カンボジア王国
送変電システム
運営能力強化プロジェクト
終了時評価調査報告書

平成 27 年 7 月
(2015 年)

独立行政法人国際協力機構
産業開発・公共政策部

産公
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15-065

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目　　次

プロジェクト位置図

出所：http://lib.utexas.edu/maps/cambodia.html（2016 年 6 月 18 日アクセス）

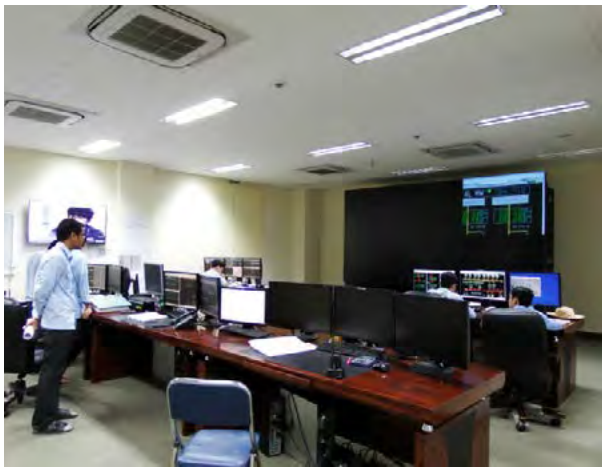
写　　真

EDC 本社

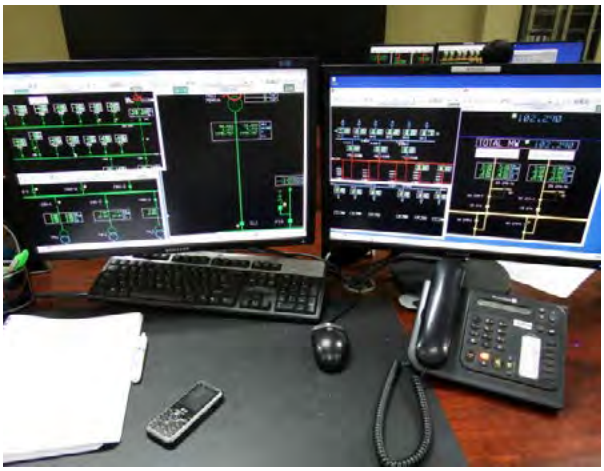
作成された EDC の送電設備の維持要則及び変電設備の点検要則（英語・クメール語）

C/P による変電所設備の点検活動

EDC National Control Center (NCC) の外観（1・2 階は世銀支援、3・4 階部分は EDC 建設中）



NCC オペレーション室



NCC　SCADA システム画面

EDC 電力大学

115/230kV 訓練用鉄塔及び送電線（供与機材）

遮断機分析機器（供与機材）

プロジェクトで育成したトレーナーによる新人トレーナー教育（遮断機）

合同評価調査メンバーによる協議

第 3 回合同調整委員会における合同評価報告書の署名式

略　語　表

略　語	正式名称	日本語
C/P	Counterpart personnel	カウンターパート
DGA	Dissolved Gas Analysis	油中ガス分析
EAC	Electricity Authority of Cambodia	カンボジア電力庁
EDC	Electricité du Cambodge	カンボジア電力公社
GDP	Gross Domestic Product	国民総生産
GoJ	Government of Japan	日本政府
IES	Institute of Electrical Science	電力大学
IPP	Independent Power Producer	独立系発電事業者
JCC	Joint Coordinating Committee	合同調整委員会
JET	Japanese Expert Team	日本人専門家チーム
JFY	Japanese Fiscal Year	日本の会計年度
JICA	Japan International Cooperation Agency	国際協力機構
MME	Ministry of Mines and Energy	鉱業エネルギー省
M/M	Minutes of Meeting	協議議事録
MM	Man Month	人 / 月
MOU	Memorandum of Understanding	覚書
NCC	National Control Center	中央給電指令センター
NSDP	National Strategic Development Plan	国家戦略開発計画
NTL	National Transmission Line	全国送電線
ODA	Official Development Assistance	政府開発援助
OJT	On the Job Training	実地訓練
PDM	Project Design Matrix	プロジェクト・デザイン・マトリックス
PSS/E	Power System Simulation for Engineering	PSS/E（系統解析ソフトの名称）
RPO	Relay Protection Office	保護リレー室
RGC	Royal Government of Cambodia	カンボジア政府
SAIDI	System Average Interruption Duration Index	需要家 1 軒当たりの年間平均停電時間
SAIFI	System Average Interruption Frequency Index	需要家 1 軒当たりの年間平均停電回数
SCADA	Supervisory Control and Data Analysis	設定値制御及びデータ収集システム
SS	Substation facilities	変電施設
TC	Technical Committee	技術委員会
THB	Thai Baht	タイ・バーツ
TL	Transmission Line	送電線

TOT	Training of Trainers	トレーナー研修
USD	United States Dollars	米ドル

評価調査結果要約表

１．案件の概要		
国名：カンボジア王国		案件名：送変電システム運営能力強化プロジェクト
分野：電力		援助形態：技術協力プロジェクト
所轄部署：産業開発・公共政策部資源エネルギーグループ第一チーム		協力金額（評価時点）：3 億 3,700 万円
協力期間	（R/D）：2013 年 1 月～2015 年 9 月 （延長）：－ （F/U）：－	先方関係機関：カンボジア電力公社（EDC）
		日本側協力機関：－
		他の関連協力：－

１－１　協力の背景と概要

カンボジア王国（以下、「カンボジア」と記す）では、急速な経済成長に伴い、電力需要も 2003 ～ 2010 年の間に年平均 20%以上の高い伸びを示すなど急増しており、これに対応するため、安定的な電力供給体制の構築が課題となっている。カンボジアの電気事業のうち、発電分野については、主として独立系発電事業者（Independent Power Producer：IPP）が担い、系統運用を含む送配電分野については、唯一の国営電気事業者であるカンボジア電力公社（Electricité du Cambodge：EDC ）が担っている。EDC では、全国高圧送電網の整備を計画しており、現在ベトナム社会主義共和国から輸入した電力を、プノンペンを中心とする南部地域に供給するための送電網や、新規に完成する IPP の発電所からの電力を同地域に供給する送電線等を整備中である。さらに 2012 年 1 月には、中央給電指令センター（National Control Center：NCC）が建設され、電力系統を適切にコントロールし経済的かつ高品質な電力供給を行う系統運用業務を実施するための体制も整備されつつある。

わが国は、2006 年より有償資金協力「メコン地域電力ネットワーク整備事業（カンボジア成長回廊）」によってシアヌークビル・カンポット間の送電線建設を支援している。また、JICA が実施した「カンボジア国電力セクター基礎情報収集・確認調査」（2012 年 3 月）によると、EDC では職員研修施設を EDC 電力大学（Institute of Electrical Science：IES）へと組織強化するなど、人材育成に注力しているものの、これら新規に整備された送変電設備の運用、維持・管理に関する能力・経験を有する職員育成には、さらなる取り組みを進める必要性が指摘されている。

このような状況の下、カンボジア政府は送変電システムの運営維持管理の強化をめざした技術協力プロジェクトの実施をわが国政府に対して要請した。これを受けて、JICA は 2012 年 6 月に「送変電システム運営能力強化プロジェクト」（以下、「本プロジェクト」）の詳細計画策定調査を実施し、2013 年 1 月より 2 年 9 カ月の予定で本プロジェクトは開始された。

１－２　協力内容

送変電システムの運営維持管理の強化に向け、① EDC の送変電設備運用・維持管理能力の向上、及び② EDC の新たな系統運用業務の実施基盤の整備をめざす技術協力プロジェクトである。

（1）上位目標

プノンペン連系系統地域で電力が安定的に供給される。

（2）プロジェクト目標

プノンペン送変電連系系統内で電力が安定的に供給される。

（3）成果

1．プノンペン送変電連系系統内における EDC の送変電設備の運用・維持管理能力が向上する。

2．EDC の計画・スケジューリングから日々の実運用に至るまでの新たな系統運用業務の実施基盤が整備される。

（4）投入（評価時点）

1）日本側

短期専門家派遣：延べ 15 名（55 人 / 月）長期専門家：1 名（24 人 / 月）

研修員受入：延べ 36 名（うち C/P　24 名）機材供与：約 2,670 万円（22 万 6,994 USD）

ローカルコスト負担：約 1,150 万円（10 万 414 USD）

日本側：総投入額　3 億 3,700 万円

2）カンボジア側

カウンターパート（C/P）配置：延べ 36 名　ローカルコスト負担　6 万 6,110 USD（約 790 万 9,400 円）

土地・施設提供：EDC 本社及び NCC 内のプロジェクト執務室、訓練用鉄塔設置用地の提供

２．評価調査団の概要

	担当分野	氏　名	所　属
調査者	＜日本側＞		
	総　　括	鈴木　薫	JICA 産業開発・公共政策部　参事役（資源・エネルギー）
	調査企画	内藤　伸吾	JICA 産業開発・公共政策部　資源・エネルギーグループ第一チーム調査役
	評価分析	中村　美都子	国際航業株式会社　海外事業部コンサルタント
	＜カンボジア側＞		
	総　　括	Dr. Praing Chulasa	Deputy Managing Director, EDC
	団　　員	Mr. Nou Sokhon	Director, Transmission Department, EDC
	団　　員	Mr. Oum Piseth	Director of Institute of Electrical Science（IES）, EDC
調査期間	2015 年 5 月 24 日～ 2015 年 6 月 13 日		評価種類：終了時評価

３．評価結果の概要

３－１　実績の確認

＜成果 1 ＞

送電分野は、巡視・点検（定期・臨時）、修繕、作業安全に関する基準・ルールが作成・承認され、新しい点検項目に沿って、EDC 所有の鉄塔 326 基（全体の 20%）及び電柱 505 基（全体の 43%）の点検作業が実施された。この結果、累計 1,031 件の不具合が発見されたが、補修計

画に基づき緊急度に応じて対応がとられたため事故を未然に防いでいる。変電分野は、「変電設備点検基準」及び「油中ガス分析（Dissolved Gas Analysis：DGA）による変圧器修理・取替ガイドライン」が作成・承認され、EDC 所有の変圧器全 20 台の DGA 試験が実施された。全変電設備 1,104 機器のうち 25 機器（4 施設）で普通点検が実施され、43 件の不具合が発見されたが、緊急度に応じて対応がとられており、設備事故は未発生のうえ今後の補修計画も作成されている。また、EDC IES では、合計 6 名の送変電分野のトレーナーがプロジェクトで導入した認定評価基準に基づいて認定され、研修教材を作成し研修を実施している。

＜成果 2 ＞

系統運用については、給電運転、停電作業調整、需給計画、電圧調整など系統運用業務関係の基準が作成・承認され、基準に基づき、EDC では初めてとなる系統運用計画が策定された。関係部門間の情報伝達・共有、連携はおおむねスムーズに行われている。系統保護リレーについては、系統保護継電装置設置基準、同整定基準や業務ルールが作成・承認され、EDC で初となるインピーダンスリスト・故障電流マップが作成された。系統運用状況変更に伴う同リスト・マップの更新及び、各設備の保護リレー整定の再検討と不適切箇所の見直しを行うことで事故の未然防止につながっている。また、EDC IES では、合計 4 名の保護リレー分野のトレーナーがプロジェクトで導入した認定評価基準に基づいて認定され、研修教材を作成し研修を実施していると同時に、C/P は新たに 1 名のトレーナーを育成している。

＜プロジェクト目標の達成度＞

送電線への飛散物（トタン板）の発見・除去や、送電線碍子（がいし）の破損発見・補修、保護区間の不整合の発見・既設リレーの整定見直し、などの事例が報告されている。これらを放置すれば停電事故につながったが、プノンペン送変電連系系統内で、プロジェクト期間中に変圧器の火災、電線の断線といった送変電設備における大きな事故やトラブルは発生していない。また、プロジェクトでまとめた停電統計の分析によれば、プロジェクトで定着しつつある巡視・点検を確実に実施していれば不具合を発見し防げたと思われる停電事故は件数・時間ともに減少した可能性が高いと報告されている。これらの指標達成状況から、プロジェクト目標の達成度は高いと判断される。

３－２　評価結果の要約

（1）妥当性

妥当性は高い。プロジェクト開始以降のカンボジア政府の開発政策（第三次四辺形戦略）の重点分野に変更はなく、本プロジェクトの方向性は現在の日本の対カンボジア協力政策にも合致していることが確認された。また、カンボジアにおける今後の高圧線及び変電所新規増設に伴った電力系統の拡大をかんがみると、巡視・点検技術の向上による予防維持管理の強化、系統運用計画による電力供給信頼度の向上がもたらされたこの評価は高く、本プロジェクトは受益者ニーズに対しても適切な対応であったと判断される。

（2）有効性

有効性は高い。送変電設備の巡視・点検作業にかかる基準、ルールの策定、技術の向上、人材育成の強化（成果 1）並びに、保護リレー整定を含む系統運用にかかる計画策定、実施基盤の整備、人材育成（成果 2）という 2 つの成果は、予防保全並びに電力供給信頼度の向上、ひいては電力の安定供給という目標の手段として適切であり、ほぼ達成されている。

また、プロジェクトはこれら 2 つの成果に加えて、電力の安定供給には欠かせない早期復旧計画の策定も補足的に実施しており、これらの成果や補足活動は目標達成に貢献している。プロジェクト期間中に、プノンペン送変電連系系統内で、送変電設備における大きな事故やトラブルは発生しておらず、停電時間、停電回数も減少される見込みであることから、プロジェクト目標は協力期間内に達成される見込みである。今後のプロジェクトにおいては、ルールやマニュアルの規定どおり、基準やルール、業務プロセスを実状に合わせて定期的に見直すプロセスにおいて、プロジェクトで行ったルール策定及び実務への適用を通じて得た経験やノウハウを活用・強化することが望まれる。

なお、本プロジェクト終了後は、電力需要のさらなる拡大を見据え、EDC として「低廉で安定的な電力供給」という高度な経営目標を設定することが望まれる。

(3) 効率性

効率性は高い。活動実施に必要な日本側、カンボジア側からの投入はほぼ計画どおり行われた。機材調達の遅れにより一部活動の開始が遅れたが、プロジェクト活動の延長は発生しておらず成果は計画どおり発現している。また、通信回線の問題により設定値制御及びデータ収集システム（Supervisory Control and Data Analysis：SCADA）の完全運用を前提とした系統運用業務が実施できず、技術移転の内容・レベルに変更が生じたが、かえって同システム運用以前に不足していた基礎能力の向上が図られる結果となりプロジェクト目標に貢献したと考えられる。

