared in February 2011 and submitted at 5th JCC meeting after EDC made comments and JICA project team revised some parts.

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

There were many case of emergency shutdown of machine under the influence 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 instructed the recovery procedure at the time of OJT in the second period.

JICA team directed the safety measures as part of OJT in relation with transmission line facilities, because the first thing to do in trouble shooting is to secure public safety, EUMP staff and transmission lines, and then to restart the machine for normal operation.

On the other hand, as for transfer to EUMP regarding technical guidance both for hard and soft wares, JICA project team conducted in the 1st period, mainly guidance of site work such as disassembly and replacement of the parts, etc. and in the 2nd period, desk work and training of practical inspection and electrical theory, etc. Main points of the guidance were as flows.

1st Period Guidance

1) O&M Management

The basic knowledge of operation and maintenance for Modul 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

2nd Period Guidance

1) Sequence Diagram

The understanding and how to read the block diagram and sequence diagram for Mondul Kiri power system in June and September 2010.

2) Small hydropower: plan, design and construction

The understanding and how to plan small hydropower, JICA project team had a seminar for EDC and EUMP engineers in February 2011.

3) Electrical theory

The understanding of electrical theory by JICA project team and JICA Senior Volunteer was lectured in the seminar in November 2010.

It was difficult to arrange the time of direction on the transfer of technology to the staff, because they have a routine work and many kinds of daily works in the power stations. So, it was necessary to continue and repeat the OJT considering their understanding at site. Especially, OJT and inspection for control and protection system was carried out in June and September 2010 during the periodic inspection of 2010.

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

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

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

JICA team confirmed that, during the second period work (April 2010 to March 2011), EUMP had to utilize and making an annual report to EDC headquarter.

River inflow and Output Curve

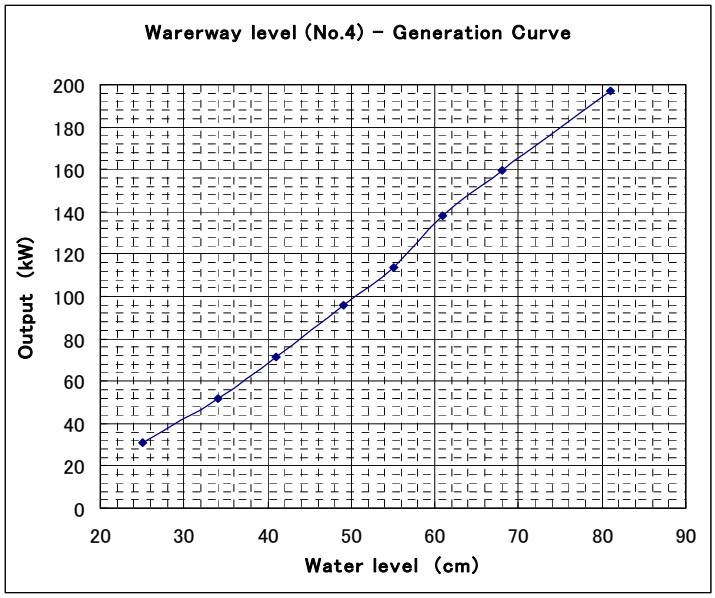
There is a very different inflow between rainy and dry season at both O'Moleng and O'Romis hydropower stations. Especially, the inflow of dry season is deeply decreased to about 1/3 of rainy season. Therefore, the output of the hydropower station as a run-of-river type is also decreased to around 1/3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

In the worst case, the 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 the water level is very quickly decreased to avoid such kind of trouble. EUMP carried out measuring of water inflow at waterway every day for one year.

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

It was a good performance of EUMP' job to prepare a [River inflow (cm) and Output Curve (kW)] which resulted from continual measuring and accumulating data for one year, and they can keep stable operation using this guidance curve for the next dry season.

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



4.2 Generating Facility and Operation Data

4.2.1 Generating Facilities

Generating facilities of EUMP as of March 2011 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.

22kVtransmission lines: 28km, 400V/230Vdistribution lines: 33km。

4.2.2 Operation Data in EUMP

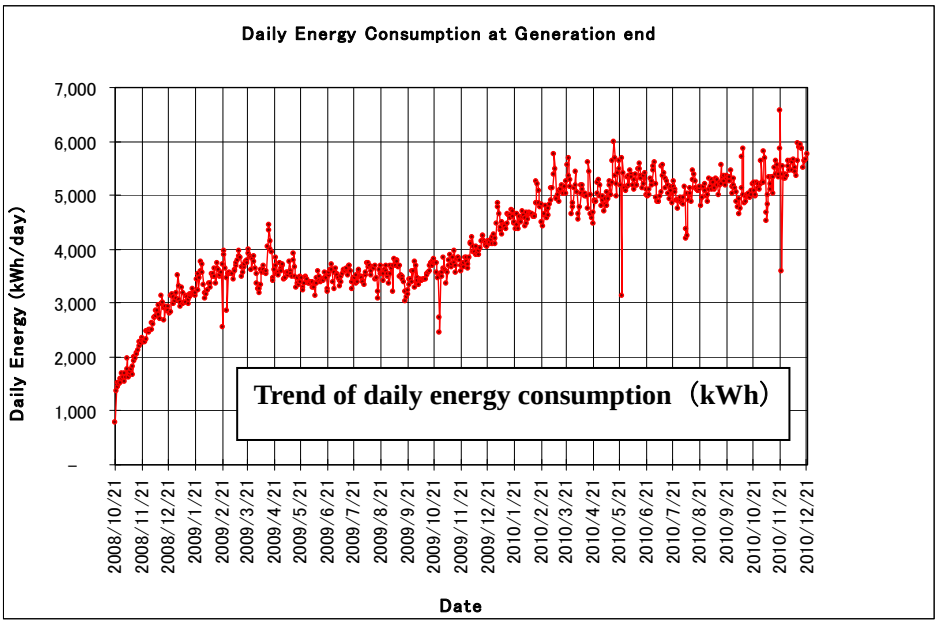
Operation Data, starting on 21st October, 2008 and up to 28th February, 2010 are as follows.

(1) Total Generation Energy (as of 20th December, 2010)

a) Hydropower Station: 2,049,423kWh
b) Diesel power Station: 1,198,287kWh
c) Total Generation: 3,247,710kWh

(2) Operation Hour (as of 20th December, 2010)

a) O'Moleng Power Station: 13,421Hours
b) O'Romis Power Station: 15,203Hours
c) Diesel Power Station: 6,999Hours



(3) Electrification Ratio in Senmonorom City

a) At starting of power supply (21, Oct, 2008) 0%⇒465/1,560= 29.8%
b) After 1 year operation (21,Oct, 2009) ⇒1,180/1,645= 72%
c) After 2 years operation (21, Oct, 2010) ⇒1,275/1,710= 75%
d) At present status (20, Dec, 2010) ⇒1,304/1,710= 77.6%

(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

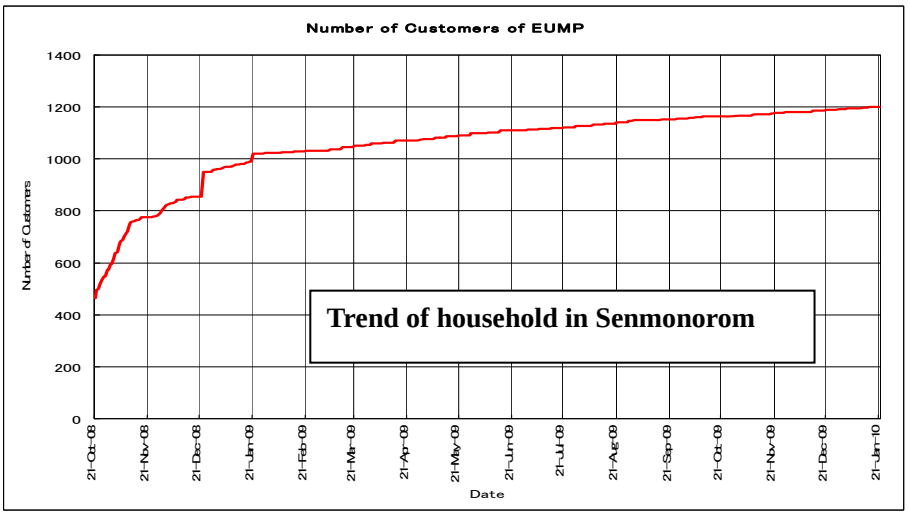
c) After 2 years operation (21,Oct, 2010) ⇒1,275 Households

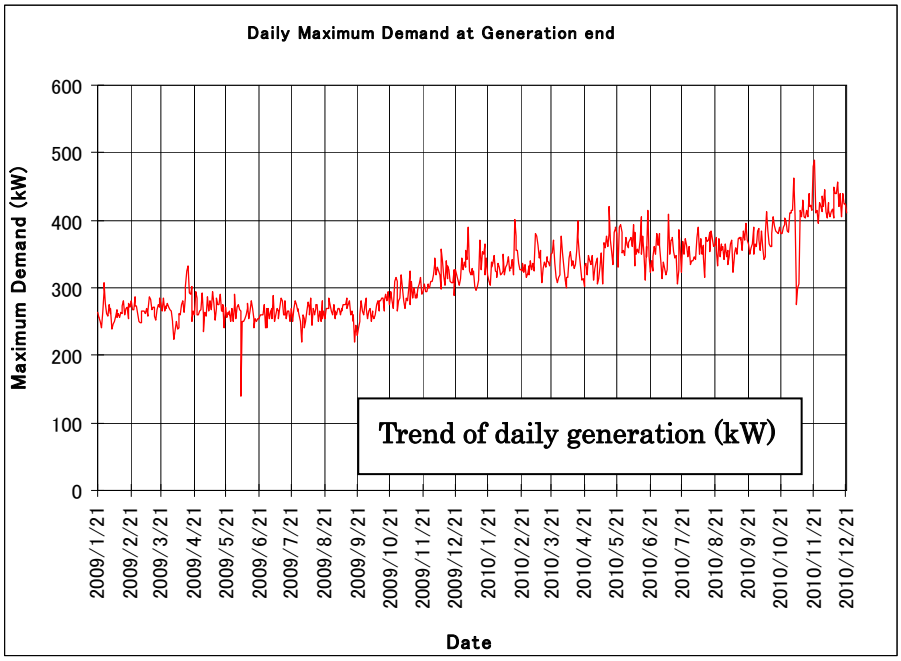
Daily peak demand= 380kW, Daily energy consumption= 5,232kWh

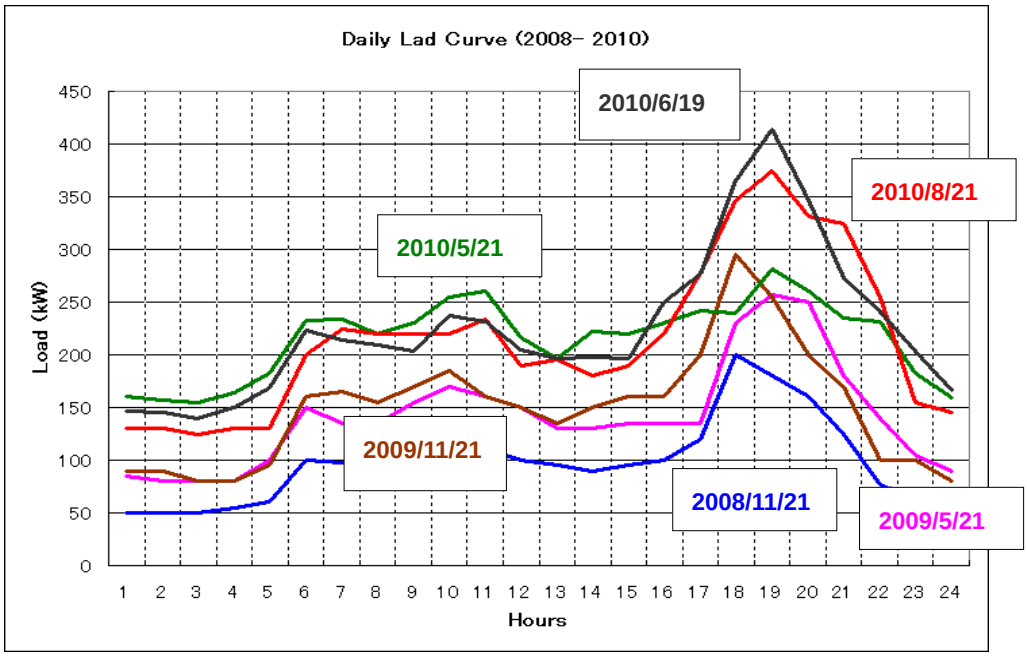
d) At present status (as of 20th Dec, 2010) ⇒1,304 Households

Daily peak demand= 425kW (past max. demand = 490kW, 2010/11/21)

Daily energy consumption= 5,664kWh (past max. energy = (6,576kWh 2010/11/21)







(5) Availability Factor (Service hours/ Total hours)

1) Time availability factor (for 1 year: December, 2008 to November, 2009)

- 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 %

Time availability factor (for 1year: January, 2010 to December, 2010)

- O'Moleng power station: 4,966/ 8,760 = 57 %
- O'Romis power station: 5,537/ 8,760 = 63 %
- Diesel power station: 5,213/ 8,760 = 60 %

2) Capacity factor:

From 21 Dec. 2008 to 20 Dec. 2009

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 %)

From 21 Dec. 2009 to 20 Dec. 2010

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

= 1,754,440/670*365*24 =29.9 %

(Hydro= 837,888/370*365*24= 25.9 %, DG= 983,657/300*365*24= 37.4 %)

3) Daily load factor

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

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

c) At present status (as of 20th December, 2010) ⇒56%

(6) Generation Reserve Margin （Supply capability kW/ Demand（3 days average） k W）

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

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

c) Rainy season = (600-373)/ 373 = 60% (20, Aug, 2010)

d) Dry season: = (360-425)/ 425 = -15% (20, Dec, 2010)

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

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

As of 7 January 2010

Forced outage ratio = Annual outage hours / Annual operation H.＋Outage H.