(4) インパクト

インパクトは大きい。プノンペン市内の需要家 1 軒当たりの年間平均停電回数（System Average Interruption Frequency Index：SAIFI）、年間平均停電時間（System Average Interruption Duration Index：SAIDI）は終了時評価時点で減少傾向にあり、協力期間後もプロジェクトで技術移転を受けた事業が継続されることで、上位目標達成（プノンペン連係系統地域における電力の安定供給）に向けた正のインパクトが確認された。しかしながら、カンボジアにおいては電力の安定供給をモニターする指標及びモニター対象地域が限定されていることから、さらなる電力統計整備が求められている。なお、負のインパクトは特段確認されていない。

(5) 持続性

持続性は高い。プロジェクト開始以降のカンボジア政府の関連政策の重点分野に変更はなく EDC に対する政策的な支援は継続される見込みである。EDC 送変電部は新たな送変電設備に必要な人員強化を進めており、離職率も 1%程度と低いことから、組織面での持続性は高く、EDC は近年収益を上げており財務状況も健全であることから、事業継続に必要な財政面にも問題はみられない。ただし、EDC 送変電部は 2007 年に設立されたばかりということもあり各部門及び職員の役割・責任分担などが明確ではなく組織としては未成熟な部分があり、本プロジェクトで作成され EDC で公式に承認された維持管理要則などに定められた役割分担、業務手順を念頭においた組織の改編、強化が必要である。また、プロジェクトの成果を EDC 送変電部内の共有にとどめるのではなく、送変電部内の関係部門や、他部門、さらには系統運用の観点から、IPP にも共有、理解促進を図ることが持続性をより高めるために効果的である。

技術面については、IES の認定トレーナーや送変電部 C/P による移転技術の普及は今後

も継続される見込みであり、持続性は高いと見込まれる。

３－３　効果発現に貢献した要因

(1) 計画内容に関すること

系統運用分野の研修をタイにて実施（第三国研修）したことで、ASEAN 諸国での電力公社での見聞のなかから EDC がめざすべき技術基準レベルを明確に認識できるようになった。

(2) 実施プロセスに関すること

プロジェクトでは、各対象分野にかかる技術移転の基本方針及び計画を決定する前にベースライン調査を行い、決定後、日本人専門家と C/P により忠実に計画に沿って活動が実施された。専門家派遣のタイミングや期間はプロジェクトの進捗に従って慎重に決定され、業務計画や内容も十分に事前に知らされていた。また、（短期）専門家チームの不在時は EDC に常駐の長期専門家によって活動支援が行われ、進捗もモニタリングされていた。EDC は効率的な技術移転を促すためにタイムリーに必要な投入を行った。これらに加え、専門家チームの不在時に緊急的な技術移転が必要となった際には、JICA カンボジア事務所及び本部の全面的な協力により、プロジェクトは TV 会議を利用したテクニカル・ミーティングを開催するなど、プロジェクト全関係者による献身的な活動と支援がプロジェクトの貢献要因といえる。

３－４　問題点及び問題を惹起した要因

(1) 計画内容に関すること：該当なし

(2) 実施プロセスに関すること

当初、本プロジェクトは、送変電システムの監視制御を目的に NCC による SCADA システムを活用した系統運用業務に関する技術移転を行う計画であった。しかし、プロジェクト開始後、通信担当の日本人専門家が詳細に調査した結果、複雑な通信上の問題が判明し、SCADA は全面的に稼働できない状態であることがわかった。EDC は外部からの協力を得て現在も問題解決の努力を続けている。これによりプロジェクトが大幅に阻害されたわけではないが、移転技術の変更により実務指導内容の一部変更を余儀なくされた。

３－５　結　論

プロジェクトは特段の問題や遅延なく実施され、期待された成果を着実に生み出していることが確認された。協力期間終了までにプロジェクト目標が達成される見込みは高いと判断される。

３－６　提　言

３－６－１　プロジェクトへの提言

(1) EDC に対する提言

1) 新たな基準、ルール、業務プロセスのさらなる普及

プロジェクトの持続性、インパクトの観点から、プロジェクトの成果を送変電部内の関係部門や、他部門に普及を図ると、より効果的である。

C/P 職員が、現場や地方を含めた全関係職員に、ルールや業務プロセスについての説明

や指導を体系的に、継続的に行うことが肝要である。さらに、系統運用の観点から、IPPにも新たな基準、ルールを継続的に知らしめる必要がある。

2）基準、ルール、業務プロセスのさらなる改善

ルールやマニュアルの規定どおり、基準やルール、業務プロセスは実状に合わせて定期的に見直し、プロジェクトで行ったルール策定及び実務への適用を通じて得た経験やノウハウを活用し、今後も改善を続けていくことが肝要である。したがって、すべての基準、ルール、業務プロセスを規定で定められたとおり定期的に見直しすること。

３－６－２　今後に向けた提言

(1) EDC に対する提言

1）低廉で安定的な電力供給に向けて

プロジェクトが予防保全及び電力供給信頼度の確保の観点から技術力の向上を図り、プロジェクトが成功を収めたことへの EDC の評価は高い。今後は、低廉で安定的な電力供給を電力公社の経営目標として掲げ、経営層が必要な対処を行うことを提言する。例えば、組織面では N-1 基準、事故の早期復旧、最小費用での開発・運用を考慮した計画、建設、維持管理、系統運用を行う中核組織の強化や、人材育成面では、人材育成部の設置や、技術部と電力大学の緊密な連携を可能にする人材育成方針の策定などが挙げられる。

2）電力統計の信頼度の向上

電力の安定供給をモニターする指標として、SAIDI、SAIFI を含め、一層信頼性のある電力統計の整備を進めることが望ましい。

3）NCC の SCADA システムの完全運用

系統運用の自動制御化に向けて、EDC は SCADA システムに関する通信上の問題を解決するために多大な労力を費やしている。プロジェクトの有効性の観点から、NCC における SCADA システム完全運用を促進し、通信システム技術を適切に管理できる職員を配置することが望ましい。

３－７　教訓

(1) 第三国研修の有効活用

系統運用分野の研修について、C/P は、タイにおける第三国研修で、実際にプロジェクトが EDC に導入しようとしている系統運用業務が国際標準であると知り、目から鱗が落ちるほどの経験を得たと報告している。研修後、C/P は策定された基準の重要性を再認識し、活動はさらに活発になり加速されたとの報告もあった。これは、ASEAN 諸国の電力公社での見聞によって、EDC が電力公社としてめざすべき技術基準レベルを明確に認識できるようになったという、第三国研修が有効に機能した好事例である。

類似プロジェクトにおいては、プロジェクトで導入しようとする基準を既に運用している第三国での研修を実施し、基準の重要性の自覚と将来的な運用技術獲得を図ることが効果的である。

(2) 停電・事故統計の整備

プロジェクトでは、予防保全の効果を分析するため、事故及び停電データの詳細記録を指導し、EDC において停電・事故統計の基礎が整備された。事故を分析し、予防できたと思われる事故の結果（停電）を試算することで、プロジェクトの効果を停電件数と停電時間の観点から定量的に推測することが可能となり、経営層へ予防保全の重要性を認識させ

ることができた好事例である。

類似プロジェクトにおいては、予防保全の効果を事故の未然防止に関する数的データとして整備することで、プロジェクトの有効性を特に経営層に効果的に示すことができる。

（3）適正技術の選択

SCADA システムに関して、EDC と IPP 間で複雑な通信上の問題があり、結果的に約 3 年もの間、同システムの完全運用が制限されている状態であった。同システムは本プロジェクトで導入されたものではないが、高度なシステムの導入にあたっては C/P 組織の技術レベルを見極め、現地の状況に即した投入を行う必要がある。

Summary of the Results of Evaluation Study

1 Outline of the Project	
Country: Kingdom of Cambodia	**Project Title:** Project for Improvement of Transmission System Operation and Maintenance
Thematic Area: Electricity	**Cooperation Scheme:** Technical Cooperation Project
Division in Charge: Industrial Development and Public Policy Department	**Total Cost:** 337 million Yen
	Counterpart Agency: Electricite du Cambodge (EDC)
Project Period: January 2013 ～ September 2015	
Supporting Organization in Japan:	

1.1 Background of the Project

Reflecting the rapid economic growth that the Kingdom of Cambodia has achieved, over the period 2003 – 2010 Cambodia's maximum power and electrical energy both grew by an average of over 20% per year. This rapid growth has drawn attention to the need for Cambodia to put in place the systems that are required in order to ensure a stable electric power supply. The electricity generation in Cambodia is mainly undertaken by independent power producers (IPPs), while Electricité du Cambodge (EDC), the most important electric-power-related organization in Cambodia, which is responsible for transmission and distribution (including system operation) .

EDC has a plan to establish a nationwide high-voltage transmission network ; currently, the company is already in the process of putting in place a transmission network to supply Southern Cambodia (in particular the area around the capital, Phnom Penh) using electric power imported from Vietnam, while also installing transmission line to supply the same region with power generated by newly established power stations owned by IPPs. In January 2012, a national Control and Center (NCC) was established in EDC, a Supervisory Control and Data Analysis (SCADA) system was installed, with the aim of ensuring effective control over the electric power system to as to be able to carry out system operation in such a way as to provide low-cost, high-quality electric power supply.

Japan began providing support for the establishment of a transmission line between Kampot and Sihanoukville through the Greater Mekong Power Network Development Project (Cambodia Growth Corridor) in 2006, a loan assistance project. In addition, JICA implemented the Data Collection Survey on Electric Power Sector in Cambodia (March, 2012), it was reported that there was a clear need to undertake further measures to strengthen the capabilities and experiences of EDC employees necessary to operate, maintain and manage the new transmission and substation equipment that has been installed while EDC has been focusing heavily on human resource development such as upgrading its training facility to Institute of Electrical Science (IES) .

Under such a circumstance, Royal Government of Cambodia requested the Government of Japan (GoJ) for technical cooperation project with a view to strengthening operation and maintenance of transmission system. In response to this request, JICA has conducted Detailed Planning Survey for "the Project for Improvement of Transmission System Operation and Maintenance" (hereinafter referred to as "the Project") in June 2012. Following the survey, the Project was launched in January 2013 for the period of two years and nine months.

1.2 Project Overview

(1) Overall Goal

Electrical power is stably supplied in Phnom Penh power grid.

(2) Project Purpose

Electrical power is stably supplied in Phnom Penh bulk power system.

(3) Outputs

1. Capacity of operation and maintenance of transmission line (TL) and substation facilities (SS) in Phnom Penh bulk power system is enhanced.
2. Basic capacity of enhanced power system operation such as planning, scheduling and actual execution is strengthened.

(4) Inputs (As of April 2015)

(Japanese Side)

- Experts: 15 short-term experts in 14 fields of expertise (55 Man/Month)

1 long-term expert (24 Man/Month)

- Training in Third Country: 36 persons (including 24 Counterparts)
- Provision of Equipment: Approximately 26.7 million JPY (226,994 USD)
- Local Cost: 100,414 USD (approximately 11,458,450 JPY)

(Cambodian Side)

- Counterpart: 36 persons (including Project Director, Project Manager, and Working Group members)
- Provision of Land and Facilities: Project office spaces, and installation place for training tower
- Local Cost: 66,110 USD (approximately 7,909,400 JPY)
- Terminal Evaluation Team

2 Terminal Evaluation Team

Member of the Evaluation Team

Japanese side

Name	Title	Occupation
Mr. Suzuki Kaoru	Leader	Senior Advisor to the Director General (Energy), Industrial Development and Public Policy Dept., JICA
Mr. Naito Shingo	Cooperation Planning	
Ms. Nakamura Mitsuko	Evaluation Analysis	Assistant Director, Team1, Energy and Mining Group, Industrial Development and Public Policy Dept., JICA Consultant, Overseas Dept. Kokusai Kogyo Co., Ltd.

Cambodian side

Name	Title	Occupation
Dr. Praing Chulasa	Leader	Deputy Managing Director, EDC
Mr. Nou Sokhon	Member	Director, Transmission Department, EDC
Mr. Oum Piseth	Member	Director of Institute of Electrical Science (IES), EDC

Period of Evaluation	24 May 2015～13 June 2015	Type of Evaluation: Terminal Evaluation

3 Project Performance

3.1 Achievements of Outputs

(1) Output 1: Almost achieved

Rules and standards of patrol, inspection, repair, and work safety of Transmission line (TL) which specify patrol and inspection items, frequency, and acceptance standards and so forth, were formulated and approved. In accordance with new inspection items, 326 transmission towers (20% of the whole towers) and 505 concrete poles (43 % of the whole poles) were already inspected. As a result, a cumulative total 1,031problems were detected. However, EDC was taking necessary counter-measures according to a status of emergency and based on the repair plan ; therefore preventing troubles from occurring. Rules and guidelines of inspection of Substation facilities (SS) were also formulated and approved. Based on the new guideline, all 20 transformers EDC owned in Phnom Penh bulk power system were diagnosed. 25 pieces of equipment out of 1,104 were inspected, and a cumulative total of 43 problems were detected. However, EDC was taking necessary counter-measures according to a status of emergency and formulating the repair plan ; therefore no troubles have been occurred. In addition, based on the certification and evaluation standards formulated by the Project, total 6 trainers on maintenance of TL and SS were certified at IES, and they prepared training materials and have been already conducting training courses.

(2) Output 2: Almost Achieved

Rules and standards for operation and planning of power system operation such as load dispatching operation, coordination of planned outage, demand & supply plans, and voltage control were formulated and approved. In addition, Power System Operation Plan, including indication of issues of power system configuration, was formulated at the first time in EDC, and information sharing and its conveyance through reciprocal coordination among relevant departments has been performed smoothly. As for the relay protection, the rules and standards for protection relay type selection, setting and work procedures were formulated and approved. The Project calculated impedance and fault current to formulate impedance list and fault current map at the first time in EDC. By reviewing relay setting of facilities and revising inappropriate settings in accordance with the situation of power system operation, troubles have been prevented from occurring. Whereas totally 4 trainers on protection relay were certified at IES, based on the certification and evaluation standards formulated by the Project, C/P also certified a new trainer additionally.

3.2 Achievement of the Project Purpose

There were actual reports such as removal of an iron roof to avoid cutting conductors, repair of broken insulators to prevent from ground fault and eventual power outage, and inconsistency and revising of relay setting in protected zone. These problems could lead to the serious accidents and troubles if any counter-measure were not taken ; however, any serious accidents and trouble such as fire on transformer or cut of conductors did not occurred during the period of cooperation. As a result of the power outage and fault data analyzed by the Project, it was reported that both frequency and duration of power outage could have been reduced if accidents and troubles were detected by patrol/inspection and review of relay setting, which are now mainstreamed by the Project. Therefore the Project purpose would satisfactorily be attained by the end of the cooperation period.

4 Review Based on the 5 Criteria

4.1 Relevance: High

There has not been any drastic change in the development plans (Rectangular Strategy for Growth, Employment, Equity and Efficiency Phase III) of Royal Government of Cambodia after launching of the Project, and the Project is also well in line with Japan's ODA policy for the Kingdom of Cambodia. Taking account of power development plan, expansion of power system network with new high voltage transmission lines and substations construction plans in the future, "strengthening preventive maintenance by improvement of patrol and inspection techniques" and "improving power supply reliability by power system operation plan," addresses the needs of beneficiaries appropriately.

4.2 Effectiveness: High

Through formulation of rules and standards of O&M of transmission line and substation facilities ; strengthening the abilities of patrol/inspection and relay protection, and formulation of power system operation plan including relay protection, it has been reported that EDC's capacity of stable electric power supply was enhanced. Towards the stable electric power supply, "technologies related to preventive maintenance (Output 1) ", and "technologies related to power system operation to ensure supply reliability (Output 2) ", were transferred by the Project. The logical sequence between the outputs and Project purpose was appropriate, and these outputs have been mostly achieved. In addition to these two outputs, the Project formulated a plan for early restoration, which is also essential for stable power supply. These outputs and supplementary activity contributed to achieve the Project purpose. It has been reported that there were no serious accidents or troubles of transmission and substation facilities during the cooperation of the Project, and it has been estimated power outage time and number would be reduced by the activities installed by the Project. Therefore the Project purpose would satisfactorily be achieved by the end of the cooperation period.

4.3 Efficiency: High

The inputs necessary for implanting activities were provided almost as planned, by both Japanese and Cambodian sides. Although a part of the Project activities was started late due to unexpected delayed procurement of equipment, the outputs of the Project have been produced as planned without extension of cooperation period. The Project re-designed the contents and level of the OJT training to a certain extent, because SCADA system has not been fully utilized for power system operation due to telecommunication issues. However, it resulted to improve essential basic capacity before starting power system operation, and eventually contributed to achieve the Project purpose.

4.4 Impact: High positive impact

Average number (SAIFI) and time of power outage (SAIDI) has been decreased in Phnom Pehn city for three years. It is expected that by continuing their activities and by enhancing their activities to the other regional areas in the countries for further scale up of achievements of the Project ("Electrical power is stably supplied in Phnom Penh power grid."), positive impacts of the Project are anticipated on the attainment of the overall goal.

4.5 Sustainability: High

It is generally assumed that the policy supports would continuously be secured. Transmission Department

of EDC is strengthening human resources necessary for new transmission and substation facilities. Since EDC's turnover rate is about 1 % and low, organizational sustainability is generally assumed high. There would be no financial resource constraints as an implementing agency. However, since Transmission Department was established in 2007, roles and responsibilities of staff and sections have not been yet clear and it has been yet immature as organization. It may still need further organizational restructuring and reinforcement by taking account of new roles, responsibilities and working procedure defined within officially approved rules and manuals in the Project. As for technical sustainability, dissemination of transferred technologies would be continuously expected by certified trainers in IES as well as C/P of Transmission Department.

4.6 Factors that have promoted or hindered the implementation of Project

Promoting factors

(1) Factors Concerning the Planning: N/A

(2) Factors Concerning the Implementation Process

The Project has conducted a baseline survey prior to determine the basic policy and plan of respective fields, then implement the activities according to the schedule, which was strictly followed by both the JET and C/Ps. Timing and length of dispatch were carefully determined according to the progress of the Project and schedules and assignments of the Project were well informed in advance, and progress of the activities during absent period of JET was also followed up and supported by the long-term expert who stationed at EDC. EDC provided necessary input timely to promote efficient technical transfer. In addition to these efforts, in case which required urgent technical transferring during absence of JET, the Project held a technical meeting via TV conference system with full support of JICA Cambodia and Headquarter office. These efforts and support dedicated by all the stakeholders of the Project should be regarded as a promoting factor to the Project.

Hindering factors

(1) Factors Concerning the Planning

(2) Factors Concerning the Implementation Process: N/A

Initially, the Project was planning to transfer the technique of power system operation with SCADA system to NCC, aiming to operate power system and control the facilities. However, it was found as a result of detailed study by Japanese expert on telecommunication that there was complicated telecommunication issue, limiting full operation of SCADA system. EDC is still making efforts to solve the problem with external support. Although this did not critically "hamper" the Project, it should be noted that the change of the technologies had required the Project to re-design the contents of the OJT training to a certain extent.

5 Results of the Terminal Evaluation

5.1 Conclusion

The Team has confirmed that the expected outputs have largely been achieved without any critical problem or notable delay in the implementation of the Project. It was also assumed that the Project would successfully achieve its expected purpose within the cooperation period.

5.2 Recommendations

Recommendation for Remaining Period of the Project

(1) Dissemination of the New Standards, Rules and Working Procedure

It is more effective to disseminate the outcome of the Project within responsible sections of Transmission Department, and other departments from the perspective of Sustainability and Impact of the Project.

It is recommended for C/Ps to continue lecturing and instructing the rules and working procedures to all the relevant staff, including filed and regional staff of the Project, in a systematic manner and in cooperation with IES. In addition, it is also recommended to notify the standards and rules to IPPs, continuously.

(2) Periodical Review of the Standards, Rules and Working Procedure

As it is regulated in the rules and manuals, it is essential to review the standards, rules or working procedures periodically to fit into the actual situation, and continue the improvement in the future, using practical knowhow and experiences of formulation and implementation within the Project.

It is recommended to conduct the periodical review of all the standards, rules and working procedure regulated by the rule.

Recommendation for Future

(1) Towards Stable Power Supply in Low Price

It is generally appreciated by the target groups that the Project has been successful in improving technical capacities of the staff in terms of “establishment of preventive maintenance” and “securing of power network and supply reliability”. However, it is recommended for EDC to set the “Stable Power Supply in Low Price” to the corporate goal, and take necessary actions at cooperate management level. For example, in terms of organizational perspective, it is recommended to strengthen the core organization for planning, construction, operation and maintenance, and power network system, considering N-1 standard, early restoration of power outage, and least cost development and operation. In terms of human resource development perspective ; it is recommended to formulate establishment of corporate human resource development section and its policy to enable collaboration between technical departments and training center more closely.

(2) Improvement of Power Statistics More Reliably

As key performance indicator to monitor the actual situation of Stable Power Supply in Low Price, it is recommended to improve power statistics more reliably including SAIDI and SAIFI.

(3) Accelerating Full Operation of NCC with SCADA system

Towards automation of power system, EDC has already been making great efforts to solve the telecommunication issue related to SCADA system. In terms of Effectiveness of the Project, it is recommended to accelerate the process and allocate appropriate personnel to manage the telecommunication system.

5.3 Lessons learned

(1) Effectiveness of Counterpart Training in Third Counties

As for training of power system operation, C/Ps reported that training in Thailand provided eye-opening experience about international standards of power system operation, which actually the Project was

introducing to EDC. After the training, it was reported that C/Ps reconsidered the importance of formulated standards and their activities became more active and accelerated. This indicates that training in Third country was very effective to enable EDC to recognize its own technical standard and level in the future as an electrical power company, through the training and experiences in other electric power companies in surrounding Southeast Asian counties (i.e. ASEAN) .

(2) Establishment of Power Outage and Fault Statistics

The Project instructed to compile fault and power outage data in detail to analyze the effect of preventive maintenance, and power outage and fault statistic was established in EDC. By analyzing faults and estimating the results of preventing power outage, it was able to assume the effect of the Project in terms of power outage number and time quantitatively, and could convince the executives of electric power company the significance of preventive maintenance. In cases of projects related to preventive maintenance, although it is difficult to show the prevented troubles, it should be noted that quantitative estimation (comparison between the actual troubles and troubles which could be prevented) is very effective and persuasive to show the effect of the Project.

(3) Selection of Appropriate Technology

As for SCADA system, it was found that there have been complicated telecommunication problems between EDC and IPPs, and it has been limiting full operation of SCADA system for almost three years. Although the SCADA system was not introduced by the Project, it is important to carefully examine the technical level of counterpart organization, and provide the appropriate operation system in accordance with the local situation.

第１章　調査の概要

１－１　終了時評価調査の背景

カンボジア王国（以下、「カンボジア」と記す）では、急速な経済成長に伴い、電力需要も2003 ～ 2010 年の間に年平均 20％以上の高い伸びを示すなど急増しており、これに対応するため、安定的な電力の供給体制の構築が課題となっている。カンボジアの電気事業のうち、発電分野については、主として独立系発電事業者（Independent Power Producer：IPP）が担い、系統運用を含む送配電分野については、唯一の国営電気事業者であるカンボジア電力公社（Electricité du Cambodge：EDC）が担っている。EDC では、全国高圧送電網の整備を計画しており、現在ベトナム社会主義共和国から輸入した電力を、プノンペンを中心とする南部地域に供給するための送電網や、新規に完成する IPP の発電所からの電力を同地域に供給する送電線等を整備中である。さらに 2012 年 1 月には、中央給電指令センター（National Control Center：NCC）が建設され、電力系統を適切にコントロールし経済的かつ高品質な電力供給を行う系統運用業務を実施するための体制も整備されつつある。

わが国は、2006 年より有償資金協力「メコン地域電力ネットワーク整備事業（カンボジア成長回廊）」によってシアヌークビル・カンポット間の送電線建設を支援している。また、JICA が実施した「カンボジア国電力セクター基礎情報収集・確認調査」（2012 年 3 月）によると、EDC では職員研修施設を EDC 電力大学（Institute of Electrical Science：IES）へと組織強化するなど、人材育成に注力しているものの、これら新規に整備された送変電設備の運用、維持・管理に関する能力・経験を有する職員育成には、さらなる取り組みを進める必要性が指摘されている。

かかる状況の下、カンボジア政府（Royal Government of Cambodia：RGC）は送変電システムの運営維持管理の強化をめざした技術協力プロジェクトの実施をわが国政府に対して要請した。これを受けて JICA は、EDC をカウンターパート（Counterpart：C/P）機関として、2012 年 6 月に「送変電システム運営能力強化プロジェクト」（以下、本プロジェクト）の詳細計画策定調査を実施し、2013 年 1 月より 2 年 9 カ月の予定で本プロジェクトを実施中である。

本プロジェクトは、① EDC の送変電設備の運用・維持管理能力の向上、② EDC の計画・スケジューリングから日々の実運用に至るまでの新たな系統運用業務の実施基盤の整備をめざした活動を行っている。

これまでプロジェクトでは、総括、送電設備、変電設備、系統運用、業務調整 / 組織研修マネジメントの各分野の専門家が派遣されている。

本プロジェクトの協力期間を 2015 年 9 月に控え、このたび終了時評価調査団を派遣することとした。

１－２　プロジェクトの概要

(1) 上位目標・プロジェクト目標・成果

本プロジェクトは、プノンペン送変電連系系統内における EDC の送変電設備の運用・維持管理能力の向上、計画・スケジューリングから日々の実運用に至るまでの EDC の新たな系統運用業務の実施基盤の整備を通じて、プノンペン送変電連系系統内で電力が安定的に供給され、ひいてはプノンペン連系系統地域で電力が安定的に供給されることをめざすものである。

上位目標	プノンペン連系系統地域で電力が安定的に供給される。
プロジェクト目標	プノンペン送変電連系系統内で電力が安定的に供給される。
成　果	1. プノンペン送変電連系系統内における EDC の送変電設備の運用・維持管理能力が向上する。 2. EDC の計画・スケジューリングから日々の実運用に至るまでの新たな系統運用業務の実施基盤が整備される。

（2）協力期間

2013 年 1 月～ 2015 年 9 月（2 年 9 カ月）

（3）実施機関

カンボジア電力公社（EDC）

（4）プロジェクト・サイト

プノンペン連系系統地域

１－３　調査団派遣の目的

本終了時評価調査の主な目的は次のとおりである。

（1）プロジェクト・デザイン・マトリックス（Project Design Matrix：PDM）とその他関連書類に示されるプロジェクトの計画の進捗状況、実績の検証

（2）評価 5 項目によるプロジェクトの評価分析

（3）プロジェクトの改善事項にかかる提言の作成

（4）類似案件への教訓の導出

１－４　合同評価調査団の構成

調査団の構成は以下のとおり。

（1）日本側評価チーム

担当分野	氏　名	所　属
総　括	鈴木　薫	JICA 産業開発・公共政策部　参事役（資源・エネルギー）
調査企画	内藤　伸吾	JICA 産業開発・公共政策部　資源・エネルギーグループ第一チーム　調査役
評価分析	中村　美都子	国際航業株式会社　海外事業部　コンサルタント

（2）カンボジア側評価チーム

担当分野	氏　名	所　属
総　括	Dr. Praing Chulasa	Deputy Managing Director, EDC
メンバー	Mr. Nou Sokhon	Director, Transmission Department, EDC
メンバー	Mr. Oum Piseth	Director of Institute of Electrical Science（IES）, EDC

１－５　調査日程

本調査は 5 月 24 日から 6 月 13 日まで 21 日間実施された。調査日程は表－１のとおりである。

表 －１　終了時評価調査日程

日　付			鈴木 / 内藤	中村
1	5/24	日		羽田→バンコク→ 19：45 プノンペン（TG584）
2	5/25	月		8：30 JICA カンボジア事務所にて打合せ 14：30 EDC にて打合せ、C/P とインタビュー
3	5/26	火		8：00 IES にて打合せ、C/P とインタビュー
4	5/27	水		8：30 NCC にて C/P とインタビュー
5	5/28	木		9：00 NCC にて視察、C/P とインタビュー 11：00 日本人専門家チームとインタビュー 午後：データ整理
6	5/29	金		9：00 IES にて打合せ、C/P とインタビュー 午後：データ整理
7	5/30	土		8：30 変電所（GS3）にて点検活動視察 午後：データ整理及び報告書案作成
8	5/31	日		データ整理及び報告書案作成
9	6/1	月		データ整理及び報告書案作成
10	6/2	火		8：30 EDC にて C/P とインタビュー 11：00 日本人専門家チームとインタビュー 16：00 団内会議（TV 会議）
11	6/3	水		9：00 WG メンバーとインタビュー 12：00 日本人専門家チームとインタビュー、データ整理
12	6/4	木		10：30 日本人専門家チームとインタビュー 15：00 データ整理及び報告書案作成
13	6/5	金		評価報告書ドラフト作成
14	6/6	土		評価報告書ドラフト作成
15	6/7	日	→プノンペン（TG584）	評価報告書ドラフト作成