= 72 H + 4 H / 8,313H +76 H = 0.9 %

From 21 December 2009 to 20 December 2010

Forced outage ratio = Annual outage hours / Annual operation H.＋Outage H.

= 12.3 H +24 H / 8,760 +76 H = 0.16 %

(8) Annual Service Capability＝ 1- (annual stoppage H /annual utility H)

As of 7 January 2010

= 1- (76 H/ 8,760 H) = 99.1 %

As of 20 December 2010

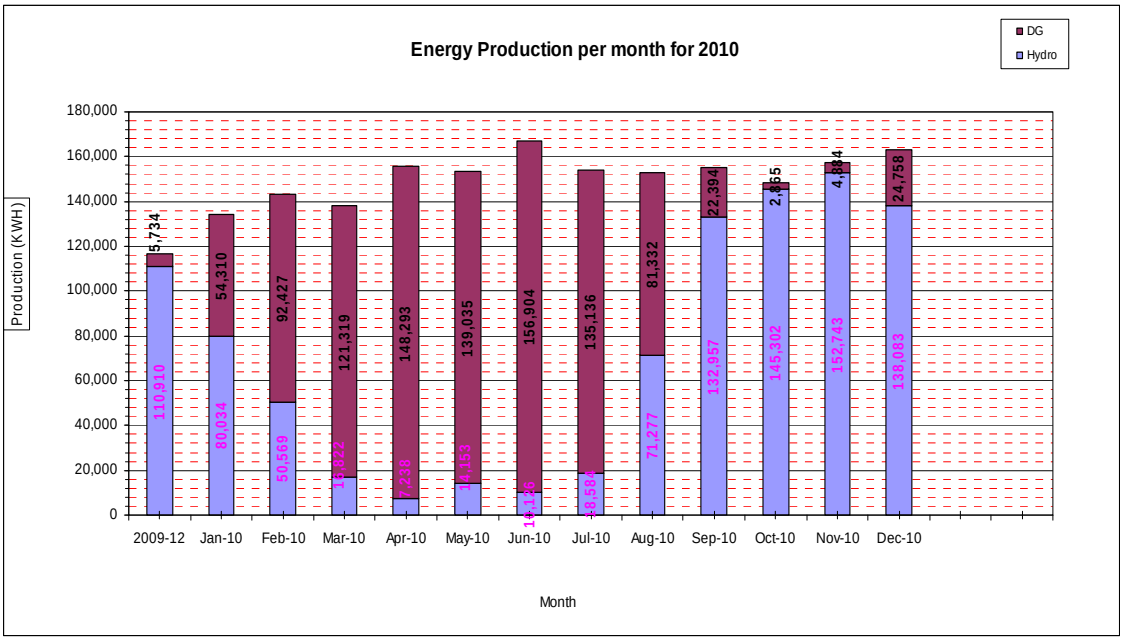
= 1- (14.3 H/ 8,760 H) = 99.8 %

But, the load shedding was done for around 2 hours at peak time in some areas (2 times per year) due to Chinese and Khmer New Year.

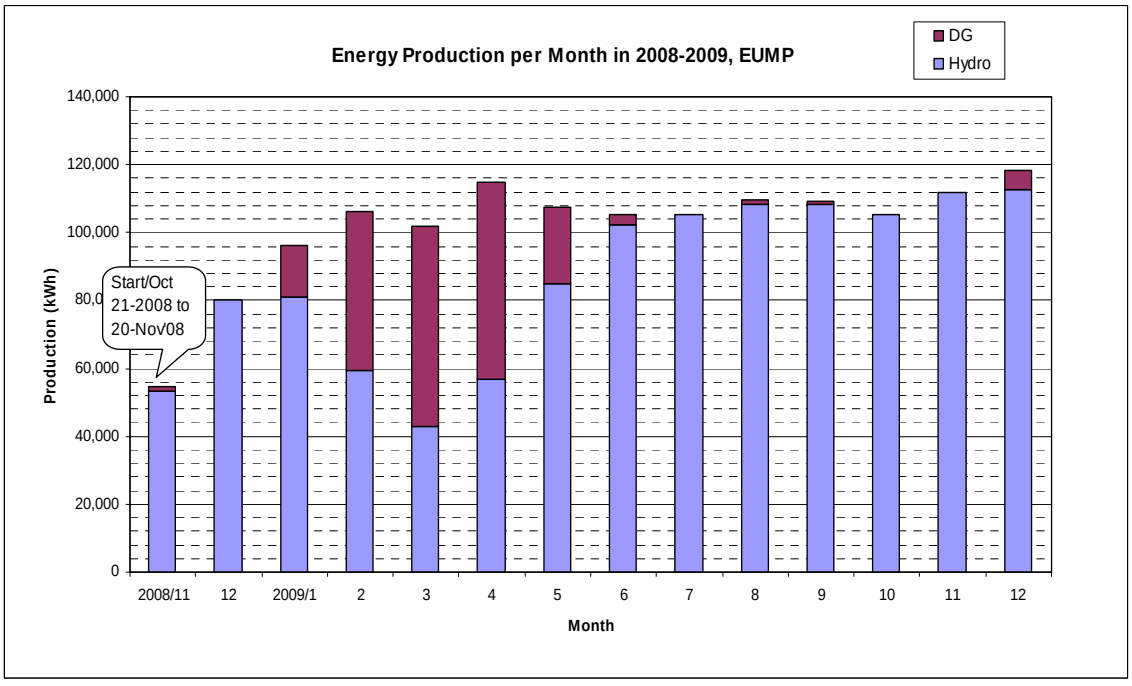
(9) Monthly Power Generation (kWh)

Hydropower generation (kWh) as 2010 in compared with year 2008 – 2009 was 1/3 of power generation. This was because river inflow for hydropower station was abnormally decreased due to the dry condition in 2010. Therefore, the hydropower generation was much decreased.

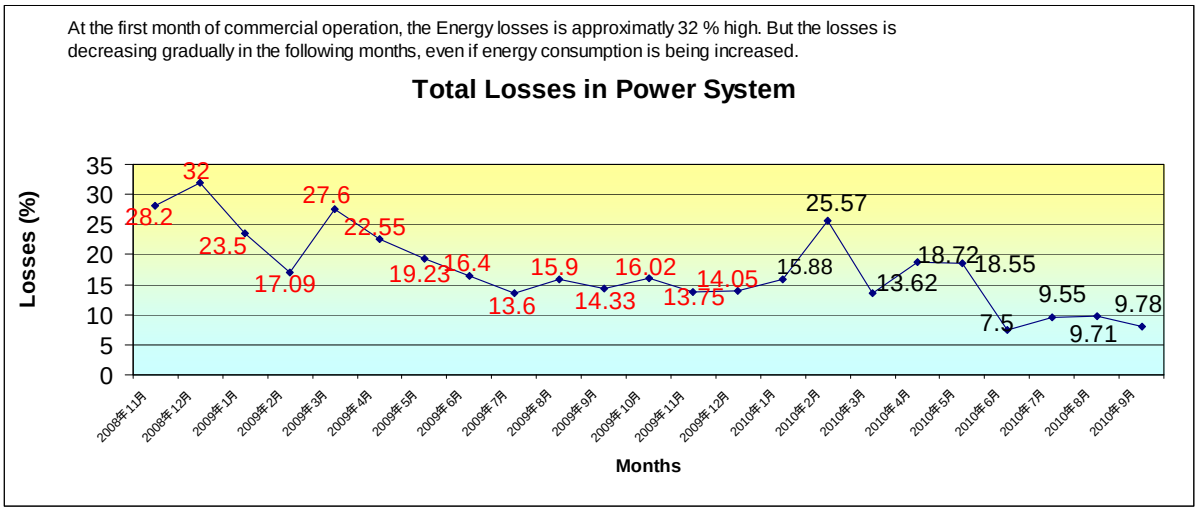
1) Energy Production in 2010



2) Energy Production from 2008 to 2009



(10) Total Loss of EUMP Power System (%)



4.2.3 Scheduled Inspection and Fault Report

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

Especially, in the 1st year inspection on hardware technique, JICA project team transferred the technology to EUMP staff. But, in the 2nd year inspection on software technique, we mainly transferred such skills as control sequence & block diagram, measurement of control circuit & inspection for analysis of failures or trouble.

(1) Periodic Inspection

Since commercial operation starting in November 2008, the first year inspection was carried out in May- June 2009 and November – December 2009 every 6 months operation. The second year inspection of the machines was conducted under the supervisors from suppliers of Tanaka hydro Mfg for turbine and Daihatsu Mfg. for diesel engine, respectively. The results were satisfactory in both third and forth inspections on turbine and control equipment.

In the 2nd year inspection, the 3rd inspection was conducted in June 2010 and the 4th inspection in November as a final work under the project. But, in the 3rd diesel inspection was extended up to August due to shortage of water inflow and waited increasing river water with operable rated output (185kW) of generator. In the 4th

inspection of diesel equipment was carried out as 8,000 hours overhaul work. It is evaluated that JICA project team transferred to EUMP technical knowledge of the inspection procedure of disassembly/assembly, general inspection of generator and control panel, etc for both hard and software technique.

Inspection Report

Inspection of every half year was according to the 2nd Period work plan, and both inspection results were satisfactory without any problem in turbine, generator and control panel, etc.
For detail inspection record, refer to [Periodic Inspection Report (No.3 and No.4)] as attached.
The actual inspection schedule was as follows.

1. Periodic Inspection (No.3)

Inspection of hydropower station on

(1) Pre meeting for inspection: 2009/05/30
(2) Periodic inspection for O'Moleng P.S : 2009/05/31 to 2009/06/04
(3) Periodic inspection for O'Romis P.S : 2009/06/04 to 2009/06/05
(4) Post meeting for inspection : 2009/06/06

Inspection of Diesel power station

(1) Pre meeting for inspection: 2009/06/09
(2) Periodic inspection for Diesel P.S : 2009/06/10 to 2009/06/12
(3) Post meeting for inspection : 2009/06/13

2. Periodic Inspection (No.4)

Inspection of Hydropower station

(1) Pre meeting for inspection: 2010/6/2
(2) Periodic inspection for O'Romis P.S : 2010/6/2 to 2010/6/3
(3) Periodic inspection for O'Moleng P.S : 2010/6/4 to 2010/6/5
(4) OJT for hydropower equipment : 2010/6/5 to 2010/6/7
(5) Post meeting for inspection : 2010/6/7

Inspection of Diesel power station

(1) Pre meeting for inspection: 2010/8/3
(2) Periodic inspection for Diesel P.S : 2010/8/4 to 2010/8/7
(3) OJT for diesel equipment : 2010/8/8 to 2010/8/9
(3) Post meeting for inspection : 2010/8/9

(Photo-left) Inspection and measurement of control panel

(Photo-right) Overhauling work for diesel engine at 8,000 running hours

(2) Daily Patrol

EUMP conducted regularly the daily patrols/inspection in order to skill up maintenance of hydro and diesel power stations and prepared a record sheet indicating management values and notes for daily and weekly inspection,

(3) Repairing Report

There was no large repairing work in the second period year. During 2 years of the project, there was a large repairing only for speed changer unit at O'Moleng power station, this repairing was proposed by the supplier of Tanaka hydro Mfg. in April 2009 as a replacement of new type of speed changer during the defect reliability period.

As for the diesel power station, there was no minor repairing work, there were small troubles as follows

Diesel power station

- Starting failure of air start valve due to rust of air start valve and non operation of the engine.
- Leakage of temperature meter in exhaust gas line due to looseness of the nut, but without power supply stoppage.

(4) Fault Report

As same as the first period year activity for operation and maintenance, JICA project team judged that EUMP did trouble shooting and repairing of the equipment, which operators detected minor trouble by them. All staff of EUMP was able to handle it when they had a serious trouble in the power system within a short time and best effort.