16	6/8	月	8：30 JICA カンボジア事務所と打合せ 9：30 団内会議 15：00 EDC 表敬訪問及びキックオフミーティング	
17	6/9	火	8：00 現場視察（IES、NCC）	評価報告書ドラフト作成
			14：30 終了時評価チームと評価報告書ドラフト及び M/M 協議	
18	6/10	水	9：00 評価報告書案及び M/M 最終案作成	
19	6/11	木	9：00 JCC 会議、M/M 署名式	
20	6/12	金	9：00 JICA カンボジア事務所へ報告 10：30 在カンボジア日本大使館へ報告 20：20 プノンペン（TG585）→バンコク	
21	6/13	土	→羽田	

１－６　終了時評価の方法

本評価は、JICA 事業評価ガイドラインに基づき、日本（調査団）・カンボジア国側双方から選出された合同評価委員会によって実施された合同評価である。

１－６－１　評価デザインの作成

プロジェクト管理のための要約表である PDM 及び活動計画（Plan of Operations：PO）、本プロジェクトの覚書（Memorandum of Understanding：MOU）をレビューし、評価調査に必要な評価設問の検討を行い、具体的な調査項目と情報・データ収集方法を記載した評価グリッド及び終了時評価調査計画を作成した。評価設問は 2015 年 6 月に変更された PDM 第 2 版に基づいて作成された。

１－６－２　評価調査の手法

本調査の情報収集にあたっては、以下のように定量・定性的なデータ・情報の収集を行った。

(1) 既存資料の分析

プロジェクト進捗報告書及び関連書類をレビュー、評価グリッドに基づき情報を整理した。

(2) インタビュー調査

日本人専門家、C/P に事前に配付した質問票を用いて広範な聞き取り調査を個別・グループで実施した。

(3) プロジェクト活動の視察

EDC IES、NCC などプロジェクト・サイトの視察、供与機材の稼働状況・保管状況の確認、プロジェクト活動の視察を行った。

１－６－３　評価分析の方法

(1) プロジェクトの実績及び実施プロセス

プロジェクトの実績は、投入実績、成果の達成度、プロジェクト目標の観点から検証された。プロジェクト実施プロセスは、活動が計画どおりに実施されたか、プロジェクトは適切にマネジメントされていたか、実施過程で生じている問題や、効果発現に影響を与えた要因は何かなどを含めて検証された。

(2) 評価 5 項目の視点

評価時点での実績（計画の達成状況もしくは達成見込み）と実績プロセスの検証を踏まえて、以下の評価 5 項目の観点から評価分析を行った。

妥当性（relevance）
プロジェクトのめざしている効果（プロジェクト目標や上位目標）が受益者のニーズに合致しているか、問題や課題の解決策として適切か、被援助国及び日本側の政策との整合性はあるか、プロジェクトの戦略・アプローチは妥当か、公的資金である ODA で実施する必要があるかなどといった「援助プロジェクトの正当性・必要性」を問う視点。

有効性（effectiveness）
プロジェクトの実施により本当に受益者若しくは社会への便益がもたらされているのか、あるいは、もたらされるのかを問う視点。

効率性（efficiency）
主にプロジェクトのコストと効果の関係に着目し、資源が有効に活用されているか、あるいはされるかを問う視点。

インパクト（impact）
プロジェクト実施によりもたらされる、長期的、間接的効果や波及効果をみる視点。予期していなかった正・負の効果・影響を含む。

持続性（sustainability）
援助が終了してもプロジェクトで発現した効果が持続しているか、あるいは持続の見込みはあるかを問う視点。

１－７　主要面談者

(1) カンボジア電力公社（EDC）

Dr. Praing Chulasa　　Deputy Managing Director

(2) EDC 送変電部

Mr. Nou Sokhon　　Director

Mr. Ing Prorseth	Deputy Director

＜送電システムユニット＞

Mr. Mak Thorn	Chief
Mr. Thourk Mony	Deputy Chief
Mr. Try Chhun Heng	Deputy Chief
Mr. Chhay Sophea	Deputy Chief, Transmission Line Division
Mr. Try Soban	Deputy Chief, Transmission Line Division
Mr. Meas Mea	Staff, Transmission Line Division
Mr. Meas Nimol	Staff, Substation Division
Mr. Kem Sopanha	Staff, Substation Division

＜中央給電指令センター（NCC）＞

Mr. Touch Samphors	Chief, Data Management & Operation Planning
Mr. Heng Ky	Chief, Shift No.1
Mr. Chan Samnang	Deputy Chief, Data Management
Mr. Hak Hout	Deputy Chief, Data Collection Division
Mr. Rin Vanny	Staff, Operation Planning

＜保護リレー室＞

Mr. Lors Pouthy	Deputy Chief
Mr. Phin Chenda	Staff
Mr. Phat Tech	Staff
Mr. Neang Vannet	Staff

（3）EDC 電力大学（IES）

Mr. Oum Piseth	Director
Mr. Meng Sokkheng	Deputy Director
Mr. Sok Pal	Chief, Electrical Department

＜テクニカル・トレーニング室＞

Mr. Chhan Buntheat	Trainer of Transmission Division
Mr. Hong Neang	Trainer of Transmission Division
Mr. Chhay Vichet	Trainer of Safety Division
Mr. Chea Mareth	Trainer of Transmission Division
Mr. Chin Pim Shokha	Trainer of Transmission Division
Mr. Nong Vibol	Trainer of Transmission Division
Mr. Chea Prach	Trainer of Power plant protection Division
Mr. Su Tek Seng	Trainer of Distribution Division

（4）EDC 経営企画事業部（Corporate Planning and Project Department）

Mr. Chun Piseth	Director

（5）EDC 発電部（Generation Department）

Mr. Peh Pha	Deputy Director, Generation Department

（6）EDC 配電部（Business and Distribution Department）

Mr. Iv Visal	Deputy Director
Mr. OrVaddhaba	Chief of Distribution Control Center

（7）JICA カンボジア事務所

Mr. Toshikazu Watanabe	Representative, JICA Cambodia Office

（8）在カンボジア日本国大使館

勝尾　嘉仁　　一等書記官

（9）日本人専門家チーム

藤井　健二	総括
廣瀬　匡一	副総括 / 変電設備 1（分野総括）
林　　秀樹	変電設備 3（ルール策定 / 現業技能 2）
吉澤　広明	送電設備 1（分野総括）
門屋　直人	送電設備 2（ルール策定 / 現業技能 1）
秋元　正俊	系統運用 1（分野総括）
久芳　史朗	系統運用 5（ルール策定 4/ リレー運用）
内藤　武司	業務調整 / 組織研修マネジメント

第２章　プロジェクトの実績と現状

２－１　投入

２－１－１　日本側の投入実績

(1) 専門家派遣

これまでに、送電設備、変電設備、系統運用等、合計 14 分野を担当する延べ 15 名の短期専門家が派遣されており、専門家派遣期間は合計で 52 人 / 月となっている。また、「業務調整 / 組織研修マネジメント」を担当する長期専門家 1 名が派遣されており、派遣期間は合計で 24 人 / 月である。これら専門家の派遣実績の詳細は付属資料 1「合同評価報告書（英文）」の Annex 4 を参照。

(2) 研修員受入れ

プロジェクト期間中、終了時評価時点までに合計 10 名の C/P 及びワーキング・グループ・メンバーがベトナム、タイにおける近隣諸国の系統運用業務視察研修に参加した。また、14 名の C/P 及び 12 名のプロジェクト関係者が、プロジェクトの関連分野で計画されたタイでの第三国研修に参加した。C/P 研修の詳細については、付属資料 1「合同評価報告書（英文）」の Annex 5 を参照。

(3) 機材供与

プロジェクト活動の実施及び技術移転に必要な研修用資機材が要請され、総額 22 万 6,994USD（約 2,670 万円）相当の機材が供与された。これら供与機材の詳細は、付属資料 1「合同評価報告書（英文）」の Annex 6 を参照のこと。

(4) ローカルコスト負担

これまでに総額約 10 万 414USD の現地業務費及び在外事業強化費によるローカルコスト負担が行われた。各年度の支出実績は表－２、表－３に示すとおりである。

表－２　短期専門家（コンサルタント）の
ローカルコスト負担　（単位：円）

年　次 *	第 1 年次	第 2 年次	第 3 年次	合　計
現地業務費	1,091,358	2,624,720	840,323	4,556,401

* 第 1 年次は 2013 年 2 ～ 12 月、第 2 年次は 2014 年 1 ～ 12 月、第 3 年次は 2015 年 1 ～ 4 月。
出所：プロジェクト作成資料

表－３　長期専門家（JICA）のローカルコスト負担　（単位：USD）

年　度 *	2013	2014	2015	合　計
在外事業強化費	7,023.29	47,213.82	253.46	54,490.57

* 年度は日本の会計年度による。2014 年は 4 ～ 5 月。
出所：プロジェクト作成資料

２－１－２　カンボジア側の投入実績

(1) C/P の配置

C/P は、これまで延べ 35 名が配置されている。その内訳は、プロジェクトダイレクター延べ 2 名、プロジェクトマネジャー 2 名をはじめ、送変電部から 19 名、電力大学（IES）から 11 名、企画部、発電部、配電部から各 1 名の合計 3 名である。

(2) 土地・施設提供

プロジェクト・メンバーのために必要な執務スペースが EDC 本社及び NCC で提供された。また、訓練用鉄塔及び送電線の設置用地と供与機材保管場所も提供された。

(3) ローカルコスト負担

EDC は、11 台の変圧器の油中ガス分析（Dissolved Gas Analysis：DGA）の費用や、PSS/E（Power System Simulation for Engineering）ソフトのライセンス費用など、総額約 6 万 6,110USD のローカルコストを負担した。

２－２　アウトプットの達成状況

プロジェクトの想定する 2 つの成果について、PDM（Ver.2）で設定された指標及び業務フローに記載された計画を基に、各成果達成のための活動状況及び達成度を以下に示す。

成果 1：プノンペン送変電連系系統内における EDC の送変電設備の運用・維持管理能力が向上する。
指標
1.1　作成されたルールに基づいて、送変電設備の巡視・点検が実施されている。
1.2　巡視・点検により発見された送変電設備の変化（錆の発生等）に対して、適切な対応がとられることで、設備における事故・トラブルが未然に防げる。
1.3　技能認定されたトレーナー（送変電維持管理）が 6 名育成される。

プロジェクトでは、巡視、点検チェックリストや頻度、異常の判断基準などを定めた、送電設備の巡視、点検及び修繕、作業安全に関する基準・ルールや、変電設備点検にかかるルールやガイドラインが作成された。ルール案の翻訳や、EDC の既存のルールやニーズに合うように日本人専門家チームとルール案を協議、改訂する過程を通じて、C/P の維持管理基準にかかる知識は向上した。ルールやガイドラインは 2013 年 11 月に総裁の承認を得て、英語とクメール語で製本され、関係各部に配付された。製本されたルール、ガイドラインのリストは表－４のとおり。なお、表－４の 1 及び 2 の「Transmission Line 及び Substation にかかるガイドライン」の内容は PDM（Ver.2）で計画されていたルールを網羅しており、それに加えて表－４の 3 の「変圧器油中ガス分析（DGA）のルール」が作成された。

表－４　ルール及びガイドラインのリスト

No.	タイトル	内　容
1	Maintenance Rule for National Transmission Line	・巡視ルール（定期巡視 / 臨時巡視） ・点検ルール（定期点検 / 臨時点検） ・修繕ルール ・安全ルール
2	The Rules of Inspection for Substation Equipment	・変電設備点検（普通点検 / 臨時点検 / 細密点検）
3	Guidelines on Planning of Repair or Replacement Transformer by Dissolved Gas Analysis in Oil（DGA）	・変圧器油中ガス分析（DGA）

出所：プロジェクト関係者からの聞き取りの結果、調査団作成

送電線保守関係については、日本人専門家から C/P に対して、現場での OJT 並びに供与された訓練用の鉄塔（以下、訓練鉄塔）を活用した実技訓練が実施された。作成された巡視・点検、修繕ルールを送変電部の巡視、点検保守に携わる関係職員に説明するためのセミナーや実技訓練が行われている。プロジェクトでは 2014 年の年間・月間巡視計画及び点検計画（2014 ～ 2018 年）を策定し、2014 年 4 月から計画に沿って巡視活動が開始された。点検活動は 2014 年 9 月に開始され、EDC が所有するプノンペン連系系統内の約 20％の鉄塔及び約 43％のコンクリート柱が、2015 年 2 月の時点で点検済みである。また、巡視・点検記録は体系的に保管されている。C/P への聞き取り調査では、約 9 割の巡視・点検記録は新しいルールに基づいて作成されているとの報告があった（本プロジェクトで作成した巡視・点検チェック表のフォーマットを使用していることが確認されればルールに基づいて記録が作成されていることになり得るが、本終了時評価ではフォーマットを使用したかどうかの確認は実施していない）。

変電設備については、変圧器の修理・更新の必要性の有無を判断するために有用な、DGA にかかる講義や外部セミナーが実施されると同時に、IES 内の既存設備を使って遮断器の普通点検にかかる実技訓練が行われた。研修機材の不足のため、IES での実技訓練には限界があることから C/P はタイでの研修に 2 回派遣されている。新たなガイドラインに基づき、プロジェクトでは民間企業の研究所を通して変圧器 9 台の DGA 試験が実施され、分析結果に基づく総合診断が日本人専門家によって行われ、C/P に技術移転された。続いて、EDC は独自の予算で EDC 所有の残り 11 台の変圧器についても、新たなガイドラインに基づき DGA 試験を実施し、C/P による独力での診断後、専門家によって指導が行われた。この結果、プロジェクト送変電連系系統内で EDC 所有の全 20 変圧器が 2014 年 11 月までに DGA を終え、EDC は 2015 年 5 月には、同試験に必要な分析機器を購入し、分析試験を自分達で実施できるようになったことは特筆に値する。

一方で、新しいルールに基づく普通点検は、2015 年 3 月から開始され、全変電設備の約 2％が 2015 年 4 月までに点検済みである。普通点検活動はスケジュール化され、日本人専門家の指導を受けずに C/P が点検作業を行っていることが確認された。

終了時評価時点で、細密点検の OJT は実施されていないものの、新しく作成されたルールに基づいた送変電設備の巡視・点検は実施されている（指標 1.1）。

送電設備の巡視・点検の結果、2015 年 2 月までに鉄塔には累計 388 件、コンクリート柱には 643 件の不具合が発見された。発見された不具合は主に、樹木や鳥の巣などによる送電線への「他物接触」や、ボルトの緩みや碍子（がいし）の破損などの「保守不備」などである。これらの不具合を放置した場合、地絡や鉄塔強度の低下などの事故やトラブルを起こし、結果的に重大な事故やトラブルを引き起こしかねないが、作成されたルールに従い、EDC は接触物の除去や、ボルト締め、破損碍子の交換など必要な対処をとっている。また、DGA 試験の結果、2 台の変圧器に内部異常が認められ、早期の内部点検実施が推奨された。このため EDC は、第一段階として故障時の事故対応を検討し、第二段階として内部点検・修理のための代替の変圧器を調達している。