There was not serious trouble in the turbine/generator unit, and the diesel power station was free from serious trouble except for small repairing without power supply stoppage to the power system.

All faults were recorded in the [Event Records]. (Appendix 4-5)

4.3 Activities

4.3.1 Site Survey Record

The site survey for 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.

1) The 6th Mission: From 2010/5/27 to 2010/6/25（30 days）
2) The 7th (1st) Mission: From 2010/7/31 to 2010/8/14（15 days）
3) The 7th (2nd) Mission: From 2010/9/25 to 2010/10/14（20 days）
4) The 8th Mission: From 2010/10/31 to 2010/11/29（30 days）

5) The 9th Mission: From 2011/2/9 to 2011/3/2 （22 days）

4.3.2 The Summary of Field Activities Record for 2nd Period Year

The summary of activities and evaluation for generation facilities conducted in the site surveys from 6th to 9th survey is shown in the following table. For detail survey report, refer to Clause 4.3.4 hereinafter.

Time of Work	Work Items	Activities	Results and Evaluation
Preparatory Work 2010/April	Inception Report (Draft)	Inception Report	Prepared Inception Report and submission to EUMP
6th Work in Cambodia (No.6) 2010/May-June	1)Technical guidance of operation and maintenance to EUMP's staffs	The pending matter discussed 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 rainy season. (3) Study of electrical theory (Sequence diagram) (4) Execution of Periodic Inspection (3rd plan) (5) First Self-evaluation was conducted.	(1)Daily Operation Data: Operation data were recorded with 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) Inflow data of the river Measured and recorded. (3) On –the-job training for trouble shooting, mainly for study of electrical theory, etc. We carried out the OJT on the desk work using manuals for understanding of electrical theory such as reading sequence diagram, block diagram and analysis of fault, etc. (4) The mission proposed and discussed with EUMP the inspection plan and execution of the inspection as follows: This time, the inspection was done mainly for generator, control panel and dummy load panel including OJT for sequence diagram. However, for diesel power station, the inspection was postponed up to August 2010 due to decreasing of river water inflow. (5) Self-evaluation was conducted for all technical staff. JICA project team judged all staff level were lower than their score, especially, in [Check 1: Plan] and [Check 6: Understanding of Drawings, sequence and document] their level were at E level (20%). Therefore, we made an action plan is as in [Improvement of Understanding of Check 6].

Time of Work	Work Items	Activities	Results and Evaluation
7th - 1st Work in Cambodia (No.7) 2010/July-Aug.	1)Technical guidance of operation and maintenance to EUMP's staff	The pending matter discussed between EUMP and the mission was measured after evaluation of collected data as follows. (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, mainly for study of electrical theory, etc. (4) Plan and execution of 3rd. Periodic Inspection for Diesel power station	(1) Recent operation data were not filed in the data book. (2) As of August, the river flow was very low and O'Romis p.s could operate only 50kW and O'Moleng p.s was utilizing operation approx.100kW for 2 to 3 hours at peak load. (3) 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 instructed the EUMP to carry out the next step for technical and evaluation of trouble shooting on the desk work using O&M manual. (4)The mission evaluated the proposed DG inspection plan of EUMP, and to execute the load control in the power system for inspection. DG inspection was carried out on 3 to 9 August, 2010. EUMP staff made a plan of load shedding for 8:00 to 16:00 every day and carried out for inspection.
	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
7th – 2nd Work in Cambodia (No.8) 2010/Sep-Oct..	1)Technical guidance of operation and maintenance to EUMP's staffs	The pending matter discussed between EUMP and this mission measured after evaluation of collected data as follows. The JICA mission re-confirmed how to change the G.V and effectiveness operation. (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)Self-evaluation and the study of Electrical theory, etc. (4)Lead to planning of spare parts, understanding of instruction and maintenance	(1)Operation data were recorded by the PC system, and such data will be useful for Annual Report, so on. (2) On 2 September 2010, EUMP has adjusted the G.V zoon and both hydropower stations were operating 100%; 185kW, (but maximum output of 200kW) as of 6 October 2010. (3) According to the Action Plan, they studied it by themselves or in groups during 3 months. Therefore, we had an examination " Electrical theory" for 13 staff on 28 September 2010 and to get 98 points in an average of the result. (4) JICA team explained document of instruction and maintenance manual provided by the project contractor. EUMP/EDC will make a plan of

Time of Work	Work Items	Activities	Results and Evaluation
		manual (5)Plan of 4th Periodic Inspection in November 2010 (6)Repairing of access road for O'Romis power station (7)4th JCC Meeting (8)Terminal Evaluation for Project	procurement of spare parts and proved budget for next inspection. (5) The 4th inspection after 2 years operation is the last inspection, we decided inspection schedule in the beginning of November 2010. (6) Temporary construction of access road finished on 4 Oct 2010, and final repairing work will be completed by coming dry season. (7) The 4th JCC Meeting was held on 4 Oct 2010 from 8 : 30 to 12 : 00 at MIME meeting room attending MIME, EAC, EDC, EUMP, JICA Cambodia office and JICA project team. (8) Terminal evaluation of the Mondul Kiri Project was carried out from 27 September to 1 October 2010 at Mondul Kiri province and Phnom Penh. JICA team/EUMP had interview and submitted necessary data and information to JICA evaluation team.
Preparatory Work 2010/October	Interim Report (Draft)	Interim Report (as of Oct. 2010)	Prepared I/R and submission to EUMP
8th Work in Cambodia (No.9) 2010/Nov～Dec	1)Technical guidance of operation and maintenance to EUMP's staffs	The pending matter discussed between EUMP and our mission measured after evaluation of collected data as follows. This mission was the final site survey so that it is important to confirm the transfer technology for management and technical matters. (1)Re-evaluation of operation data for each power station, (2)The study of operation and maintenance at flood season (3)Self-evaluation and the study of electrical theory, etc. (4)Plan of 4th Periodic Inspection in November 2010 (5)Access Pass entrance for O'Romis hydropower station	(1)Operation data were recorded with the PC system, and that data will be useful for Annual Report, so on. (2)As of November 2010, hydropower station was operable at rated out put (185kW), furthermore, river water was overflowing from dam crest, so that EUMP operated to open the gate for flushing. (3) EUMP staff were studying electrical theory such as "Sequence numbers and Symbols" as an Action Plan. So that to learn the next step, we had a seminar for 15 staff of EUMP with trainer of JICA SV (Mr. Yamakawa) and JICA project team. We will make self-evaluation as a final step coming February 2011. (4) JICA team proposed and discussed with EUMP the 4th periodic inspection plan in November 2010. Especially, inspection of diesel power station required to stop the unit continuously for 4 days (around 80 hours) and load sedding in some area has been done.

Time of Work	Work Items	Activities	Results and Evaluation
			(5) The final arrangement and repairing work will be completed by coming dry season.
9th Work in Cambodia (No.10) 2011/February	1)Technical guidance of operation and maintenance to EUMP's staffs	According to the previous 8thmission, the pending matter to be discussion between EUMP and this mission measured after evaluation of collected data as follows. So as to the final worked and instructed to EUMP staff, it was important to lead the management and O&M for hydropower and diesel power stations. (1)Re-evaluation of operation data for each power station, (2)Self-evaluation and the study of electrical theory, etc. (3)JICA Ex-Post Situation Study Mission (4)5th JCC Meeting in February 2011 (5)Seminar for Small Hydropower Engineering (6) Disaster prevention plan	(1) Operation data were recorded with the PC system, and that data will be useful for Annual Report, so on. (2) We had self-evaluation as an final after study of the electrical theory by themselves or group during 6 months. The result was satisfactory to be clear the second step with A~B level (100~80 %) for operation & maintenance as well as management of the Technical Division. (3) JICA project team has cooperated and submitted data and information to JICA Ex-Post Situation Study Mission in Cambodia office during 14 to 16 February 2011 at Mondul Kiri project site. (4) The 5th JCC as final meeting was held on 23 February 2011 from 10 : 00 to 12 : 00 at MIME meeting room, Phnom Penh JICA Cambodia office reported about Ex-Post Situation Study. (5) Seminar for small hydropower engineering was held by JICA project team at JICA Cambodia office on 22 Feb 2011 at 9:30 to 11:30. 6) JICA project team proposed EUMP to establish the disaster prevention plan for emergency and EUMP studies it.
Operation Records	From 7/ Nov. 2008 to 20/Dec. 2010	1) Total power supply 3,247,710kWh Hydro: 2,049,423kWh Diesel: 1,198,287kWh 2)Maximum demand 490kW (21 Nov. 2010)	3)Number of customers 1,304 household (20 Dec. 2010) 4)Operation hours O'Moleng: 13,421Hrs. O'Romis: 15,203Hrs. Diesel: 6,999Hrs.
Fault and Repairing Records of EUMP (2010/Jan. to 2010/Dec.)			
Experiences of Faults and repairing	During January 2010 to December 2010	(1)Hydropower stations	(1) There was no large trouble from in Jan. to Dec. 2010.

Time of Work	Work Items	Activities	Results and Evaluation
		(2)Diesel power station	1) 2010/4/14: DG failed in re-starting because air starting valve was not working with rust. 2) 2010/ 1 2/16: Exhaust gas temperature meter of DG was leaked, and then DG shortly stopped for repairing. 3) 2010/12/19 DG fuel oil meter was broken, and change the by-pass circuit. (but not stopping of DG)

4.4 Field Activity 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.

4.4.1 6th Survey: from 2010/5/27 to 2010/6/25

Operation and Maintenance of Generating Facilities

The hearing and data collection in 6th survey mission was carried out from EUMP staff in order to evaluate for actual conditions of operation and maintenance management at site as follows.

1. Date of Survey

1st meeting: 2 June 2010

2nd meeting: 17 June 2010

Attendants

EUMP side: Mr.Kong Pisith (Director of EUMP)
Mr. Chin Sokhun (Deputy Director of Technical Division)
Mr. Thai Kihn (Chief of Technical Division)
Mr. Pen Pidu (Deputy Chief of Technical Division, O'Romis)
Mr. Yeb Thav (Deputy Chief of Technical Division, Diesel)
Mr. Yang Soyen (Section Chief of Technical Division, O'Moleng)

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

2. Collection Data

1) Items discussed and surveyed

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

The previous mission instructed the measure of hydropower operation during dry season. But the rainy did not start yet at site (in June) and the mission re-confirmed how to change the GV operation.

(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, mainly for study of electrical theory, etc.
(4) Plan and execution of 3rd. Periodic Inspection for Hydropower stations excepting diesel power station
(5) Self-evaluation of C.P and making Action Plan

<u>1st Step</u>

Operation data from 1st Feb to June 2010 for each power stations were collected and to evaluate them.

2nd Step

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

Operation data and failure record of power system were recorded at every power station very well and put into the PC system provided by JICA project team. But the work procedure and plan were not implemented or lacked, because that work plan was under the revision of O&M Manual. So we proposed to apply it after completion of O&M Manual in Khmer version. The revised plan will be applied from 3rd periodic inspection.

3rd Step

We proposed to apply it after completion of O&M Manual in Khmer version. EUMP agreed to apply it in the 3rdof periodic inspection (June 2010).

2) Results

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

Operation data were recorded with 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 of the staff thinking well, the hydropower stations were reasonably operated by changing the guide vane during dry season from Dec 2009. In the rainy season of June, it was continued to operate in the same condition because the river water inflow was still low. As of June, especially, O'Romis hydropower stopped in day time and O'Moleng operated only for peak load in the morning and evening of 2-3 hours, respectively.

(3) On –the-job training for trouble shooting, mainly for study of electrical theory, etc.

In order to maintain the reliability and the least of shutdown in the power system, we gave re-training of the trouble shooting to EUMP staff 2 times in 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. On the other hand, we carried out OJT on the desk work using manuals for understanding of electrical theory such as reading sequence diagram, block diagram and analysis of fault, etc. Therefore, we instructed the EUMP to carry out the next step as a technical and evaluation of trouble shooting, then EUMP staff would follow action plan to improvement of their skill.

OJT at Control Panel

OJT for electrical theory using spare parts and actual equipment

(4) Plan and execution of Periodic Inspection

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

For O'Moleng and O'Romis hydropower stations disassembly/assembly inspection were carried out from 2 June to 9 June 2010. This time, the inspection was done mainly for generator, control panel and dummy load panel including OJT for sequence diagram.

However, Diesel power station was postponed up to August 2010 due to decreasing of river water inflow.

Servo-motor inspection at O'Romis P.S

Generator inspection and cleaning at O'Romis P.S

Inspection and Cleaning of Dummy Load at O'Moleng P.S

Inspection and Cleaning of Control Panel at O'Moleng P.S

(5) Self-evaluation

Self-evaluation was conducted for all technical staff (O'Moleng 4, O'Romis 5 and Diesel 5).

The results showed high points as a first evaluation and the study of electrical theory, etc. and trend of points balance was mostly same. This mean that, 1) staff had a study at same time of OJT, and 2) same manner of operation and maintenance practices. But, JICA project team judged all staff level were lower than their score, especially, in [Check 1: Plan] and [Check 6: Understanding of Drawings, sequence and document] their level were lease of E level (20%). Therefore, we made an action plan as shown in [Improvement of Understanding of Check 6].

In order to maintain the reliability and the least of shutdown in the power system, we gave re-training of the electrical theory such as "Sequence numbers and Symbols" as a previous Action Plan, they studied it by themselves or group during 3 months.

Therefore, we had an examination " Electrical theory" for 13 staff on 28 September 2010 and they got 98 points in an average of the result. This means that the first step was cleared and we made a next step to learn " Block and Wiring Diagram" coming November 2010.

3. Interconnection Plan between Mondul Kiri Power System and Viet Nam System

EDC is planning to import the power from Viet Nam power system in the future. In this regard, EDC asked JICA project team to recommend technical matter and advice to EDC before/after interconnection. JICA project team reported to JICA Cambodia office, who agreed the support of technical matter and site survey such as transmission line route recommendation of technical specifications and attendance of technical meeting.

On the other hand, EDC has no experience of interconnection plan as a hybrid system in mixing hydropower and diesel power. JICA project team had meetings for technical matter on 11 June and 21 June 2010 at EDC head office. (refer to Memo No.1 & 2 as attached in Appendix)

Check Point of Border Line

Non-electrification Village near by planed transmission line route

4. Transfer to EDC Organization

In the 3rd JCC meeting in January 2010, MIME/EDC announced that EUMP was proceeding the transfer to EDC from June 2010. In June 8th "Transfer Ceremony of EUMP" was held with attendance of MIME, EDC, EDC, State Government, JICA Cambodia office and EUMP/JICA project team at Senmonorom city.

Transfer of EUMP is good for future enterprise under the EDC organization on operation and maintenance. All staff of EUMP would be transferred to EDC, and the least risk might remain, but EDC/EUPM would be required to solve it step by step in this year.

Transfer Ceremony at Gov't office

Same as left

5. Instruction

JICA project team led EUMP to study and improve the skill and knowledge according to the [Action Plan] during daily and monthly working period and to make a target of next evaluation in September 2010.

4.4.2 7th Survey: from 2010/7/31 to 2010/8/14 (15 days)

Operation and Maintenance of Generating Facilities

The 7th-1st site survey was carried out for periodical operation and maintenance during flood season after transferring to EDC. JICA project team confirmed to do high efficiency operation by changing of guide vane. The 3rd periodic inspection of diesel power station was carried out in August 2010 without any trouble because of the delayed schedule inspection for diesel due to shortage of inflow.

The hearing and data collection in 7th survey mission was carried out from EUMP staff in order to evaluate actual conditions of operation and maintenance management at site as follows.

1. Date of Survey

out in August 2010 and data

1st meeting: 3 August 2010

Attendants

EUMP side: Mr.Kong Pisith(Director of EUMP)
Mr. Chin Sokhun(Deputy Director of Technical Division)
Mr. Thai Kihn(Chief of Technical Division)
Mr. Pen Pidu(Deputy Chief of Technical Division, O'Romis)
Mr. Yeb Thav(Deputy Chief of Technical Division, Diesel)
Mr. Yang Soyen(Section Chief of Technical Division, O'Moleng)

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

2. Collection Data

1) Items discussed and surveyed

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

The previous mission instructed the measure of hydropower operation during dry season. But as of August 2, 2010 the rainy did not start yet at site and the mission re-confirmed how to change the GV operation.

(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, mainly for study of electrical theory, etc.
(4) Plan and execution of 3rd. Periodic Inspection for Diesel power station

1st Step

Operation data from 1 July 2010 for each power station were collected and evaluated.

2nd Step

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

Operation data and failure record of power system were recorded at every power station very well and put into the PC system provided by JICA project team. But recently operation data were not filed in the data book. Inspection work procedure and stoppage plan were made before periodic inspection.

3rd Step

We proposed EUM to provide the procedure and stoppage plan for periodic inspection. EUM agreed to apply it in the 3rd of periodic inspection in August 2010.

2) Results

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

Operation data were recorded with the PC system, and that data will be useful for Annual Report, so on. But recently operation data were not filed in the data book.

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

Through the training and actual work to the staff thinking well, the reasonable operation of the power station and stable supply to the power system was implemented. As of August, the river flow was very low and O'Romis p.s coudl operate only 50kW and O'Moleng p.s was utilizing operation approx.100kW for 2 to 3 hours at peak load.

(3) OJT

In order to maintain the reliability and the least of shutdown in the power system, we gave re-training of the trouble shooting to EUMP staff 2 times in yearly 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 instructed the EUMP to carry out the next step as a technical and evaluation of trouble shooting on the desk work using O&M manual.

(4) Plan and execution of Periodic Inspection

The mission proposed and discussed with EUMP about the inspection plan and execution of the load control in the power system for inspection.

In the first, periodic inspection of DG was planned in June, but we postponed in August due to shortage of generation by hydropower stations. Then DG inspection was carried out from 3 to 9 August, 2010. Since this rainy season was low inflow in the river, and had to limit the supply power to the customers. EUMP staff made a plan of load shedding for 8:00 to 16:00 every day and carried out for inspection.

DG disassembly inspection
4,000－5,000 hours

Cleaning and checking for parts

DG Cylinder assembly

OJT for inspection method and maintenance records

3. Instruction

JICA team instructed that in the restriction of load supply to the customers, EUMP had to make a plan and to announce in the public before periodic inspection so as not to cause claim from the customer.

4.4.3 7th -2nd Survey: from 2010/10/31 to 2010/11/29

Operation and Maintenance of Generating Facilities

The 7th 2nd site survey was carried out from 2010.09.25 to 2010.10.14 during flood season in order to lead and confirm the effectiveness operation of 3 power stations such as O'Romis and O'Moleng Hydropower and Diesel-power station. Both hydropower stations were operating well and output was 185kW in rating capacity. As for Diesel power station which was carried out the periodic inspection in August 2010, were operating only for load during 19-20:00 at peak time. The hearing and data collection in 7th survey mission was carried out from EUMP staff for the evaluation of actual condition in operation and maintenance management at site as follows.

1. Date of Survey

1st meeting: 29 September 2010

2nd meeting: 6 October 2010

Attendants

EUMP side: Mr. Chin Sokhun (Chief of EUMP)
Mr. Thai Kihn (Deputy Chief of EUMP)
Mr. Theng Setha (Division Chief of Technical Division)
Mr. Heng Sokhon (Section Chief of Technical Division, O'Romis)
Mr. Yang Soyen (Section Chief of Technical Division, O'Moleng)
Mr. Yeb Thav (Section Chief of Technical Division, Diesel)

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

2. Collection Data

1) Items discussed and surveyed

The pending matter discussedn between EUMP and this mission measured after evaluation of collected data as follows.

The previous mission instructed the measure of hydropower operation during dry season. But as of the beginning of September 2010, EUMP adjusted the guide vane (G.V) for operable 100% output against the river water inflow. The JICA mission re-confirmed how to change the G.V and effectiveness operation.

(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) Self-evaluation and the study of electrical theory, etc.
(4) Lead to planning of spare parts, understanding of instruction and maintenance manual
(5) Plan of 4th Periodic Inspection in November 2010
(6) Repairing of access road for O'Romis power station
(7) 4th JCC Meeting
(8) Terminal Evaluation for Project

1st Step

Operation data from 15 August 2010 for each power station were collected and evaluated.

2nd Step

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

Operation data and failure record of power system were recorded at every power station very well and put into the PC system provided by JICA project team. But recently operation data were not filed in the data book, then we confirmed with EUMP to complete the data book.

3rd Step

We proposed EUMP to provide the document, operation records, fault records and drawings for the JICA Terminal Evaluation Mission. The EUMP provided them, showing the documents to the

Mission.

2) Results

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

Operation data were recorded with the PC system, and that data will be useful for Annual Report, so on.

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

Through the training and actual work to the staff thinking well, the reasonable operation of the power station and stable supply to the power system was implemented. On 2 September 2010, EUMP adjusted the G.V zoon and both hydropower stations were operating 100% ; 185kW, (but maximum output of 200kW) as of 6 October 2010. This adjustment was 3 months delay compared with last year.

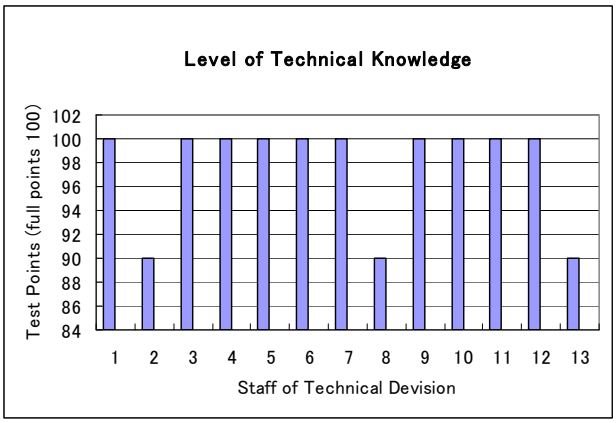
Sand flushing at O'Romis gate

Adjusting of G.V 3/3 at O'Romis

(3) Self-Evaluation and the study of Electrical theory, etc.

In order to maintain the reliability and the least of shutdown in the power system, we gave re-training of the electrical theory such as "Sequence numbers and Symbols" as a previous Action Plan, they studied it by themselves or group during 3 months.

Therefore, we had an examination " Electrical theory" for 13 staff on 28 September 2010 and they got 98 points in an average of the result. This means that the first step was cleared and we made a next step to learn " Block and Wiring Diagram" coming November 2010.



Note) O'Moleng (Staff no. 1 to 4)
O'Romis (Staff no. 5 to 8)
Diesel (Staff no. 9 to 13)

(Photo) Examination of Action Plan for Self-Evaluation

(4) Lead to planning of spare parts, understanding of instruction and maintenance manual

JICA project team explained document of instruction and maintenance manual provided by the project contractor. EUMP/EDC will make a plan of procurement of spare parts and secure budget for next inspection.

(5) Plan of 4th Periodic Inspection in November 2010

JICA project team proposed and discussed with EUMP the 4th periodic inspection plan in November. The 4th inspection after 2 years operation was the last inspection under the supervising of Japanese and required the load control in the power system for stoppage of DG power station.

Since this rainy season had low inflow in the river, and had to limit the supply power to the customers, then we decided inspection schedule in the beginning of November 2010.

(6)Repairing of access road for O'Romis power station

After new construction of national road route 76, access road of O'Romis had to be repaired by EUMP/EDC because of no compensation from the road contractor and state government. Temporary construction of access road has finished on 4 Oct 2010, and final repairing work will be completed by coming dry season.

Access road from route 76 to O'Romis

Road from O'Romis to Route 76

(7) The 4th JCC Meeting

The 4th JCC Meeting was held on 4 Oct 2010 from 8：30 to 12：00 at MIME meeting room attending MIME, EAC, EDC, EUMP, JICA Cambodia office and JICA project team.

4th JCC Meeting

(8)Terminal Evaluation for Project

Terminal evaluation of the Module Kiri Project was carried out from 27 Sepember to 1 October 2010 at Mondul Kiri province and Phnom Penh attended MIME, EAC, EDC, EUMP, JICA Cambodia office and JICA project team.

JICA project team/EUMP had interview and submitted necessary data and information to JICA evaluation team.

Interview for EUMP staff

3. Instruction

JICA project team instructed that in the restriction of load supply to the customers, EUMP has to make a plan and to announce in the public before periodic inspection so as not to cause claim from the customers. Especially, when DG power station stops for overhauling work, the supply power must be limited during 80 hours through 4 days inspection.

4.4.4 8th Survey: from 2010/10/31 to 2010/11/29

Operation and Maintenance of Generating Facilities

The 8th site survey was carried out from 2010.10.31 to 2010.11.29 during flood season in order to lead and confirm the effectiveness operation of 3 power stations such as O'Romis and O'Moleng Hydropower and Diesel-power station. Both hydropower stations were operating well and output was 185kW in rating capacity. As for Diesel power station was operated only for at peak load about 2 hours operation for supporting hydropower stations.

The hearing and data collection in 8th survey mission was carried out from EUMP staff for the evaluation of actual condition in operation and maintenance management at site as follows.

1. Date of Survey

1st meeting: November 3, 2010

2nd meeting: November 24 2010

Attendants

EUMP side: Mr. Chin Sokhun (Chief of EUMP)
Mr. Thai Kihn (Deputy Chief of EUMP)
Mr. Theng Setha (Division Chief of Technical Division)
Mr. Heng Sokhon (Section Chief of Technical Division, O'Romis)
Mr. Yang Soyen (Section Chief of Technical Division, O'Moleng)

Mr. Yeb Thav (Section Chief of Technical Division, Diesel)
JICA project team mission : Mr. Yukitaka HIRAGA (Electro-mechanical Engineer)

2. Collection Data

1) Items discussed and surveyed

The pending matter discussed between EUMP and our mission measured after evaluation of collected data as follows. This mission was the final site survey so that it was important to confirm the transfer technology for management and technical matters.