一方、変電設備の普通点検の結果、2015 年の 4 月と 5 月で累計 43 件の不具合が発見されている。そのなかには稼働していない予備の遮断器のため大きな事故にはつながらなかったが、深刻な不具合が発見されたとの報告があった。小規模かつ緊急を要する不具合について、EDC は必要な対応をとっており、緊急でない不具合もしくは大規模な修理については、スペアパーツの調達など修理計画を自分たちで作成し、実行に移している。

本調査では、プロジェクトの送変電設備の巡視・点検活動は 2014 年 4 月より各分野で順次開始されたこと、また実際に未然に防止された事故やトラブルは事故統計には現れないことから、事故やトラブル数の変化を定量的に比較することは難しかったが、上記の事例や報告から、点検活動が事故やトラブルを未然におおむね防止していたと判断された（指標 1.2）。

プロジェクトでは、人材育成に関して、既に新しい基準、ルールに基づく送変電設備の点検保守業務に従事している送変電部及び IES の C/P のなかからトレーナーが選ばれることを想定していた。しかし、技術部（送変電部）と IES の連携体制が脆弱であることや、不明確な EDC の人材育成方針、技術部と IES の C/P の実務経験や職務の違い、IES における維持管理の実技研修不足などが考慮され、送変電部の C/P をトレーナーとして育成するのではなく、IES における送電設備修繕の実技及び、変電設備（遮断器）の普通点検にかかる基礎研修コースが表－５のとおり設計された。IES のトレーナー経験者から候補者が配置され、訓練鉄塔の活用や既存の訓練設備（遮断機）を活用すると同時に、日本人専門家が作成したデモンストレーション映像などの視聴覚教材を使用してトレーナー研修（Training of Trainers：TOT）が実施された。これらの候補者は、前述した各分野で新しく作成されたルールに基づく、送変電部 C/P 向けの実技訓練にも参加した。日本人専門家によって作成された認定評価基準に基づき、送電線保守分野で 3 名、遮断機普通点検分野で 3 名、合計 6 名のトレーナーが認定された。

プロジェクトでは、特に EDC の長期的な人的資源開発を考慮にいれて、トレーナーの知識や技術だけでなく、自己学習、新トレーナーの育成、新研修コース開発を新たなトレーナー評価基準に加えた点は特筆に値する。終了時評価の時点で、研修教材の初稿は作成され、表－５のとおり、認定トレーナーによって複数回の研修コースが実施されている。IES は既に 2015 年の訓練スケジュールにこれら研修コースを組み込んでいる。

認定トレーナーによる研修を受けた受講生の理解度は非常に高く、調査団が実施したアンケート調査の結果によれば、認定トレーナーによる研修の全受講生が、講師の指導を 5 段階評価のうち、「よい（5 段階中上から 2 段目）」、「とてもよい（5 段階中上から 1 段目）」と評価しており、研修で身につけた技能の 80 ～ 100％を現場で活用していると答えている。

表－５　基礎研修コース

＜送電線保守基礎作業＞

No.	期　間	研修員の所属先（人数）	研修員数合計
1	2015 年 1 月 19 日～ 30 日	Transmission System Unit of Transmission Dept.（6）	6
2	2015 年 3 月 30 ～ 4 月 10 日	Transmission System Unit of Transmission Dept.（3）, Business and Distribution Dept.（1）, Siem Reap Province（1）, Prey Veng Province（1）	6

＜遮断器普通点検＞

No.	期　間	研修員の所属先（人数）	研修員数合計
1	2014 年 10 月 13 日～ 22 日	Transmission System Unit of Transmission Dept.（3）	3
2	2015 年 1 月 19 日～ 27 日	Relay Protection Office of Transmission Dept.（1）, Chak Angre Kroam Branch（1）, Siem Reap Province（1）	3
3	2015 年 4 月 20 日～ 28 日	Relay Protection Office of Transmission Dept.（1）, Siem Reap Province（1）	2

出所：プロジェクト作成資料

既述のとおり、EDC において、実務と直結した OJT と IES における集団研修の役割分担や、技術部と IES の連携体制など、送変電設備の維持管理にかかる明確な人材育成方針は不足しているものの、IES における送変電設備点検保守にかかる研修能力は強化された。

以上のことから、成果 1 は「達成された」と判断された。

今後、プロジェクトが完了するまで、プロジェクトで技術移転を受けた成果を、認定トレーナーを含む C/P から C/P 以外のスタッフにいかに体系的に普及していくか検討されることで、成果 1 の達成度がより高まることが期待できる。

成果 2：EDC の計画・スケジューリングから日々の実運用に至るまでの新たな系統運用業務の実施基盤が整備される。
指標
2.1 系統運用や需要計画、停電作業調整など作成されたルールに基づく系統運用業務や、設備運用面の問題点の指摘も含めた系統運用計画の策定ができるようになる。
2.2 保護リレー整定業務が適切に行われる。
2.3 各部でトレーナー（系統運用）が 3 名育成される。

プロジェクトでは、系統システムの運用及び計画にかかる基準、ルールが表－６のとおり、作成された。設定値制御及びデータ収集システム（Supervisory Control and Data Analysis：SCADA）が複雑な通信上の問題により完全運用に至らなかったが、基準やマニュアルは将来的に SCADA システムを前提とした中央給電指令センター（NCC）の活動に適用できるように工夫して作成

された。ルール案の翻訳や、EDC の既存のルールやニーズに合うように改訂する過程を通じて、C/P の系統運用にかかる知識だけでなく、系統運用計画を行うにあたって必要な系統解析ソフト（PSS/E）の業務への具体的な活用方法を習得した。ルールやガイドラインは 2014 年 7 月に総裁の承認を得て、英語とクメール語で製本され、関係各部に配付された。製本されたルール、ガイドラインのリストは表－６のとおり。

表－６　ルール及びガイドラインのリスト

No.	タイトル	内　容
1	Rules for Power System Operation	・給電運転ルール ・停電作業調整ルール ・需給計画ルール ・電圧調整ルール ・給電記録ルール

C/P 及び NCC 関連職員は系統運用にかかる技術研修に参加するためタイに派遣された。2014 年 6 月以降、プロジェクトは新ルール説明のためのセミナーを度重ねて行い、ルールに定められたとおり系統運用計画の策定を始めた。基準・ルールによる業務を開始した当初は、関係部門間の連携の弱さや、ルールの理解不足のため、必要なデータが集まらない、関係部局がデータを管理していないなどの問題があり、関係部門との連携がうまく機能しなかったものの、問題点を解決するために関係部門との協議を重ね、状況は大きく改善されている。例えば、月間の停止要求については､各部門から基準・ルールに定められた期限（毎月 10 日）までに要求が出なかったが、セミナーを通じた基準・ルールの周知や、ワーキンググループの活動を通じて、現在では期限までに要求が出てくるようになっている。また、需給計画（需要の予測と発電機の運転計画）については、NCC で年間・月間・週間の単位で策定できるようになっており、毎週木曜日に NCC 関係者による各関係部門との需給計画会議の開催が定着している。さらに、プロジェクトでは、供給信頼度上の設備形成面での問題点の指摘を含めた系統運用計画を 2015 年に作成している。したがって、EDC 職員は系統運用計画の作成も含め、作成されたルールに沿って系統運用業務を行うことができると判断された（指標 2.1)。

保護リレーについては、表－７のとおり基準とルールが策定され、総裁の承認を得ている。

表－７　保護リレーの基準ルール

No.	タイトル	内　容
1	Standard and Rule Protection Transmission line and Busbar 115kV-230kV	系統保護継電装置設置基準 系統保護継電器整定基準 系統保護整定業務ルール

保護リレー分野では、電力系統を構成する送電線、変圧器及び発電機データを収集し、インピーダンス及び故障電流の計算を行い、EDC で初となるインピーダンスリスト・故障電流マップが作成された。系統運用状況変更に伴い、上記インピーダンスリスト・故障電流マップの更新

が実施されている。ただし、リレー部門への系統運用状況変更の情報提供が遅いため、現在関係部門への働きかけを行っている状態である。作成したインピーダンスリスト・故障電流マップを基に、11 カ所の保護リレーの整定を日本人専門家とともに再検討し、不適切箇所の見直しが行われた。現在は、EDC 独自にリレー整定見直しを実施しており、既に 3 カ所の整定が見直された。以上のことから、整定業務は作成されたルールにしたがって適切に行われていると判断された（指標 2.2）。

系統運用業務にかかる人材育成については、EDC において系統運用業務、計画の業務経験をもつ C/P や職員はおらず人材が不足している。このため、プロジェクトでは系統運用業務のうち保護リレー分野に焦点を絞り、保護リレーにかかる基礎コースが計画され、TOT が実施された。送変電部門の人材育成と同様に、認定評価基準が作成され、4 名のトレーナーが認定されたことから、指標 2.3 は達成されたと判断できる。終了時評価の時点で、研修教材の初稿は作成され、表－８のとおり、認定トレーナーによって複数回の研修コースが実施されている。IES は既に 2015 年の訓練スケジュールにこれら研修コースを組み込んでいる。

調査団が実施したアンケート調査の結果によれば、認定トレーナーによる研修の全受講生が、講師の指導を 5 段階評価のうち、「よい（5 段階中上から 2 段目）」と評価しており、研修で身につけた技能を現場で部分的に活用していると答えている。

表－８　設定トレーナーによる研修コース

No.	期　間	研修員の所属先（人数）	研修員数合計
1	2014 年 10 月 20 日～ 24 日	Protection Relay Office（6）	6
2	2015 年 6 月 3 日～ 5 日	Substation Unit（7）, Siem Reap Province（1）	8

出所：プロジェクト作成資料

以上のことから、成果 2 は達成されたと判断された。

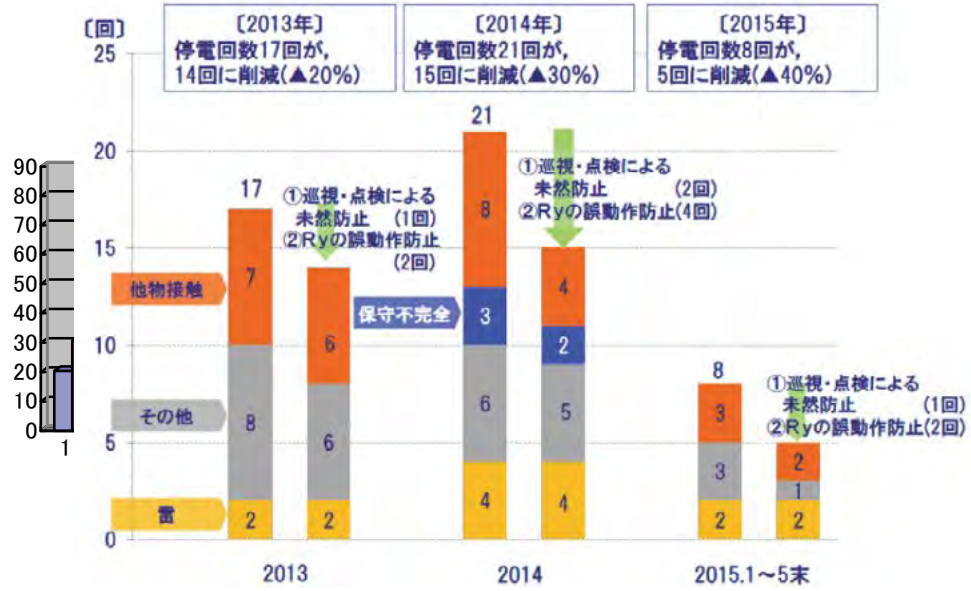
２－３　プロジェクト目標の達成状況

プロジェクト目標：プノンペン送変電連系系統内で電力が安定的に供給される。
指標
1. プノンペン送変電連系系統内で、送変電設備における大きな事故やトラブルが発生しない。
2. プノンペン送変電連系系統内で、停電時間、停電回数が減少する。

プロジェクトで取りまとめたプノンペン送変電連系系統内の停電事故データによれば、プロジェクト期間中に変圧器の火災、電線の断線といった送変電設備における大きな事故やトラブルは発生していない。ついては、プロジェクト目標の指標 1. は達成されたと判断できる。「２－２アウトプットの達成状況」で既述のとおり、送電線への飛散物（トタン板）の発見・除去や、送電線碍子（がいし）の破損発見・補修、予備遮断器の不具合の発見など、放置すれば停電事故につながりかねなかった事例が多く報告されている。これに加え、技術移転の一環として、既存リレーの整定を見直した際、保護区間の不整合が発見され、既設リレーの見直し前に事故が発生した場合、事故が発生した際の不要な箇所の停電により、カンボジア南部地域一帯に停電が起こり

得たが、これを防ぐことができたという事例も報告された。これらの事例は、成果 1 及び成果 2 の活動により達成された成果によって、放置すれば重大な事故やトラブルが起こり得た不具合を発見することができたことを示すものである。したがって、プロジェクト活動の結果、プロジェクト目標の指標 1 の達成につながったと判断できる。

また、プロジェクトでまとめた事故統計の分析結果によれば、プロジェクトで定着しつつある巡視・点検を確実に実施していれば不具合を発見し防げたと思われる停電事故は件数・時間ともに減少した可能性が高いと報告されている[1]。分析結果は図－1 及び図－2 のとおり（2013 年度から 2014 年度にかけて停電件数・時間ともに増加している要因は、この期間に設備増強が進んだため）。



出所：プロジェクト作成

図－1　プノンペン送変電系統の事故統計（停電回数）

[1] プノンペン送変電系統における事故に起因する需要家の停電回数及び停電時間を集計（左）し、本プロジェクト成果による削減効果を試算（右）したもの。

出所：プロジェクト作成

図－２　プノンペン送変電系統の事故統計（停電時間）

図－１及び図－２の試算によれば､例えば､2013 年に発生した停電回数 17 回は､もしもプロジェクトで支援したとおり、巡視・点検によって事故が未然に防止されていれば停電回数を 1 回、保護リレーの誤動作が防止されていれば 2 回削減することができたと考えられるため､合計 14 回（約 20%）に削減できたはずということができる。同様に、停電時間についても削減が見込めたことが確認できた。したがって、指標 2 についても、ほぼ達成されたと判断された。