(1) Re-evaluation of operation data for each power station,
(2) The study of operation and maintenance at flood season
(3) Self-evaluation and the study of electrical theory, etc.
(4) Plan of 4th Periodic Inspection in November 2010
(5) Access Pass entrance for O'Romis hydropower station

1st Step

Operation data from 15 Oct. 2010 for each power station were collected and to evaluated.

2nd Step

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

Operation data and failure record of power system were recorded every power station very well and to put into the PC system provided by JICA project team. But recently operation data were not filed in the data book, then we asked with EUMP to complete the data book.

3rd Step

We led EUMP to continue the management of power stations as previous condition.

2) Results

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

Operation data were recorded with the PC system, and that data will be useful for Annual Report, so on.

(2) The study of operation and maintenance at flood season

The year 2010 saw unusual dry condition for hydropower stations, the river inflow delayed around for 3 months. As of November 2010, hydropower station was operable at rated out put (185kW), furthermore, river water was overflowing from dam crest, so that EUMP operated to open the gate for flushing.

(Left)
Over flow at O'Romis dam
(Left-bottom)
Overflow at O'Moleng dam
(Right-bottom)
Sand flushing at O'Moleng

(3) Self-evaluation and the study of electrical theory, etc.

EUMP staff were studying electrical theory such as "Sequence numbers and Symbols" as an Action Plan. In order for them to learn the next step, we had a seminar attended by 15 staff of EUMP with trainer of JICA SV (Mr. Yamakawa) and JICA project team. Especially, we confirmed that the skill for the understanding of "Sequence numbers and Symbols" and calculation of electric theory was transferred. We would make self-evaluation as a final step coming February 2011.

(Photo) Seminar for Action Plan（Trainers: JICA SV and JICA project team ）

(Photo)Seminar for Action Plan

(4) Plan of 4th Periodic Inspection in November 2010

JICA project team proposed and discussed with EUMP the 4th periodic inspection plan in November 2010 due to unusual inflow in this year. The 4th inspection after 2 years operation was the last inspection under the supervising of Japanese.

Especially, inspection of diesel power station was required to stop the unit continuously for 4 days (around 80 hours) so that load shedding in some areas was done against peak load of 450kW to decreased to 300kW.

(Photo) Disassembly inspection at O'Moleng P.S

(Photo)Inside inspection of Runner

(Photo)Checking of Spare Parts for DG **(Photo)Disassembly inspection of DG**

The commercial staff of spare parts agent (dispatched to the site from Singapore and explained how to proceed with the parts procurement and supervisor for overhaul work.

Agent name: DAIKAI Engineering Pte Ltd. Mr. Rodny Tan

NO. 128 Pioneer Road Singapore 639586

E-mail: rodtan@daikai.com

Tel. +65 6863 2856 Fax. +65 6863 2876

(5) Access Pass Entrance for O'Romis hydropower station

After new construction of national road route 76, access road of O'Romis was repaired and inspected by EUMP/EDC in 4th October 2010. The final arrangement and repairing work would be completed by coming dry season.

Access road to O'Romis (before)

After repairing and pavement road

3. Instruction

(1) Inspection and Load Shedding Plan

JICA project team instructed that in the restriction of load supply to the customers, EUMP had to make a plan and to announce in the public before periodic inspection so as not to cause claim from the customers. Especially, when DG power station stops for overhauling work, the supply power must be limited during 80 hours.

(2) Periodic Inspection Plan in the future

1. As for hydropower station, the periodic inspection shall be planned once a year, however small inspection has to be done weekly and monthly in accordance with O&M Manual.

Inspection Item	Interval	Kind of Inspection
Weekly inspection	Every 2 weeks	Patrol and cleaning, etc.
Monthly inspection	Every 3 months	Visual inspection and grease up for generator bearing every 6 month, etc.
Periodic inspection	Once a year	1) Turbine disassembly and inside inspection 2) Change of turbine bearing grease every year. 3) Check lub. oil for speed changer every year, but if oil dirty, to change lub. oil. Normally, lub. oil shall be changed every 2 years. 4) Cleaning dummy load 5) Check of control panels

2. As for Diesel power station, the periodic inspection shall be carried out in accordance with running hours in the following table, and interval of filters cleaning/change shall be every 2,000 hours running of diesel engine.

Interval	Running Hours (h)	Kind of Inspection	Kind of Inspection
1st Inspection	4,000-5,000	Top haul work	Check F.O nozzles and cleaning, etc. Change of water J.W line: 100l And to fill rust inhibitor: 4ml/litter = 400ml
2nd Inspection	8,000-10,000	Overhaul work	Check piston/cylinder and cleaning, change lub. Oil and cooling water, etc. Change of water J.W line: 100l And to fill rust inhibitor: 4ml/litter = 400ml Change of Cooler water line: 400l and to fill rust inhibitor: 2ml/litter = 800ml
3rd Inspection	12,000-14,000	Top haul work	Same as 1st Inspection
4th Inspection	16,000-18,000	Overhaul work	Same as 2nd Inspection

3. This is a point and normal way for the periodic inspection in Japan that EUMP/EDC shall arrange the supervisor from agent or original manufacture in order to overhaul work of both hydro and diesel power stations, respectively. EUMP/EDC must provide the budget for the supervisor fee in the yearly financial plan, 2011 in accordance with Chapter 3 Long & Medium Term Plan, Volume I in the O&M Manual.

Even if, EUMP/EDC staff is able to carry out for small inspection such as weekly, monthly check without supervisor, but for overhaul work it is necessary to arrange the supervisor to prevent the trouble or damage of equipment during the work and in the future.

4.4.5 9th Survey: from 2011/2/9 to 2011/3/2

Operation and Maintenance of Generating Facilities

The 9th site survey was the final work, carried out from 2011.2.9 to 2011.3.2 during dry season.
In order to lead and confirm the effectiveness operation of 3 power stations such as O'Romis and O'Moleng hydropower and diesel-power station, both hydropower stations have been well operating at the lowest output around 30-40kW with parallel running of diesel power station in out put around 200 to 300kW. The hearing and data collection in 9th survey mission was carried out from EUMP staff for the evaluation of actual condition in operation and maintenance management at site as follows.

1. Date of Survey

1st meeting: 17 February 2011
2nd meeting: 25 February 2011
Attendants
EUMP side: Mr. Chin Sokhun (Chief of EUMP)
Mr. Thai Kihn (Deputy Chief of EUMP)
Mr. Theng Setha (Division Chief of Technical Division)
Mr. Heng Sokhon (Section Chief of Technical Division, O'Romis)
Mr. Yang Soyen (Section Chief of Technical Division, O'Moleng)
Mr. Yeb Thav (Section Chief of Technical Division, Diesel)
Project Mission : Mr. Yukitaka HIRAGA (Electro-mechanical Engineer)

2. Collection Data

1) Items discussed and surveyed
According to the previous 8thmission, the pending matter discussed between EUMP and this mission measured after evaluation of collected data as follows.
So as to the final worked and instructed to EUMP staff, it was important to lead the management and O&M for hydropower and diesel power stations.

(1) Re-evaluation of operation data for each power station,
(2) Self-evaluation and the study of electrical theory, etc.
(3) JICA Ex-Post Situation Study Mission
(4) 5th JCC Meeting in February 2011
(5) Seminar for Small Hydropower Engineering

1st Step
Operation data from 1 Dec. 2010 for each power station were collected and to evaluate them.

2nd Step
The analysis and evaluation of actual data, the pending matter was as follows,

Operation data and failure record of power system has been recorded every power station very well and put into the PC system provided by JICA project team. But recently operation data were not filed in the data book, then we asked EUMP to complete the data book.

3rd Step

We led EUMP to continue the management of power stations as previous condition.

2) Results

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

Operation data were recorded with the PC system, and that data will be useful for Annual Report, so on.

(2) Self-Evaluation and the study of Electrical theory, etc.

In order to maintain the reliability and the least of shutdown in the power system, we gave re-training of the electrical theory such as “Sequence numbers and Symbols” as an “Action Plan”, they studied it by themselves or group during 6 months.

Therefore, we had a final self-evaluation in order to confirm their improvement and skill up, and getting average point of the staff in Technical Division of EUMP. The result was satisfactory to clear the second step with A~B level (100~80 %) for operation & maintenance as well as management of the Technical Division.

(Photo) Action Plan: Final Self-Evaluation

(3) JICA Ex-Post Situation Study Mission

JICA project team has cooperated and submitted data and information to JICA Ex-Post Situation Study Mission in Cambodia office during 14 to 16 February 2011 at Mondul Kiri project site.

(Photo) JICA Ex-Post Situation Study Mission at O'Moleng hydropower station

(Photo) JICA Ex-Post Situation Study Mission(dry condition at O'Moleng dam)

(Photo) JICA Ex-Post Situation Study Mission Interview to JICA project team

(Photo) JICA Ex-Post Situation Study Mission Interview to non-electrification village leader

(4) The 5th JCC Meeting in February 2011

The 5th JCC as the final meeting was held on 23 February 2011 from 10 : 00 to 12 : 00 at MIME meeting room, Phnom Penh attended by MIME, EAC, EDC, EUMP, JICA Cambodia office and JICA project team (around 38 persons).

Chairman addressed an opening remark, and EUMP and JICA project team presented about the performance in the second period year, 2010 and forecasting in 2011.

JICA Cambodia office reported about Ex-Post Situation Study.


（Photo）5th JCC Meeting, at MIME 2011.2.23

(5) Seminar for Small Hydropower Engineering

Seminar for small hydropower engineering was held at JICA Cambodia office on 22 Feb 2011 at 9:30 to 11:30. The JICA project team presented the following theme in the seminar.

1. Small hydropower (Plan)
2. Small hydropower (Design)
3. Mondul Kiri Electrification Project (Construction)

Attending :

1. EDC head office: 10 persons
2. EDC Rattana Kiri: 2 persons
3. EDC Mondul Kiri: 8 persons
4. Japanese side JICA Cambodia office : 2 officers
   JICA project team: 5 advisors


（Photo）Seminar for Small Hydropower, 2011.2.22

(6) Disaster Prevention Plan

In order to establish the disaster management support system (DMSS), the JICA project team held a meeting with recommendation (plan) to EDC Mondul Kiri branch office attended by 25 staff.

They agreed to make future plan considering idea and instruction of EDC headquarter on 25 Feb 2011.

（Photo）meeting for Disaster Prevention Plan
(2011/2/25）

3. Evaluation of Work Performance for Generating Facilities (in the 1st and 2nd Period)

In the 9th site survey in February 2011, JICA project team held the final meeting with EUMP regarding their performance in summation, O&M management and technical transfer knowledge for 2 years activities as follows.

JICA project team evaluated that the results are there for all to see and to achieve the total ability for O&M management from 2 years their activities. However, they lack knowledge in the electrical theory or analysis, so that they have to study continual.

The machine condition of all power stations were confirmed to be well operated at periodic inspection last November 2010.

1) O&M management

EUMP is at enough level for operation of start, parallel-in, stop and countermeasure of system fault, etc for 2 years operation and management, also as for maintenance, EUMP has experiences 4 times periodic inspection for 2 years. Furthermore, they studied to operate high efficiency operation for hydropower by changing guide vane between dry and rainy season

Hydropower station is influenced by the river inflow, especially output of O'Romis hydropower station might be heavily affected in daily inflow, so that they made a [River Inflow (cm) - Output (kW) Curve] (*1) at 1st period work. JICA project team confirmed that EUMP should use this operation curve in daily or seasonal in order to be stable operation.

Note: (*1) O'Romis output (kW) is proportional between inflow and generation due to provided head tank, and it is necessary to check the water level and output periodically.

2) Transfer of Technology

As for the transfer of technology, the target level of technologies was set as "the minimum level for stable electricity supply" since it was started with almost nothing in basic knowledge. In this regard, EUMP improved technical and management performance up to around 80～60％ (as a level A~B) by mean of 24 hours power supply continuously for 2 years.

JICA project team considers EUMP that in order to keep highly sustainable operation and management of EUMP, further upgrading of know-how, technologies and skill is definitely necessary.

Therefore, EUMP must do their best effort for further "self-reliant "and "study" by using many manuals and drawings, etc.

3) Operation and Maintenance System

In the starting of the Project, JICA project team recommended the shift of operators for each power station by [3-shift and 2 operators] system, but started [2-shift and 4 operators] due to lacking numbers of operator and skill-up. We further recommend that [3-shift and 2 operators] system might be comfortable for labor work condition such as 1) relief of operator, 2) take leave, 3)

emergency crew and 4) systematic management daily work.

As for daily desk work, it is important to nominate the relief or deputy position for smooth management work while a responsible personnel has left.

Appendix 4 Generation Facilities

Appendix 4-1 Energy consumption graph (2010)

Appendix 4-2 Energy consumption records (2010)

Appendix 4-3 Monthly energy consumption balance (2010 dry and rainy seasons)

Appendix 4-4 Daily load curves (2010 maximum load)

Appendix 4-5 Fault records (2010)

Appendix 4-6 Periodic inspection plan (2010 3rd and 4th inspections）

Appendix 4-7 Periodic inspection report（2010 3rd and 4th inspections）

Appendix 4-8 elf-evaluation for technical transfer (2011 February)

Appendix 4-9 Seminar for small hydropower (2011 February)

Appendix 4-10 Disaster prevention plan for EDC/Mondul kiri (2011 February)

Appendix 4-11 Viet Nam power interconnection plan (Memo No.1,2 & 3)

Appendix 4-12 Specification s for Viet Nam power interconnection plan

Chapter 5 Transmission and Distribution

Chapter 5 Transmission and Distribution

5.1 General

Transmission and distribution engineering advisor has been dispatched five times for the field work and conducted home work three times in the second year from Apr. 2010 to Mar. 2011.

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 date and so on.

Outputs and activities in the second year are as follows.

5.2 Achievements by PDM Activities

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

We checked necessity of modification of the mid- and long-term plans which were approved in the first period. There was no significant modification affected by transferring to EDC in June 2010 due to no facility change. When connecting to Vietnam system, they should be revised because the component of facilities will be considerably changed.

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

Regarding transmission/distribution section of the O&M manual, some items not matching EDC internal rules and areas requiring additions of the O&M manual were examined together with the two persons dispatched from the EDC headquarters and a revision plan (English version) was created in July 2010. Then C/Ps translated them into Khmer in August 2010 and the O&M manual was submitted at the fifth JCC in February 2011.

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

The OJT of preventive maintenance were conducted, which are assuring ground height of road crossing lines in May 2010 and trimming of trees in Dec. 2010.

We lectured the GREPTS, the SREPTS and EDC Design Standards in order to make C/Ps understand the technical basis of distribution facilities.

Regarding Vietnamese power importation, the site survey was conducted in July 2010 in Svay Rieng where was connecting to Vietnam.

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

To record and compile relevant data is caught on among the staff by the OJT such as the fault record Furthermore distribution loss is analyzed by using operation data. The circumstance of efficient operation is being put into place.

5.3 Outline of Transmission and Distribution Facilities

(1) Main Transmission and Distribution Facilities

22kV Transmission and Distribution Line : 28km
22kV Switchgear Substation : 2 places
22kV/230･400V Transformer : 44 units (10kVA:8units, 25kVA:17units, 30kVA:2units 50kVA:10units, 100kVA:4units, 250kVA:2untis, 400kVA:1unit)
230･400V Distribution Line : 33km
VHF/UHF Radio System Facilities : 1 lot (O'Moleng, O'Romis Hydropower stations, Diesel Power station and Administration Office)

5.4 Activities

5.4.1 Field Activities

(1) Members

【Counterpart】

Mr. Chin Sokhun, Chief
Mr. Thai Khin, Deputy Chief of Technique
Staff members of Transmission and Distribution team

【JICA team】

Mr. Junya SHINOHARA, Transmission and distribution engineering advisor, the Chugoku Electric Power Co., Inc.

(2) Summary of Activities

Field work timing	Work description	Work implemented	Evaluation of implementation
Preparatory Home Work in Japan May 2010	Preparation of Inception Report	Work of preparing Inception Report	Prepared on schedule.
Sixth Field Work in Cambodia May to June, 2010	Inspection of EUMP transmission/distribution facility status	1) Determined equipment status via on-site observation 2) Determined operational management status to date via interviews with EUMP engineering section staff and responsible persons.	1) Confirmed the situation of insufficient above-ground elevation for transmission lines due to road construction, installation of new transformers and other items. 2) Confirmed that suitable measures have been implemented for periodic work such as tree trimming and calculation of system loss.

	Proposal to EDC related to power importation route from Vietnam	1) Route confirmed	1) On-site inspection made together with EUMP and EDC staff, and confirmed equipment necessary for interconnection with Vietnamese system.
	C/P evaluation	1) Explained C/P evaluation plan and performed self-evaluation of first round. 2) Established action plan.	1) Excluding items related to constructions with no prior experience, it was indicated that the comprehension is around 80% or more. 2) Individual action plan was established for items with a low level of comprehension.
Seventh Field Work in Cambodia Round 1 July to Aug., 2010	O&M Manual revision	1) Revised draft of the O&M Manual was created.	1) A revised version of the O&M Manual (English) was jointly created with EDC and EUMP staff. Afterwards (end of Aug.), the EDC staff translated the manual into Khmer.
	Proposal to EDC related to power importation route from Vietnam	1) Selection of synchronizer location 2) On-site inspection in Svay Rieng Province	1) The synchronizer installation location was studied together with EDC headquarters staff. 2) An inspection of facilities in Svay Rieng Province (similar case to Mondul Kiri) was made with EUMP staff.
	Support for C/P action plan	1) Support for action plan	1) A lecture was given regarding the EDC Design Standards, used as distribution line standards.
Seventh Field Work in Cambodia Round 2 Sept. to Oct., 2010	C/P evaluation	1) C/P interim self-evaluation 2) Action plan interim report	1) Self-evaluation of second round was performed. The level of comprehension was generally improved in comparison with the first round. 2) Actions were performed based on each individual action plan although General Requirements of Electric Power Technical Standards (GREPTS) and Specific Requirements of Electric Power Technical Standards (SREPTS) have not yet been obtained.
	Proposal to EDC related to power importation route from Vietnam	1) On-site inspection 2) Discussions with EDC headquarters	1) The conditions of the planned road route during the rainy season and intervening villages were confirmed. 2) The specifications of the synchronizer and cost targets were indicated.
	Reception of final evaluation team	1) On-site inspection 2) Fourth JCC was held	1) The visit of the evaluation team with Yasujiro Suzuki

			(Chief Representative of JICA Cambodia Office) as team leader was received. 2) A report was given regarding the status of activities and final evaluation results.
Eighth Field Work in Cambodia Dec. 2010	C/P evaluation	1) C/P final self-evaluation 2) Action plan final report	1) Final self-evaluation was performed. C/P level of comprehension for all items exceeded 80%. 2) Actions were performed based on each individual action plan and objectives were achieved within the time frame.
	Work safety	1) Presentation of a fault simulation video	An explanation was presented using a video describing what occurs when there is an electrical fault such as a short circuit, in order to implement work safety.
	SREPTS and design standards	1) Lecture of design guidance of distribution facilities	1) Booklets including GREPTS and SREPTS received from the EAC were distributed to all distribution workers. 2) Explanations were provided, based on the texts, describing how to determine, using formulas, items such as the strength and length of poles.
	Guidance related to trimming in areas where trees contacts low-voltage distribution lines	1) Tree-trimming instructions	1) A special inspection was carried out on Dec. 17 to make sure that tree was not contacting distribution lines due to the start of heavy typhoon-like winds. 2) Tree trimming was performed on Dec. 18 for low-voltage lines because prior consent of landowners had not been obtained.
Ninth Field Work in Cambodia Feb. 2011	Work safety	1) Allocation of safety appliances	Rubber gloves and voltage checkers were allocated and how to use and maintain them were taught.
	Reception of Post-Evaluation Mission	1) Interview	Supply capability will be increased by power importation route from Vietnam. Therefore it will be possible for EUMP to extend the system to the unelectrified villages. Hereafter the demand will increase. Regarding the energy security,

			own hydropower or biomass power should be developed to resolve high dependence to Vietnam in the future.
	Fifth JCC	1) Final JCC was held	The fifth JCC was held on February 23, 2011 at MIME conference room.

5.4.2 Field Activity Record

(1) Sixth Field Work in Cambodia (May 18 to June 1, 2010)

a. Status of resolution of insufficient above-ground elevation for transmissions line due to road construction.

(a) Vicinity of O'Romis Power Station

Locations where lines cross roads were changed and 14-m poles (longer than the existing ones) were installed on both sides to ensure sufficient ground height. Ground elevation was visually confirmed to be approximately 10.8 m such that the standard of 8 m is sufficiently satisfied and there are no problems.

(b) Vicinity of the hospital

14-m poles (longer than the existing ones) were installed on both sides to ensure sufficient above-ground elevation although road construction resulted in the inability to maintain the 8-m standard and the subsequent removal of medium-voltage wires. Due to this, PMT03 (25 kVA) could not be supplied resulting in connection with low-voltage wires from PMT02 (50 kVA) to supply the PMT03 load. PMT02 has a use rate of approximately 80% and the low-voltage system terminal voltage is approximately 220 V such that there are no problems with power supply.

(c) PMT02: Locations where low-voltage line cross over roads

Although no problems were found during on-site inspection in December, road elevation was built up afterwards resulting in the lowest areas falling short of the standard of 6.5 m with a height of approximately 4.3 m (confirmed visually). However, locations of 4.3 m were present at the edges of the road while 5 m was maintained in areas where vehicles passed and there is an approximately 5-m high gate on the road to Phnom Penh such that there is thought to be only a low possibility of an accident occurring. As it was difficult to further raise the installation locations of transformer poles of low-voltage line, instructions were provided to install new 12-m poles for the transformer poles to ensure an above-ground elevation of the standard of 6.5 m or more.

b. Instability of pole foundation due to road construction

The results of the on-site inspection indicated that there were no particular problems. The current amount of embedment is approximately 4 m with the standard of 2 m for a 12 m pole combined

with a 2 m embankment. As the embankment portion is 2 m, the original pole embedment will remain as it is and it is thought that there are no problems as there is almost no possibility of the soil being washed away. Additionally, even if the soil were washed away for some reason, it is thought that there is only a low possibility of an accident because the poles would remain suspended from the wires due to the formation of the line.

c. Power importation from Vietnam

(a) Comparison of power importation routes

The on-site inspection held in April together with EUMP and EDC teams resulted in a change from the originally planned route (towards Busra) to towards Dak Dam.

An issue with the Dak Dam route is a problem on the Vietnamese system. When EDC was questioned, it was found out that thick line for medium voltage has been substituted on the Vietnamese side, and that the distribution systems are different (Vietnam: 3-phase/4-wire neutral resistance grounding system - Cambodia: 3-phase/3-wire neutral non-grounding system), resulting in the plan to install an automatic voltage regulator that automatically regulates the voltage at a substation that also functions as a switching station at the border of the two countries. This is expected to resolve the problem.

Table Comparison of Power Importation Routes

Item	Dak Dam route	Busra route
Distance	○ Approx. 30 km	× Approx. 70 km
Roads	○ Dirt road	× Dirt road, no road in some parts
Environment	○ Mostly tablelands with a low amount of trees that needs to be trimmed.	× The road passes through forest and there is a large amount of trees that must be trimmed.
Demand along roads	× Almost none	△ Some settlements with approx. 0.5 MW of demand
Power system on Vietnam side	× Approx. 80 km to substation. Medium voltage line is thin (50 mm^2) in some parts with voltage low at 19 kV at the terminal of the Vietnamese system.	△ Approx. 45 km to substation

Source: EUMP and EDC

Legend:

○: Positive point ×: Negative point △: Neutral point

(b) On-site Inspection

An on-site inspection of the route towards Dak Dam was conducted on May 22, 2010. The route passes almost completely through tablelands with few trees that would obstruct power distribution lines along the road. However, it does pass through forest from the Cambodia border gate to the Vietnam border gate making it necessary to cover the power lines or install overhead cable to prevent faults.

d. New Transformer Installation

Two new pole transformers were installed. All new transformer construction costs are covered by customers and they are transferred to EUMP after construction.

(a) PMT37

Newly installed at OR23. Manufactured by S.P. Electric Industry of Thailand and with a transformer capacity of 30 kVA.

(b) PMT38

Divergence from OM110. 23 poles over approximately 1.3 km fitted with medium voltage lines. Manufactured by Thibidi of Vietnam and with a transformer capacity of 30 kVA.

e. C/P evaluation

(a) Explanation of C/P evaluation plan

The Evaluation Plan was explained to Deputy Director of Technique and Chief of Technical Section in the morning on May 22, 2010. In the afternoon of the same day, Deputy Director of Technique provided an explanation including task codes to all staff, and they were instructed to fill in a self-evaluation sheet by May 24, 2010. The target C/P consists of 10 persons including the new/former sections (Deputy Director of Technique, Chief of Technical Section and eight transmission/distribution staff members).