上記の指標の達成度の確認に基づき、終了時評価時点でプロジェクト目標は十分に達成されており、協力期間終了までにさらに達成度が高まる見込みは高いと判断される。

２－４　上位目標の達成見込み

上位目標：プノンペン連系系統地域で電力が安定的に供給される。
指標
1. プノンペン連系系統地域の需要家 1 軒当たりの年間停電回数（SAIFI)。
2. プノンペン連系系統地域の需要家 1 軒当たりの年間停電時間（SAIDI)。

上位目標の指標に関し、EDC 配電部の配電センターによる SAIFI、SAIDI レポートは、プロジェクト開始後 NCC の管理するプノンペン連系系統全域ではなく、プノンペン市内の連系系統のみをカバーしていることから、今般調査においてはプノンペン連係系統地域レベルの信頼できる統計資料（SAIFI、SAIDI）は入手できなかった。そのため、プロジェクトの詳細計画調査時点以降の過去 3 年間の SAIFI、SAIDI データの推移（実績）に基づき上位目標達成の予測を行った。表－９のとおり、2012 年以降、SAIFI、SAIDI ともに減少傾向にある。

表－９　最近 3 年間の停電回数と停電時間の推移（需要家 1 軒当たり）

	2012	2013	2014[2]
SAIFI（回数）	104.87	100.99	24.53
SAIDI（時間）	8,619.43	7,850.92	2,052.93

出所：SAIFI and SAIDI Report

上位目標の達成には、「プノンペン連系系統の発電所が計画どおりに電力供給を行う」「近隣諸国からの安定的に電力が輸入される」「プノンペン連系系統の配電施設が適切に運営維持管理される」との外部条件が確保される必要があるが、協力期間中に、これら外部条件を阻害するような出来事は起きていない。したがって、協力期間後もプロジェクトで技術移転を受けた事業が継続されることで、上位目標達成（プノンペン連係系統地域における電力の安定供給）に向けた正のインパクトを見込むことが可能であると判断される。

２－５　実施プロセス

(1) プロジェクト活動の変更

2013 年 12 月 13 日の第 1 回 JCC 会議において、プロジェクトは、現状レビュー及びベースライン調査及び結果に基づき、プロジェクトの活動範囲を明確にするため成果の指標及び目標値の設置､活動の追加を行い､PDM（Ver.1）を作成した。さらに､成果 2 の指標とプロジェクトの進捗に応じた活動の追加を行うために、PDM（Ver.1）は PDM（Ver.2）に改訂された。後述するいくつかの活動を除き、ほとんどの活動は業務フローで計画されたとおり、タイムリーかつ効率的に実施された。

プロジェクト全体の実施を阻害したわけではないが、予想不可能な建設工事のミスによって訓練用機材の調達が遅れ、訓練鉄塔を活用した送電線保守のトレーナー研修の実施が遅延した。さらに、プロジェクトは、現在でもなお未解決の EDC の通信上の問題により、完全に機能していない SCADA システムを活用した系統運用業務の活動について臨機応変な対応もとっている。SCADA システムの完全運用が難しいと判断した際には、プロジェクトは技術移転の内容を、システム未使用の場合に備えて事前に準備していた NCC の日常業務における系統解析ソフト(PSS/E)の活用に切り替えている。EDC は技術移転の遅延を避けるため、彼らの予算を使って PSS/E ソフトの追加ライセンスを購入するなど代替策をとった。

(2) 意思決定とモニタリングのメカニズム

プロジェクトの最高意思決定機関である JCC は、これまで 2 回開催され、プロジェクトの活動進捗及び成果達成状況と次期活動計画内容の確認・承認等の機能を担ってきた。加えて、プロジェクトで作成された基準やルールの承認の際は、送変電部長や総裁が責任権限にしたがって必要な意思決定を行っている。

JCC 以外でも、カンボジアでの現地活動の終了時（3 カ月に 1 度程度）に、各専門分野の専門家チーム（短期専門家）と C/P は活動の進捗をプロジェクト・マネジャーに報告している。活動の進捗は EDC に常駐する長期専門家によって日常的に把握されている。関係者の

[2] 2013 年半ばに EDC では新しい発電所（石炭・水力）の稼働が開始された。

インタビューでは、2 名のプロジェクトマネジャーはどちらも、日本人専門家によるプロジェクトの現場での活動と進捗の報告に非常に助けられたとの回答があった。

プロジェクト実施全体で重大な問題となったわけではないが、プロジェクト活動中に送変電部と IES の C/P 全員が活動の進捗を共有したり協議したりするための技術的な総会や会合が開かれなかったことは悔やまれる。インタビューでは、訓練に際して送変電部と IES 間の連携が必要であり、プロジェクトで強化されるべきだったという意見もみられた。

(3) 関係者とのコミュニケーション

短期専門家のシャトル型派遣にもかかわらず、C/P と日本人専門家のコミュニケーションは良好であった。インタビューでは、活動の計画やスケジュールが事前に十分知らされていたため、日本人専門家との協働には全く問題がなかったとの回答が多くを占めた。日本人専門家は、各専門分野の活動で C/P の関与を引き出すための事前の段取りの重要性を特に配慮していたことは特筆に値する。短期専門家が日本に滞在している間は、日本人専門家は業務の進捗や質問に答えるため、メールだけでなく国際電話を活用していた。

インタビューでは、プロジェクトの開始当初、C/P はプロジェクトを研修ととらえ、ルールの策定や業務を自分たちで行うのではなく、準備された研修プログラムに参加することを活動と思っていたなど、日本人専門家との間でプロジェクトに対する認識の差が存在したことが確認された。一方で、インタビューに回答した日本人専門家は、電力公社である EDC のミッションともいえる「安定した電力供給」や、そのミッションを達成するための活動に対する EDC の認識が当初は弱く、一部 C/P や関係部門の参加が受動的、依存的であったと回答している。このため、日本人専門家は、ワーキンググループなどの活動を通じて、プロジェクトの目的と C/P 組織を中心とした技術移転の手法の説明に特に注力したことは特筆に値する。多くの C/P や関係部門がプロジェクトの趣旨を理解し、その後、プロジェクト開始時に比べて積極的になった。C/P と日本人専門家の関係性もアクティブになり、かつ依存性がより弱まってきている。

第3章　評価5項目による評価

３－１　妥当性

以下の理由から本プロジェクトの妥当性は高いと評価された。

(1) カンボジア政府（RGC）の政策との合致

RGC の掲げる第三次四辺形戦略において、「電力開発」は、四本柱の 1 つである「インフラの開発」に含まれる重点分野として位置づけられている。また、「国家戦略開発計画」（2014 ～ 2018 年）においても、効率のよい電力供給とマネジメントに向けた改善のため EDC の能力開発、組織強化がうたわれている。したがって、本プロジェクトの方向性は RGC の今後の政策に合致したものであるといえる。

(2) 日本の開発援助政策との整合性

2012 年に策定された「対カンボジア王国国別援助方針」において「経済インフラの整備」は 4 重点分野の 1 つとして位置づけられている。具体的には、「海外からの民間投資促進のため重要な要素である安定的な電力供給システムの支援に優先的に取り組む」としており、カンボジアの政策及び日本の援助政策と整合性がある。

(3) ターゲット・グループ選定の適切性

カンボジアの電気事業体制は、行政組織である鉱業エネルギー省（Ministry of Mines and Energy：MME）とカンボジア電力庁（Electricity Authority of Cambodia：EAC）の規制の下、EDC や IPP などの電気事業者が電力の供給を行っている。電力の安定供給のためには、この電気事業者の能力向上が必要不可欠であり、そのなかでも、EDC はカンボジア国土の約 90％の電力供給を担っている。したがって、EDC を本プロジェクトのターゲット・グループとして選定したことは適切であった。

(4) 日本の技術の優位性

日本の年間平均停電回数及び停電時間の少なさは世界トップの水準である。これは、日本の電力会社がこれまで電力の安定供給のために長年にわたり設備の維持・運用を行い、その能力を向上してきた結果であり、本プロジェクトは、その長年のノウハウを移転するものであり、日本の技術の優位性がある。

(5) 他ターゲット・グループへの波及効果

カンボジアの電気事業者のなかで唯一、全国送電線（National Transmission License：NTL）を受けている EDC は、同国の「給電規定（Grid Code）」のなかで、他の電気事業者から提出される停電計画等を調整したうえで、電力系統の運用計画策定等を行うようになっている。

３－２　有効性

以下の理由から本プロジェクトの有効性は高いと評価された。

(1) プロジェクト目標達成の見込み

本プロジェクトの目標は、プノンペン送変電連系系統内で電力が安定的に供給されることである。送変電設備の巡視・点検作業にかかる基準、ルールの策定、技術の向上、人材育成の強化（成果 1）並びに、保護リレー整定を含む系統運用にかかる計画策定、実施基盤の整備、人材育成（成果 2）を通じて、EDC が電力の安定供給を行う能力は強化された。プロジェクト期間中には、重大な事故やトラブルを未然に防止した好例が多く報告され、プロジェクトでまとめた停電・事故統計に基づいて、巡視・点検や保護リレーの見直しにより、停電回数や停電時間の削減にかかるプロジェクトの効果も推計された。プロジェクト期間中に、プノンペン送変電連系系統内で、送変電設備における大きな事故やトラブルは発生しておらず、上記の確認結果をもって、プロジェクト目標は協力期間中に十分に達成されると判断された。

(2) プロジェクト目標達成に対する成果の貢献度

プロジェクトによって、電力の安定供給にむけた予防保全技術（成果 1）並びに、供給信頼度の確保に向けた系統運用技術（成果 2）が移転され、これら 2 つの成果はほぼ達成され、既述のとおり、プロジェクト目標の達成に貢献している。また、プロジェクトはこれら 2 つの成果に加えて、ワーキンググループの活動や提案（ロードマップ）を通じて電力の安定供給に対する意識の向上をもたらした結果、電力の安定供給には欠かせない早期復旧計画の策定も補足的に実施されており、これらの成果や活動は目標達成に貢献している。

(3) プロジェクトの有効性に対する貢献要因

プロジェクトでは、各対象分野にかかる技術移転の基本方針及び計画を決定する前にベースライン調査を行い、決定後、日本人専門家と C/P により忠実に計画に沿って活動が実施された。専門家派遣のタイミングや期間はプロジェクトの進捗にしたがって慎重に決定され、業務計画や内容も十分に事前に知らされていた。また、(短期) 専門家チームの不在時は EDC に常駐の長期専門家によって活動支援が行われ、進捗もモニタリングされていた。EDC は効率的な技術移転を促すためにタイムリーに必要な投入を行った。これらに加え、専門家チームの不在時に緊急的な技術移転が必要となった際には、JICA カンボジア事務所及び本部の全面的な協力により、プロジェクトは TV 会議を利用したテクニカル・ミーティングを開催するなど、プロジェクト全関係者による献身的な活動と支援がプロジェクトへの貢献要因といえる。

(4) プロジェクトの有効性に対する阻害要因

当初、本プロジェクトは、送変電システムの監視制御を目的に NCC による SCADA システムを活用した系統運用業務に関する技術移転を行う計画であった。しかし、プロジェクト開始後、通信担当の日本人専門家が詳細に調査した結果、複雑な通信上の問題が判明し、SCADA は全面的に稼働できない状態であることがわかった。EDC は外部からの協力を得て現在も問題解決への努力を続けている。これによりプロジェクトが大幅に阻害されたわけではないが、移転技術の変更により実務指導内容の一部変更を余儀なくされた。

３－３　効率性

以下の理由から本プロジェクトの効率性は高いと評価された。

(1) 日本人専門家

日本人専門家については、適切な専門分野の専門家が期待される指導的な役割を担っており、C/P の関係も良好であった。

(2) 機材供与

プロジェクトに必要な機材及び技術移転が、機材の調達の遅れによって発生したが、プロジェクトの期間内で問題なく吸収することができている。研修用機材は十分に活用され保管状態も良好である。しかし、適切な維持管理のために EDC の機材リストに登録する必要がある。

(3) 第三国研修

プロジェクトが提供した海外研修の参加者はおおむね研修内容は妥当かつ適切であったと評価している。変電施設の設備点検の研修については、全面談者が非常に有益で、大多数が点検活動や訓練を通じて得た知識を業務に生用していると回答している。しかし一部、変電施設の点検機材の違いや不足のため習得した技能を生かせていないとの回答もみられた。系統運用分野の研修について、C/P は、タイにおける第三国研修で、実際にプロジェクトが EDC に導入しようとしている系統運用業務が国際標準であると知り、目から鱗が落ちるほどの経験を得たと報告している。研修後、C/P は策定された基準の重要性を再認識し、活動はさらに活発になり加速された。

３－４　インパクト

以下のとおり、プロジェクトは高い正のインパクトが見込まれる。

(1) 上位目標の達成見込み

前節で述べたとおり、送変電施設の維持管理能力及び系統運用業務の基盤は、送変電部及び IES の C/P の積極的な関与により強化された。プノンペン市内の需要家 1 軒当たりの年間停電回数（SAIFI)、年間停電時間（SAIDI）は終了時評価時点で減少傾向にあり、協力期間後もプロジェクトで技術移転を受けた事業が継続されることで、上位目標達成（プノンペン連係系統地域における電力の安定供給）に向けた正のインパクトの発現が見込まれる。

(2) 負のインパクト

終了時評価時点で、負のインパクトは確認されなかった。

３－５　持続性

多くの観点から本プロジェクトの高い持続性が予見されるが、後述するとおり、組織面ではさらなる強化を必要としている。

(1) 政策・制度面

本プロジェクトは、NSDP 2014-2018 など、最新のカンボジア政府の国家開発計画に沿って実施されてきている。プロジェクト終了後も政策面での支援の持続性は確保されていると

考えられる。

(2) 組織面

EDC 送変電部は、カンボジアで急速に拡大する送変電システムの管理を行うために、EDC が所有する送変電施設の運用維持管理の責任をもつ部署として 2007 年に設立された。送変電部は、中央給電指令センター（NCC)、保護リレー室（Relay Protection Office：RPO）から構成されている。2015 年 5 月の時点で、地方も含め 3,659 名の職員が在籍している。そのうち送変電部門には変電所の現場スタッフを含め 416 名が勤務しており、離職率は 1%程度と非常に低い。年間報告書によれば、EDC は近年収益を上げており、財務状況も健全である。また、送変電部門には十分な人員と予算が配置され、EDC 上層部の決断で業務に必要な費用も支出されている。したがって、EDC の組織面、財政面の持続性は確保されている。

一方で、今般調査では、送変電部内の NCC や RPO や各部門及び職員の役割・責任分担などが明確ではなく、組織としては未成熟な部分がある。本プロジェクトで新しい基準やルール、作業手順が作成され、送変電部の各 C/P は、ルールに定められた役割を遂行する能力を向上させた。今後は、さらに拡大が進むカンボジアの連系系統において安定した電力供給に向けて効果的、効率的な送変電設備の運用維持管理を進めていくために、EDC は各業務部門（NCC や RPO）の業務分担、業務手順を念頭においた組織の改編やさらなる人材強化について検討を始める必要がある。

(3) 技術面

本プロジェクトは、基準やルールの策定に加えて実施面を重視していることから、EDC は電力安定供給に必要な専門分野、すなわち送電、変電、系統運用、保護リレーにかかる技術を身につけ業務を実施できるようになっている。作成された基準やルールは EDC の内部規定としてすべて総裁に承認されている。

技術の普及について、プロジェクトは IES において送電、変電、保護リレー分野の合計 10 名のトレーナーを認定し、計画された研修コースを実施することで普及体制は整備された。さらに、送変電部は変電所の新入社員や未経験者に対して、機材や SCADA、通信システム、保護リレーに関する技術研修を実施しており、送変電部長は 2 カ月ごとに各変電所の現状とニーズを把握し、技術研修の内容を決めている。以上の観点から、プロジェクトの技術的持続性のレベルは高いと判断される。

３－６　結論

今後の電源開発計画、系統拡張による系統エリアの拡大をかんがみた場合、電力安定供給のため、送変電設備の予防維持管理と本プロジェクトでリレー整定を含む運用系統の基盤を同時に強化した功績は大きく、本プロジェクトを実施した有効性は非常に高いと判断される。また、本プロジェクトで導入された技術の有効性はカンボジア側関係者に十分認識されており、移転した技術の持続性も高いと判断される。

第4章　提言と教訓

４－１　プロジェクト期間終了時までの提言

(1) 新たな基準、ルール、業務プロセスのさらなる普及

プロジェクトの持続性、インパクトの観点から、プロジェクトの成果を送変電部内の関係部門や、他部門に普及を図ると、より効果的である。

C/P 職員が、現場や地方を含めた全関係職員に、ルールや業務プロセスについての説明や指導を体系的に、継続的に行うことが肝要である。さらに、系統運用の観点から、IPP にも新たな基準、ルールを継続的に知らしめる必要がある。

(2) 基準、ルール、業務プロセスのさらなる改善

ルールやマニュアルの規定どおり、基準やルール、業務プロセスは実状に合わせて定期的に見直し、プロジェクトで行ったルール策定及び実務への適用を通じて得た経験やノウハウを活用し、今後も改善を続けていくことが肝要である。したがって、すべての基準、ルール、業務プロセスを規定で定められたとおり定期的に見直しすること。

４－２　今後に向けた提言

(1) 低廉で安定的な電力供給に向けて

プロジェクトが予防保全及び電力供給信頼度の確保の観点から技術力の向上を図り、プロジェクトが成功を収めたことへの EDC の評価は高い。今後は、低廉で安定的な電力供給を電力公社の経営目標として掲げ、経営層が必要な対処を行うことを提言する。例えば、組織面では N-1 基準、事故の早期復旧、最小費用での開発・運用を考慮した、計画、建設、維持管理、系統運用を行う中核組織の強化や、人材育成面では、人材育成部の設置や、技術部と IES の緊密な連携を可能にする人材育成方針の策定などが挙げられる。

(2) 電力統計の信頼度の向上

電力の安定供給をモニターする指標として、SAIDI、SAIFI を含め、一層信頼性のある電力統計の整備を進めることが望ましい。

(3) NCC の SCADA システムの完全運用

系統運用の自動制御化に向けて、EDC は SCADA システムに関する通信上の問題を解決するために多大な労力を費やしている。プロジェクトの有効性の観点から、NCC における SCADA システム完全運用を促進し、通信システム技術を適切に管理できる職員を配置することが望ましい。

４－３　教訓

(1) 第三国研修の有効活用

系統運用分野の研修について、C/P は、タイにおける第三国研修で、実際にプロジェクトが EDC に導入しようとしている系統運用業務が国際標準であると知り、目から鱗が落ちるほどの経験を得たと報告している。研修後、C/P は策定された基準の重要性を再認識し、活

動はさらに活発になり加速されたとの報告もあった。これは、ASEAN 諸国の電力公社での見聞によって、EDC が電力公社としてめざすべき技術基準レベルを明確に認識できるようになったという、第三国研修が有効に機能した好事例である。

(2) 停電・事故統計の整備

プロジェクトでは、予防保全の効果を分析するため、事故及び停電データの詳細記録を指導し、EDC において停電・事故統計の基礎が整備された。事故を分析し、予防できたと思われる事故の結果（停電）を試算することで、プロジェクトの効果を停電件数と停電時間の観点から定量的に推測することが可能となり、経営層へ予防保全の重要性を認識させることができた好事例である。

(3) 適正技術の選択

SCADA システムに関して、EDC と IPP 間で複雑な通信上の問題があり、結果的に約 3 年もの間、同システムの完全運用が制限されている状態であった。同システムは本プロジェクトで導入されたものではないが、高度なシステムの導入にあたっては C/P 組織の技術レベルを見極め、現地の状況に即した投入を行う必要がある。

付　属　資　料

１．合同終了時評価報告書（英文）

Joint Terminal Evaluation Report

on

The Project for Improvement of

Transmission System Operation and Maintenance

in the Kingdom of Cambodia

Phnom Penh, 11 June 2015

Mr. Suzuki Kaoru
Team Leader
Japanese Terminal Evaluation Team
Senior Advisor to the Director General
Japan International Cooperation Agency (JICA)

Dr. Praing Chulasa
Team Leader
Cambodian Terminal Evaluation Team
Deputy Managing Director
Electricité du Cambodge (EDC)

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Abbreviations

C/P	Counterpart personnel
DGA	Dissolved Gas Analysis
EAC	Electricity Authority of Cambodia
EDC	Electricité du Cambodge
GDP	Gross Domestic Product
GoJ	The Government of Japan
IES	Institute of Electrical Science
IPP	Independent Power Producer
JCC	Joint Coordinating Committee
JET	Japanese Expert Team
JFY	Japanese Fiscal Year
JICA	Japan International Cooperation Agency
MME	Ministry of Mines and Energy
M/M	Minutes of Meeting
M/M	Man/Month
MOU	Memorandum of Understanding
NCC	National Control Center
NSDP	National Strategic Development Plan
NTL	National Transmission Line
ODA	Official Development Assistance
OJT	On the Job Training
PDM	Project Design Matrix
PSS/E	Power System Simulation for Engineering
RPO	Relay Protection Office
RGC	Royal Government of Cambodia
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Analysis
SS	Substation facilities
TC	Technical Committee
THB	Thai Baht
TL	Transmission Line
TOT	Training of Trainers
USD	United States Dollars

1. Introduction

1-1 Background of the Terminal Evaluation

The Project for Improvement of Transmission System Operation and Maintenance in the Kingdom of Cambodia (hereafter referred to as "the Project") was launched in February 2013, and has been carried out for two year and four months. This time, about 4 months prior to the completion of the Project, the Terminal Evaluation Study (hereafter referred to as "the Study") was conducted in accordance with the Japan International Cooperation Agency's (hereafter referred to as JICA) evaluation guidelines to evaluate whether the Project has been achieving the expected outputs and the project purpose.

1-2 Objectives of the Evaluation Study

The specific objectives of the evaluation study are outlined as follows:

1) To review the progress and achievements of the Project
2) To evaluate the achievement in accordance with the five evaluation criteria (relevance, effectiveness, efficiency, impact and sustainability)
3) To make recommendations for the Project

1-3 Member of the Evaluation Team

The Joint Evaluation Team (hereinafter referred to as "the Team") was organized by following members.

1-3-1 Japanese side

(1) Mr. Kaoru Suzuki (Leader)
Senior Advisor to the Director General (Energy), Industrial Development and Public Policy Department, JICA

(2) Mr. Shingo Naito (Cooperation Planning)
Assistant Director, Team1, Energy and Mining Group, Industrial Development and Public Policy Department, JICA

(3) Ms. Mitsuko Nakamura (Evaluation Analysis)
Consultant, Overseas Operation Department, Kokusai Kogyo Co., Ltd.

1-3-2 Cambodian side

(1) Dr. Praing Chulasa (Leader)
Deputy Managing Director, Electricité du Cambodge (EDC)

(2) Mr. Nou Sokhon (Member)
Director, Transmission Department, EDC

(3) Mr. Oum Piseth (Member)
Director of Institute of Electrical Science (IES), EDC

1-4 Schedule of the Evaluation

No.	Date		Activities	
			Mr. Suzuki /Mr. Naito	Ms. Nakamura
1	May 24	Sun		Haneda > Bangkok > 19:45 Phnom Penh (TG584)
2	May 25	Mon		8:30 Meeting at JICA Cambodia office

No.	Date		Activities	
			Mr. Suzuki /Mr. Naito	Ms. Nakamura
				14:30 Meeting and interview with C/P at EDC
3	May 26	Tue		8:00 Meeting and interview with C/P at IES, Site visit
4	May 27	Wed		8:30 Interview with C/P at NCC
5	May 28	Thu		9:00 Interview with C/P at NCC, Site visit 11:00 Interview with Japanese Expert (JET) PM Data analysis
6	May 29	Fri		9:00 Interview with C/P at IES PM Data analysis
7	May 30	Sat		8:30 Site Observation at GS3 substation PM Data analysis & Report preparation
8	May 31	Sun		Data analysis & Report preparation
9	June 1	Mon		Data analysis & Report preparation
10	June 2	Tue		8:30 Interview with C/P at EDC 11:00 Interview with JET 16:00 Internal Meeting (TV conference)
11	June 3	Wed		9:00 Interview with working group members 12:00 Interview with JET, Data analysis
12	June 4	Thu		10:30 Interview with JET 15:00 Data analysis & Report preparation
13	June 5	Fri		Drafting of Evaluation Report
14	June 6	Sat		Drafting of Evaluation Report
15	June 7	Sun	>Phnom Penh(TG584)	Drafting of Evaluation Report
16	June 8	Mon	8:30 Meeting at JICA office 9:30 Internal Meeting 15:00 Courtesy visit to EDC and Kick off Meeting	
17	June 9	Tue	8:00 Site Observation (IES, NCC)	Drafting of Evaluation Report
			14:30 Discussion on Evaluation Report with Joint Evaluation Team, Drafting of M/M	
18	June 10	Wed	9:00 Finalizing of Evaluation Report and M/M	
19	June 11	Thu	9:00 Joint Coordination Committee Meeting Signing of M/M	
20	June 12	Fri	9:00 Debriefing to JICA office 10:30 Report to Embassy of Japan 20:20 Phnom Penh (TG585) > Bangkok	
21	June 13	Sat	>Haneda	

1-5 Methodology of the Evaluation

The Project was evaluated jointly by the Cambodian and Japanese evaluation team, based on the Project Design Matrix (hereinafter referred to as the "PDM)", which is a summary table of the Project. The details of methodology are as follows.

1-5-1 Design of the Evaluation

Based on materials showing the framework of the Project such as PDM, Plan of Operation (PO) and the Memorandum of Understanding (MOU), the Team formulated the Evaluation Grid (See Annex 3) and Evaluation Plan in advance, which identified the specific evaluation points and the data collection methods. The Evaluation grid was designed based on the PDM Ver.2 (see Annex1) which has been modified on June 2015.

1-5-2 Evaluation activities

For the data and information collection, the Team applied various methods such as analysis on reports, individual and group interviews with counterparts (hereinafter referred to as the "C/P"), JICA experts (hereinafter referred to as the "JET"), based on the questionnaires distributed before the field survey, the observation of the project site, the provided equipment in use, and the project activities.

1-5-3 Points for the Evaluation and Analysis

(1) Achievements and Implementation Process of the Project

Achievement of the Project was reviewed in terms of Inputs, Activities, Outputs, and Project Purpose. Implementation of the Project was examined to see if the activities had been implemented according to the schedule, to see if the Project had been managed properly, and to identify promoting and inhabiting factors that had affected the implementation process.

(2) Five Evaluation Criteria

In addition to the review of the achievement and implementation process, the Team reviewed the Project from the viewpoints of the following Five Evaluation Criteria.

Table1-1: Definitions of Five Evaluation Criteria

Five Criteria	Definitions by "the JICA Evaluation Guideline"
Relevance	Relevance refers to the validity of the Project Purpose and the Overall Goal in connection with the development policy of the government of Cambodia and assistance policy of Japan.
Effectiveness	Effectiveness refers to the extent to which the expected benefit(s) was (were) brought about as a result of the Project.
Efficiency	Efficiency refers to the productivity of the implementation process. It examines whether the inputs of the Project have been efficiently converted into the outputs.
Impact	Impact refers to direct and indirect, positive and negative impacts caused by the implementation of the Project, including the extent to which the Overall Goal has been attained.
Sustainability	Sustainability refers to the extent to which the Project can be further developed by the Cambodian authorities concerned and the extent to which the benefits generated by the Project can be sustained under the national policies, technology, systems and financial state.

1-6. List of Interviewees

1. Electricité du Cambodge (EDC)
   - Dr. Praing Chulasa — Deputy Managing Director
2. Transmission Department.
   - Mr. Nou Sokhon — Director
   - Mr. Ing Prorseth — Deputy Director

<Transmission System Unit>

- Mr. Mak Thorn — Chief
- Mr. Thourk Mony — Deputy Chief
- Mr. Try Chhun Heng — Deputy Chief
- Mr. Chhay Sophea — Deputy Chief, Transmission Line Division.
- Mr. Try Soban — Deputy Chief, Transmission Line Division.