(b) Results of first self-evaluation and establishment of action plan

On the morning of May 25, 2010, each staff member was interviewed with translation provided by Ms. Sodavy as a local staff member and the results of the self-evaluation were checked. Action plans were established for five persons still attached to the T&D section after EDC transfer of control.

f. Others

(a) Technical guidance related to the trimming of trees near power distribution lines

The status of tree trimming for which guidance was provided in Oct. 2009 was checked.

a. Trimming plan

A trimming map was created based on distribution line position diagrams. Locations

requiring trimming were understood through previous inspections and trimming is being performed before contact through the use of periodic patrol inspections.

b. Bamboo thicket trimming (between OM185 and 186)
Bamboo that might come into contact with medium-voltage lines was discovered during a patrol on May 21, 2010 and negotiations were carried out immediately with the landowner to trim the bamboo.

(b) Calculation method for distribution line loss

Deputy Chief of Technique requested to confirm the calculation method for distribution line loss. Guidance was provided the first year in relation to the calculation method and causes of distribution line loss, and confirmed that calculation was performed according to the manual with no errors in the calculation results. Examining the loss rate shows that the loss rate increases in the dry season when demand is increased in comparison with the rainy season when demand is decreased. There is no particular problem with this because distribution line loss is proportional to the square of the current. However, each transformer was checked individually and there were some with low-voltage line loss exceeding 20% resulting in instructions to perform on-site inspection of those transformers' low-voltage line systems.

There was also a question regarding the calculation of load loss and non-load loss for new pole transformers (30 kVA). 30 kVA had not been previously used at EUMP and accordingly there was no data in the transformer specifications provided in the first year. To this, it was explained that this could be obtained from the specifications table supplied when the transformers are purchased or from the nameplate on the transformer unit. Afterwards, specifications were obtained from the manufacturer's website. It was also explained how transformer performance quality can be determined from the load loss and non-load loss values, and guidance was provided that it is best to select a manufacturer for purchase by considering not only the transformer per-unit cost but also total cost over unit lifetime.

(c) PMT01 transformer: Burnout of secondary CB-box

A meter installed to the secondary side of the PMT101 transformer burnt out due to lightning striking the low-voltage line. The cause is thought to be due to a lightning-induced surge in the low-voltage distribution line caused by neighborhood lightning, or that when lightning struck the neighborhood, a great deal of thunder and lightning caused an abnormal increase in the earth potential with the lightning surge passing through the device ground to penetrate the low-voltage circuit. The burnt-out meter was necessary for metering low-voltage line loss, so arrangements for another meter were immediately made by EUMP given its high level of importance. Repairs are to be made when the meter arrives.

(2) Seventh Field Work in Cambodia, Round One (July 18 to Aug. 1, 2010)

a. Revision of O&M manual

Regarding transmission/distribution section of the O&M manual, some items not matching EDC internal rules and areas requiring additions of the O&M manual were examined together with the two persons dispatched from the EDC headquarters listed below, and a revision plan (English version) was created.

- Mr. Houng Chantha, Chief of Technical Office, Corporate Planning & Projects Department
- Mr. Ngeth Lavy, Distribution Network Unit , Distribution Department

Main points of revision are as follows:

- For all descriptions throughout the manual where T&D were used, "transmission" was deleted and only "distribution" used. In EDC, all equipment is considered to be distribution because transmission is used for equipment of 115 kV or more.
- "Director" and similar titles were changed to those used at EDC such as "Chief" and similar.
- Volume II, Section IV, "2.8 Construction" was completely revised. Although the manual is assumed for use by EUMP for their own construction operations, but these are usually performed by sub-contractors at EDC. Additionally, construction/design decisions are made by the headquarters, with project teams for construction supervision and inspection including staff from the headquarters.

The revision plan was provided to Mr. Chin Sokhun, Chief of EDC Mondul Kiri, who then provided his feedback and noted that because prior consultation with related personnel is required before creating a construction plan, such information was added to the manual. Afterwards, the above-mentioned three EDC staff members were to translate the revision plan (English version) into Khmer by the end of August, 2010 for the C/P.

b. Power Importation from Vietnam

(a) Synchronizer installation location

It is necessary to regulate the power due to the difference in distribution systems (Vietnam: Y connection 3-phase/4-wire neutral resistance grounding system - Cambodia: Δ connection 3-phase/3-wire neutral non-grounding system) for the interconnection line from the Dak Dam area. An automatic voltage regulator (AVR) is also necessary to automatically regulate voltage due to the long distance from the substation in Vietnam. It is further necessary to synchronize the systems in Vietnam and Cambodia at the time of interconnection for which a proposal is being considered to install a synchronizing relay to function as a circuit breaker that provides short circuit and grounding fault protection.

On-site discussions during this round focused on considering a location for installation of this equipment. EDC opined that a plan providing the lowest cost would be optimal and proposed consideration of two locations offering the shortest interconnection distribution line:

A: Proposal to install in the hospital cubicle (Point A)

B: Proposal to install synchronizer on pole at national road crossing (Point B)

However, considering the synchronizer functioning as a relay from the viewpoint of operation and maintenance, an aboveground location would be optimal. Accordingly, the JICA advisor team recommended "A: Proposal to install in the hospital cabinet" due to the large merits for maintenance and system operation. Synchronizer specifications are due to be provided separately to EDC at a later time.

An auto recloser will be installed at the border of the countries to prevent the spillover into Vietnam of any fault occurring in Cambodia.

(b) Svay Rieng on-site inspection

An on-site inspection was carried out on July 27 to 28, 2010 in the Kampong Ro District of Svay Rieng Province as it presents a case similar to that of Mondul Kiri. Equipment for an interconnection with Vietnam was installed in Kampong Ro in 2006 using an ADB loan and functions for reference in the case of Mondul Kiri. The following staff member participated in this on-site inspection:

- Mr. Muong Youri, Technical Office, Corporate Planning & Projects Department
- Mr. Thoung Yarafat, Technical Office, Corporate Planning & Projects Department
- Mr. Thai Khin, Deputy Chief of Mondul Kiri Unit

A grounding transformer including functions as a low-voltage supplier was installed in the switching station, and system protection is provided in Cambodia by circuit breakers and relays. Dual-line distribution lines are used in Cambodia but because the circuit breakers and grounding transformer in the switching station are all single line, and the only single lines come from Vietnam, only single-line distribution lines are used. While there is a 1,200 kW generator in Svay Rieng, it is generally only used when the supply from Vietnam is stopped (distribution line fault or planned outage). However, as it is insufficient for the 3MW load of Svay Rieng, it only supplies power to the central part of the province. This generator can perform synchronized operation with the Vietnamese system.

c. C/P upskilling

(a) Action plan support

On the morning of July 26, 2010, staff interviews were carried out with translation provided by local staff member Ms. Sodavy, and the status of action plan implementation for four persons attached to the T&D section was checked. A lecture was given regarding GREPTS and EDC distribution line design standards since nearly all staff members mentioned items related to construction in their action plans. The lecture explained the role of GREPTS and design standards as well as their differences and why design standards are necessary. All staff members will continue self-study of the Khmer version of the GREPTS obtained by EAC and the distributed design standards in preparation for the interim evaluation in September.

d. Other

(a) System fault status

The main objective of OJT this round was measures taken when faults occur during the rainy season (mainly caused by lightning) such that a distribution line fault did not occur during our stay. This was due to preventive maintenance such as thorough trimming of trees and maintaining a low grounding resistance (grounding wire is not stolen) so that lightning arresters function effectively against lightning. Guidance was provided to maintain records of previous distribution line faults (2009 and 2010).

(3) Seventh Field Work in Cambodia, Round Two (Sept. 19 to Oct. 7, 2010)

a. C/P evaluation

(a) Explanation of C/P evaluation plan

On the afternoon of Sept. 22, 2010, the Chief, Deputy Chief and Distribution Dept. staff members received an explanation of interim self-evaluation and action plan status check scheduled for this on-site inspection period. Distribution personnel increased by two in comparison with the previous evaluation period in May and those two persons only participated in the self-evaluation. One of these persons was transferred from a diesel power station and the other was previously working as a driver. They started working in the Distribution Department from August.

(b) Interim self-evaluation results and action plan status

On the morning of Sept. 25, 2010, staff interviews were carried out with translation provided by local staff member Davy to check self-evaluation results and action plan status. In general, the comprehension level of the staff in relation to work duties increased and progress had been made in regards to action plans. The GREPTS and SREPTS (Khmer version) recommended in the lecture held in July had not yet been obtained. Accordingly, guidance was given for it to be obtained immediately through Mr. Chin Sokhun, Chief of EDC Mondul Kiri (EOM), and to understand the important technical topics.

b. Interconnection with Vietnam

(a) On-Site inspection

On the morning of Sept. 28, 2010, an observational visit was made together with Mr. Chin Sokhun EOM Chief and JICA final evaluation team, to the 22 kV distribution line construction route and Dak Dam village that is midway along the route. Although road conditions were poor due to it being the rainy season, we learned that the roads would be paved in a basic manner starting in October with assistance from China. Although accounts of construction time varied between six months and three years depending on who we asked, it is thought that paving the road will increase traffic and abet economic expansion.

Additionally, a casino had pre-opened at the national border. This serves as a good sign for the EDC since it is probable that the casino will become a large-scale customer after the Vietnamese

interconnected system goes online.

Dak Dam village is located approximately 2.5 km to the north of where the 22 kV distribution line is planned to be constructed and approximately 14.5 km from national highway No. 76. There are currently more than 300 houses in the village with this amount increasing. EDC is considering supplying power to this village after the construction of Vietnamese interconnected line and, accordingly, is considering assigning one or two staff members to the village after completion.

(b) Meeting with EDC

From three o'clock, on the afternoon of Oct. 1, 2010, a meeting was held at MIME with the following persons in attendance: Mr. Houng Chantha, Technical Sect. Chief of the Planning Dept., one member of the Technical Sect., one member of the Distribution Dept., one member of the Generation Dept., Mr. Chin Sokhun EOM Chief, Mr. Thai Khin EOM Deputy Chief. Together with team member Mr. Hiraga, an explanation was provided in relation to specifications of the synchronizer (including vacuum circuit breakers), cabinets and protective relays needed for the Vietnamese interconnection as well as the approximate costs of corresponding Japanese and Vietnamese equipment. This is planned to be installed near the O'romis power station. Other specifications, such as those for the AVR for voltage regulation, distribution lines in Cambodia from the Vietnamese border and protective devices are to be prepared by EDC.

c. Reception of final evaluation team and holding of 4th JCC

(a) Reception of final evaluation team

The final evaluation team with Mr. Yasujiro Suzuki as team leader was received from Sept. 24 to Oct. 6, 2010. Observational visits to Mondul Kiri power plants, interviews with EDC staff at EDC Mondul Kiri, and similar activities were performed by evaluation team member Ms. Watanabe and staff member Mr. Kanematsu (from Sept. 24 to 29, 2010) and by team leader Mr. Suzuki, Mr. Mayusumi (junior expert of Electric Power Sec., Industrial Dev. Dept.) and Mr. Shinoda (from Sept. 26 to 29, 2010). In general, we accompanied the final evaluation team to provide explanations during their visit.

(b) Holding of 4th JCC

The 4th JCC was held on the morning of Oct. 4, 2010 at the MIME conference room. Action reports and final evaluation results were reported and minutes of meeting (MM) were signed by representative of both countries. It was noted in the MM that technical support is expected to be received from JICA even after the project is completed.

d. Others

(a) O'romis Power Station: Entrance road lighting and service lines

Power station entrance road lighting was installed by plant staff to provide nighttime safety. However, due to insufficient service line height in some locations, guidance was provided to

repair the lines on Sept. 23, 2010. Additionally, a service line had been routed through house that was located on the river alongside the power station. This also lacked sufficient ground elevation, and were routed through already existing routing points of the house such that they contacted metal roofing. As this could lead to short circuits if winds caused parts of the service line where the covering had peeled away to contact the metal roofing, possibly resulting in fire, instructions were also given on Sept. 23, 2010 to immediately remedy the conditions. A repair letter regarding the relocation of the houses and repair of the road lighting was issued to EDC from the JICA advisor team.

(b) Deployment of bucket truck

EDC headquarters deployed a bucket trucks: Ford truck equipped with a bucket manufactured by the ArmLift company (USA) http://www.armlift.com/. Although these were outfitted to be deployed Keosema (transferred to EDC at same time of EUMP), Keosema branch had no storage space so as a result it is being stored at the EDC Mondul Kiri office in Sen Monorom. As this truck has no outriggers, the operating range is narrower than Japanese-made bucket truck provided as grant aid, and only one person at a time can be in the bucket whereas Japanese-made ones allow for two persons in the bucket. It was mainly used for low-voltage line work and work around instrument boxes.

(4) Eighth Field Work in Cambodia (Dec. 11 to Dec 25, 2010)

a. C/P evaluation

(a) Explanation of C/P evaluation plan

On the morning of Dec. 14, 2010, Chief, Deputy Chief and Distribution Dept. staff members received an explanation of the final self-evaluation and action plan implementation results check to be made as scheduled for this on-site inspection period. Distribution personnel decreased by one in comparison with the previous evaluation period in Sept. and that one person did not participate in the self-evaluation. The one person reduction was someone who was transferred to the warehouse in Oct.

(b) Final self-evaluation results and action plan implementation results

On the morning of Dec. 15, 2010, staff interviews were carried out with translation provided by local staff member Ms. Sodavy to check self-evaluation and action plan implementation results. All staff members had increased their comprehension of work procedures for which they had a low level of comprehension at the interim stages, and they all had also achieved their objectives in the allotted period.

b. Work safety

(a) Presentation of fault simulation video

An explanation was presented using a video describing what occurs when there is an electrical distribution line fault such as a short circuit, in order to implement work safety. The contents of

the video showed conditions of the following:

- Short circuit of high-voltage distribution line (when dry)
- Short circuit of high-voltage distribution line (when damp)
- Short circuit in meter terminal block
- Prevention of falling by using an auxiliary rope when safety rope has fallen off
- Touching electricity with one's finger (when dry and damp)
- Arc when disconnector is opened
- Manmade lightning

c. SREPTS and design standards

(a) Lecture of design guidance of distribution facilities

All distribution staff received booklets including a Khmer version of GREPTS and SREPTS from EAC. Afterwards, they received an explanation, based on the prepared text and utilizing numeric formulas, about how to determine items such as pole strength and length. As the area supplied by EUMP is considered to be an urban area similar to Phnom Penh according to SREPTS, above-ground elevation for medium voltage lines (excluding cables) must be 8 m or more where crossing roads and 6.5 m or more in other areas. Given these conditions, minimum length scales for spans of only low-voltage lines, only medium voltage lines and when combined. However, EDC regulations stipulate standard sizes of 9 m, 12 m, and 14 m such that, for example, if 10 m are needed, a 12 m pole should be used.

EUMP personnel are responsible for supervision and inspection of the construction of distribution facilities by independent contractors, besides operation and maintenance of distribution facilities. This lecture was thought to be useful as they will form part of the inspection team checking work during construction for the interconnected lines from Vietnam planned for next year.

d. Guidance related to trimming in areas where trees contact low-voltage distribution lines

A special inspection was carried out on Dec. 17, 2010 to make sure that trees were not contacting distribution lines due to the start of heavy typhoon-like winds from the night of Dec. 16, 2010. The results showed that there were no areas of contact with medium voltage power lines but tree trimming was not performed until Dec. 18, 2010 for low-voltage lines because prior consent of landowners had not been obtained.

Firstly, landowner’s permission for trimming was obtained verbally, after which trees contacting wires was trimmed back using a bucket truck. This time, the trees contacting wires were mostly fruit trees such as jackfruit, avocados, milk fruit, coconuts and longans, where the fruit had not yet been harvested so permission for trimming could not be obtained.

e. Others

(a) Power outages

On Dec. 16, 2010, there was a power outage at approximately ten o'clock. As the outage only lasted approximately 17 minutes and power returned rapidly, a request was made for a report regarding the cause of the outage and guidance was given to create an accident record. The cause of the outage was that supply became insufficient due to the emergency stoppage of a diesel power station for repairs without performing load regulating, and this resulted in the stoppage of the O'Moleng power station and of the entire system. After creating an accident record, specialists Mr. Hiraga and Mr. Bono checked the malfunction of the diesel power station and discovered that the cause was due to a failure to tighten nuts to the proper torque so the personnel responsible were instructed to tighten parts and check torque daily. Guidance was also given to perform load regulation at the electrical power supply capability of the remaining power stations (temporary outage) when there is an emergency outage at a power station.

(5) Ninth Field Work in Cambodia (February 13 to 27, 2011)

a. Work safety

(a) Allocation of safety appliances

An explanation was presented using a video describing what occurs when there is an electrical distribution line fault such as a short circuit, in order to implement work safety in September. However there were no enough safety appliances. Therefore 10 sets of rubber gloves and voltage checker for low voltage were provided.

On Feb. 17, a guidance to use rubber gloves and voltage checker for low voltage was given. Rubber gloves for low voltage cannot be used with a hole due to no insulation. Therefore they have to be treated with care and used with protection gloves. When they work around electric power meter, at first they have to check the voltage by the voltage checker and put rubber gloves on to prevent electric shock. And regarding appliance management, they should be registered to EDC, passed to each worker and be checked conditions every month because they have to be used every day.

b. Reception of post-evaluation mission

The post-evaluation mission with Mr. Piseth as a local staff member, Mr. Yamakawa as a senior volunteer and two EDC staff members of Generation Dept. was received from Feb. 14 to 16, 2011. Observational visits to Mondul Kiri power plants, interviews with EDC staff at EDC Mondul Kiri, road construction condition to Vietnam, and interviews with unelectrified villagers were performed by the Mission on Feb. 15, 2011. Interviews with Mayer of Sen Monorom City and interviews with advisors were performed on Feb. 16, 2011.

There are a lot of positive impacts by grant aid of hydropower plants including the distribution system such as living standard improvement, increase of tourists, etc. Supply capability will be increased by power importation route from Vietnam. Therefore it will be possible for EUMP to extend the system to the unelectrified villages. Hereafter the demand will increase. Regarding the energy security, own hydropower or biomass power should be developed to resolve high

dependence to Vietnam in the future.

c. Holding of fifth JCC

The fifth JCC was held on the morning of Feb. 23, 2011 at the MIME conference room. Dr. Ith Praing as the chairman of JCC expressed sincere appreciation to Japanese side and requested the further support of technique for EDC Mondul Kiri and grant aid for small-scale hydropower development in Mondul Kiri and Ratana Kiri province.

d. Others

(a) Power importation route from Vietnam

Road improvement from Sen Monorom to Dak Dam boarder proceeded. Widening of road is under construction.

(b) New pole mounted transformer

New 50kVA pole mounted transformer was put at the branch pole from OR100 which is crossing the road.

Appendix 5 Transmission and Distribution Line Facilities

Appendix 5-1 Status Photos

Appendix 5 2 Documents Related to Power Rates

Appendix 5-3 Documents Related to Civil Engineering

A-4 Documents Related to Power Generation

Appendix 5-5 Documents Related to Transmission/Distribution

1) Transmission/Distribution System Diagrams as of March 2011

2) Evaluation Plan for Abilities of EUMP

3) Compiled Self-Evaluation Results (First)

4) Compiled Self-Evaluation Results (Second)

5) Compiled Self-Evaluation Results (Final)

6) Action Plan Results (English Translation)

7) Energy Loss Calculation

Appendix

Appendix-1 : Photo of Activities

Appendix-2 : Management and Administration

Appendix-3 : Civil Work Structures

Appendix-4 : Generation Facilities

Appendix-5 : Transmission and Distribution Line Facilities

Appendix 1 General

Appendix 1-1 : Photo of Activities

Appendix 2 Management and Administration

Appendix 2- 1: Organization Chart of EUMP

Appendix 2- 2: Example of Assumed Tariff Rate after connection with Viet Nam (Second version)

Appendix 2- 3: 4th JCC Meeting

1) Agenda
2) Attendants list
3) Information
4) Presentation Material for 4th JCC by EUMP

Appendix 2- 4: Self-evaluation sheets for Administration division

Appendix 2- 5: 5th JCC Meeting

1) Agenda
2) Attendants list
3) Information
4) Presentation Material for 5th JCC by EUMP

Appendix 3 Civil Work Structures

Appendix 3-1: Self-evaluation sheets for civil section

Appendix 3-2: Action plan sheets for civil section

Appendix 3-3: Example of the patrol record

Appendix 4 Generation Facilities

Appendix 4-1: Energy consumption graph (year 2010)

Daily load curves (rainy and dry seasons)

Appendix 4-2: Energy consumption records (year 2010)

Appendix 4-3: Monthly energy consumption Balance

(dry and rainy seasons in 2010)

Appendix 4-4: Daily operation records (maximum load in 2010)

Appendix 4-5: Event and fault records(year 2010)

Appendix 4-7: Periodic Inspection report (3rd and 4th in 2010)

Appendix 4-6 : Periodic Inspection plan (3rd and 4th in 2010)

Appendix 4-8: Self-evaluation sheets for generation section

(February 2011)

Appendix 4-9: Seminar for small hydropower (February 2011)

Appendix 4-10: Disaster prevention plan (February 2011)

Appendix 4-11: Memo for Viet Nam interconnection plan

(No. 1, 2 & 3 in 2010)

Appendix 4-12: Specifications for Viet Nam interconnection plan

Appendix 5 Transmission and Distribution Line Facilities

Appendix 5-1 Single line diagram for 22kV Transmission Line System

(as of March 211)

Appendix 5-2 Distribution line map (as of March 211)

Appendix 5-3: Self-evaluation sheets for T/L section (June 2010)

Appendix 5-4: Self-evaluation sheets for T/L section (September 2010)

Appendix 5-5: Self-evaluation sheets for T/L section (February 2011)

Appendix 5-6: Action plan sheets for T/L section

Appendix 5-7: Energy Loss Calculation

Appendix 1 General

Appendix 1-1 : Photo of Activities

Transfer ceremony to EDC

2010/6/8

MIME, Gov. of Mondulkiri, EAC, EDC, EUMP, JICA Study Team (Approx. 100 participants)

EDC's President Visiting

2010/6/8

President, EDC (H.E. Keo Rottanak) visited at O'Mleng hydropower station, Mondulkiri

Meeting with Gov. of Mondulkiri

2010/9/27

JICA terminal evaluation mission had interview to Gov. of Mondulkiri state.

Meeting with EUMP Saff

2010/9/27

JICA terminal evaluation mission had interview to EUMP staff at site.

JICA Project Terminal Evaluation

2010/10/4

JICA terminal evaluation mission had sign in the MOM at MIME.

4th JCC Meeting

2010/10/4

MIME, EAC, EDC, DIME, EUMP, JICA Cambodia office, JICA study team.
(Approx. 50 participants)

Self-evaluation

2010/12/11

Consultation of improvement for self evaluation with EUMP staff after 6 months work.

Small Hydropower Engineering Seminar

2011/2/22

JICA study team conducted a seminar to EDC engineers and EUMP at JICA Cambodia office. (Approx. 50 participants)

5th JCC Meeting

2011/2/23

MIME, EAC, EDC, DIME, EUMP, JICA Cambodia office, JICA study team.
(Approx. 50 participants)

Commencement of 2nd period work

2010/5/31

Explanation of Inception report to EDC and EUMP at EDC head office

Transfer ceremony to EDC

2010/6/8

New assignment of EUMP'S Chief and Deputy Chief by the prosdent of EDC at site office

Site visiting by EDC Headquarter

2010/6/4

Visiting site by EDC staff at O'Moleng hydropower station.

JICA project Terminal Evaluation

2010/9/27
JICA terminal evaluation mission had interview to EUMP, Mondulkiri staff.

Adoministartion office and Diesel power station

2010/10/6
Placed car parking and warehouse at site

National Road Root 76

2010/10/9

Paved national road view from Mondulkiri to Kev Siem after new construction

Commencement of 2nd period work

2010/5/24

Hearing of EUMP staff in daily work at hydropower station

Maintenance of Dam

2010/5/21
Measuring of sedimentation at intake gate at O'Romis hydropower staion

Opening of Dredging Gate

2010/10/6
Dradging sedimentation of mad and sond at O'Romis dam

Overflow from Head Tank

2010/10/7
Overflow due to increasing river water inflow at O'Romis
(generation output: rated185kW)

Reservoir at O'Moleng Dam

2010/10/7

Full reservoir level due to increasing river water
(generation output: rated185kW)

オモレンダム貯水状況

2010/10/7

Overflow from dam top due to increasing river water inflow at O'Moleng
(generation output: rated185kW)

3rd Periodic Inspection

2010/6/3
Measuring Insulation resistance of Generator

3rd Periodic Inspection

2010/6/2

Adjustment of Servo-motor stroke for Guide-vane

3rd Periodic Inspection

2010/6/5
Inspection and cleaning of Generator inside

Self-evaluation for Operator

2010/6/16

Hearing of working knowledge to EUMP staff

OJT for Contral Panel

2010/6/7－8

Site training for control circuit, sequence and electrical parts, etc

OJT for Contral Panel

2010/6/7－8

OJT for electrical theory and sequence diagram to operators and staff

Patrol for 22kV T/L

2010/5/21

Patrol for Checking Ground Height of Medium Voltage Conductor, crossing line near O'Romis road

Self-evaluation for T/L

2010/5/22
Interview for Setting Action Plan

Site Training

2010/5/23
Lecture of GREPTS, SREPTS and EDC Design Standards

Interconnection Plan

2010/5/22

Field Survey of existing Switching Station in Svay Rieng for the future 22kV interconnection line from Vietnam to Mondul Kiri

Site Training

2011/12/14

Lecture of Design Guidance of Distribution Facilities

Daily Maintenance

2011/12/18

Trimming Work for Trees to prevent faults