Mr. Meas Mea	Staff, Transmission Line Division
Mr. Meas Nimol	Staff, Substation Division,
Mr. Kem Sopanha	Saff, Substation Division

< National Control Center (NCC)>

Mr. Touch Samphors	Chief, Data Management & Operation Planning
Mr. Heng Ky	Chief, Shift No.1
Mr. Chan Samnang	Deputy Chief, Data Management
Mr. Hak Hout	Deputy Chief, Data Collection Division
Mr. Rin Vanny	Staff, Operation Planning,

< Relay Protection Office>

Mr. Lors Pouthy	Deputy Chief
Mr. Phin Chenda	Staff
Mr. Phat Tech	Staff
Mr. Neang Vannet	Staff

3. Institute of Electrical Science (IES)

Mr. Oum Piseth	Director
Mr. Meng Sokkheng	Deputy Director
Mr. Sok Pal	Chief, Electrical Department, IES

< Technical Training office>

Mr. Chhan Buntheat	Trainer, Transmission Division
Mr. Hong Neang	Trainer of Transmission Division
Mr. Chhay Vichet	Trainer of Safety Division
Mr. Chea Mareth	Trainer Trainer of Transmission Division
Mr. Chin Pim Shokha	Trainer of Transmission Division
Mr. Nong Vibol	Trainer of Transmission Division
Mr. Chea Prach	Trainer of Power plant protection Division
Mr. Su Tek Seng	Trainer of Distribution Division

4. Corporate Planning and Project Department

Mr. Chun Piseth	Director

5. Generation Department

Mr. Peh Pha	Deputy Director, Generation Department

6. Business and Distribution Department

Mr. Iv Visal	Deputy Director
Mr. OrVaddhaba	Chief of Distribution Control Center,

7. JICA Cambodia Office

Mr. Toshikazu Watanabe	Representative, JICA Cambodia Office

8. Japanese Expert Team

Mr. Kenji Fuji	Chief Advisor
Mr. Masakazu Hirose	Deputy Chief Advisor/ Substation1 (Leader)
Mr. Hideki Hayashi	Substation 3 (Rule formulation 2/ Field work techniques 2)
Mr. Hiroaki Yoshizawa	Transmission Line 1 (Leader)
Mr. Naoto Kadoya	Transmission Line 2 (Rule formulation 1/ Field work techniques 1)
Mr. Masatoshi Akimoto	System Operation 1 (Leader)

Mr. Shiro Kuba	System Operation 5 (Rule formulation 4/ Relay protection)
Mr. Takeshi Naito	Project Coordinator/Organizational and Training Management

2. Outline of the Project

2-1. Background of the Project

Reflecting the rapid economic growth that the Kingdom of Cambodia has achieved, over the period 2003 – 2010 Cambodia's maximum power and electrical energy both grew by an average of over 20% per year. This rapid growth has drawn attention to the need for Cambodia to put in place the systems that are required in order to ensure a stable electric power supply. The current situation is the electricity generation in Cambodia is mainly undertaken by independent power producers (IPPs), while EDC, the most important electric-power-related organization in Cambodia, is responsible for transmission and distribution (including system operation).

EDC has a plan to establish a nationwide high-voltage transmission network; currently, the company is already in the process of putting in place a transmission network to supply Southern Cambodia (in particular the area around the capital, Phnom Penh) using electric power imported from Vietnam, while also installing transmission line to supply the same region with power generated by newly established power stations owned by IPPs. In January 2012, a national Control and Center (NCC) was established in EDC, a Supervisory Control and Data Analysis (SCADA) system was installed, with the aim of ensuring effective control over the electric power system to as to be able to carry out system operation in such a way as to provide low-cost, high-quality electric power supply.

In 2006, Japan began providing support for the establishment of a transmission line between Kampot and Sihanoukville through the Greater Mekong Power Network Development Project (Cambodia Growth Corridor), a loan assistance project. In addition, according to the Data Collection Survey on Electric Power Sector in Cambodia (March, 2012) which was implemented by JICA, while EDC has been focusing heavily on human resource development such as upgrading its training facility to Institute of Electrical Science, there is a clear need to undertake further measures to strengthen the capabilities and experiences of EDC employees necessary to operate, maintain and manage the new transmission and substation equipment that is now being installed.

2-2. Outline of the Project

First, the framework of the project, PDM ver.0, was decided in the MOU signed on September 28, 2012. Then, the PDM Ver.0 was modified to PDM Ver.1 in the 1st JCC meeting on December 13, 2013, and then modified to PDM Ver.2 on June, 2015. The Project summary described in PDM Ver.2 is as follows (For more details, see Annex2)

(1) Overall Goal

Electrical power is stably supplied in Phnom Penh power grid.

(2) Project Purpose

Electrical power is stably supplied in Phnom Penh bulk power system.

(3) Outputs

1. Capacity of operation and maintenance of transmission line (TL) and substation facilities (SS) in Phnom Penh bulk power system is enhanced.
2. Basic capacity of enhanced power system operation such as planning, scheduling and actual execution is strengthened.

3. Achievements and Implementation Processes of the Project

During the Study, the achievements of the Project including inputs, activities and outputs, as well as the implementation process were reviewed to assess the degree of achievements, the results of which are described in the following.

3-1 Inputs

The Team has confirmed that the Project has provided the following inputs along with the plan stated in PDM (Ver.2).

3-1-1. Inputs from the Japanese side

(1) Assignment of Japanese Experts

A cumulative total of 15 short-term experts in 14 fields of expertise and 1 long-term expert in charge of Project Coordinator and Organizational and Training Management have been dispatched. Total duration of the short-term experts' assignment is about 52 Man/Month (M/M); and long-term expert's is 24 M/M. by the end of April 2015, the details of which are shown in the Annex 4.

(2) Training of C/P in the Third Country

In total 10 C/Ps and Working Group members were dispatched to Vietnam and Thailand for discussion about "Power System Operation" in neighboring countries. A cumulative total of 14 C/Ps and 12 staff were dispatched to Thailand for training on the subjects relevant to the scope of the Project. The details of training are shown in Annex 5.

(3) Provision of Equipment

Machinery and equipment of approximately total value equivalent to 26.7 million JPY (226,994 USD) have been provided for the Project activities. (Exchange rate 1USD = 117.58 JPY as of December 2014). The list of these machinery and equipment are shown in Annex 6.

(4) Local Operation Cost

A total amount of 100,414 USD (approximately 11,458,450 JPY) has been provided to supplement a portion of operational expenses for the Project activities by the end of April 2015, as indicated in Table 3-1.

Table 3-1: Local expenses borne by short-term experts (consultant)

Unit: JPY

	1st Year*	2nd Year**	3rd Year***	Total
Local operation cost	1,091,358	2,624,720	840,323	4,556401

Note *Feb. 2013-Dec. 2013 **Jan. 2014 – Dec. 2014 ***Jan. 2015 – April
Exchange rate: *1USD = 102.19 JPY, 1THB=3,185 JPY as of Dec. 2013 **1USD = 117.58 JPY, 1THB=3,593 JPY as of Dec. 2014 ***1USD = 119.64 JPY as of April 2015

Table 3-2: Local expenses borne by long-term experts

Unit: USD

	JFY* 2013	JFY 2014	JFY 2015**	Total
Local operation cost	7,023	47,213.82	253.46	54,490.57

Note *Japanese Fiscal Year (April – March). **2: Figures are based on the accounts to be settled by May 2015.
Exchange rate: *1USD = 102.19 JPY, 1THB=3,185 JPY as of Dec. 2013 **1USD = 117.58 JPY, 1THB=3,593 JPY as of Dec. 2014 ***1USD = 119.64 JPY as of April 2015

3-1-2. Inputs from the Cambodian side

(1) Assignment of Counterparts

A cumulative total of 35 counterpart personnel assigned to the Project: cumulatively 2 Project Directors, 19 from Transmission Department, 11 from IES, and 3 from Corporate Planning and Project Department, Generation Department and Business and Distribution Department respectively. A list of the counterpart personnel are shown in Annex 7.

(2) Provision of Land and Facilities

The necessary project office spaces for the Project members have been provided in the premises of EDC headquarter. Installation places for the training tower for transmission line and storage for the provide equipment have been also provided.

(3) Project Operational Cost

EDC has allocated the necessary local cost such as Dissolved Gas Analysis (DGA) test of 11 transformers and a license of PSS/E software. Total expense born is 66,110 USD (approximately 7,909,400 JPY*) *Exchange rate: 1USD = 119.64 JPY as of April 2015

3-2 Achievement of Outputs

The Project has implemented its activities as per the plan stated in the PDM Ver.2 and Operational Flow (Annex 2). The Team reviewed the performance and progress of the Project activities and measures the achievement of the Outputs in the following.

(1) Output 1

Currently, the status of indicators suggests high achievement level of Output 1 as seen below.

Narrative Summary	Achievement
Capacity of operation and maintenance of transmission line (TL) and substation facilities (SS) in Phnom Penh bulk power system is enhanced.	High
Verifiable Indicators	**Achievement**
1.1 Patrol and inspection of TL and SS are safely practiced complied with formulated rules.	Mostly Achieved
1.2 Accidents/troubles at TL and SS are prevented from occurring.	Mostly Achieved
1.3 Six (6) trainers are certified as trainers	Achieved

Activities and achievements:

Rules and standards of patrol, inspection, repair, and work safety of TL, and rules and guidelines of inspection of SS, which specify patrolling and inspection items, frequency, and acceptance standards and so forth, were formulated in the Project. Through formulation process, such as translating and revising draft rules to be suited to EDC's existing rules and its needs, and discussing with the JET, C/Ps' knowledge of operation and maintenance standards was enhanced. The Team confirmed that the rules and guideline were approved by the Managing Director of EDC in November 2013, published in English and Khmer, and distributed to the relevant departments. The list of documents is summarized in Table 3-3.

Table 3-3: List of the published rules and standards in the Project

No.	Title	Contents supported by the Project
1	Maintenance Rule for National Transmission Line	· Patrol Rule (regular/extraordinary) · Inspection Rule(regular/extraordinary) · Repair Rule · Safety Work Procedures
2	The Rules of Inspection for Substation Equipment	· Inspection Rule (regular/extraordinary/overhaul) · Inspection Guidelines for Substation Equipment
3	Guidelines on Planning of Repair or Replacement Transformer by Dissolved Gas Analysis in Oil (DGA)	· Guidelines on planning of repair or replacement by Dissolved Gas Analysis in Oil (DGA)

As for the field of TL, OJT in the field and practical training by using the provided training transmission tower were conducted by JET to C/Ps, and a seminar and practical training were organized to explain the formulated standard and rules to the relevant staff of Transmission Dept., such as patrol and maintenance staff. The Project also formulated annual and monthly patrol plan of 2014 as well as inspection plan (2014-2018). Patrol activity was started from April 2014, according to the schedule. Inspection activity was started from September 2014, and about 20% of transmission towers[1] and about 43 % of concrete poles[2] were already inspected at the end of February 2015. Both patrol and inspection record were organized very well. During interviews, it was reported by C/P that 90% of the patrol and inspection reports indicated that the activities had been practiced based on the new rules.

As for the field of SS, lecture and seminar on Dissolved Gas Analysis (DGA) for maintenance of transformer, as well as practical training on regular inspection of circuit breaker by utilizing existing facility in IES were conducted. C/Ps were dispatched to Thailand twice for training, since there is a limit to practical training at IES, due to lack of training equipment. Based on the new guideline, the Project conducted DGA test of 9 transformers through a laboratory of private company and knowhow of diagnosis based on the results of analysis was instructed by JET as part of the technical transferring activities. Subsequently EDC also implemented DGA test of the remaining 11 transformers by their budget and diagnosis was conducted by C/Ps and then instructed by JET. As a result, it should be noted, all 20 transformers[3] EDC owned in Phnom Penh bulk power system were diagnosed by November 2014, and EDC purchased the test equipment necessary for DGA in May 2015, so as to conduct it themselves. On the other hand, regular inspection based on the new rules was started from March 2015, and about 2 % of substation equipment[4] was inspected by the end of April 2015. During the study, the Team confirmed that inspection activities were scheduled, and C/P was implementing regular inspection without JET based on the new rules. Although OJT activity of extraordinary inspection was not finished at the time of the Study, it was concluded that patrol and regular inspection of TL and SS have been safely practiced complied with formulated rules (indicator 1.1)

As a result of patrol and inspection of TL, a cumulative total of 388 problems at transmission towers and 643 problems in concrete poles were detected by February 2015. It is reported that the detected

[1] 326 towers out of 1,457 transmission towers owned by EDC
[2] 505 poles out of 1,193 concrete poles owned by EDC
[3] At the time of the Study, number of transformers was 26 since EDC is expanding substation facilities.
[4] 25 equipment out of 1,104 substation equipment

problems mainly consist of "contact the external substance" such as trees and a bird's- nest and maintenance deficiencies such as bolt loosening and broken insulator. If any counter-measure were not taken, these problems would cause accidents or troubles, for example, ground fault, deterioration of strength of towers, etc. and eventually lead to serious accidents or troubles. Following the formulated rules, EDC was taking necessary counter-measures, for example, by removing an iron roof, tightening the loosened bolts and replacing the broken insulator. As a results of DGA test, two transformers were diagnosed as internal abnormality and required early detailed inspection. Therefore, as a first-step, EDC discussed coping strategy in case of the breakdown and as a second-step a substitute transformer for future inspection and repair was procured by EDC. As a result of regular inspection of SS, a cumulative total of 43 problems were detected in March and April 2015, and a very serious problem was detected on the preliminary circuit breaker, although it was not in operation and did not cause any accident. As for small and urgent problems EDC is taking necessary counter-measures, and as for the less urgent problems or large scale of repair EDC has formulated and implemented the repair plan themselves such as procurement of spare parts. It can be said by this case that the inspection activity could prevent accidents or troubles.

During the Study, it was difficult to compare the quantitative change of accidents and troubles because patrol and inspection of TL and SS just started from April 2014 respectively and actual prevented accidents and troubles are not shown in the fault records. However, the examples described as above suggests the accidents and troubles were mostly prevented from occurring by patrol and inspection (indicator 1.2).

As for training of trainers (TOT) in the Project, it was assumed that trainers would be selected from the C/Ps of Transmission Dept. and IES who have already demonstrate an ability to carry out their inspection jobs of TL and SS in accordance with relevant standards and manuals. However, considering background of weak collaboration scheme between technical departments and IES and unclear human resource development approach of EDC; differences in practical experiences and duties of C/Ps; and lack of practical skill training on operation and maintenance of TL and SS at IES, the Project designed fundamental practical skill training programs on inspection of TL and SS for IES, as summarized in Table 3-4. Suitable candidates were assigned from experienced trainers of IES and TOT was conducted by using the provided training transmission towers and existing substation facility as well as visual aids, such as demonstration video made by the JET. These candidate trainers also participated in practical training in accordance with the formulated rules, which were conducted at IES for C/Ps of Transmission Dept. as aforementioned. Based on the certification and evaluation standards formulated by JET, 3 trainers on maintenance of TL, and 3 trainers on maintenance of SS were certified (indicator 1.3).

It should be noted that the Project included not only knowledge and skills of trainers, but also understanding of trainer's duties such as self-development, training of new trainers and development of new training courses as evaluation criteria, especially taking account of human resource development of EDC in a long-term. At the time of the Study, first version of training materials were prepared and new training programs were conducted several times by the certified trainers as shown in Table 3-4. IES already inserted the training courses into the training schedule of 2015.

According to the results of questionnaire survey[5] by the Team, all trainees, who participated to the training program by the certified trainers, evaluated instruction of the trainers as "good" or "very good", and answered that they are currently applying 80% to 100% of the skills acquired through the training on their field.

[5] The number of trainees' answers was 18 (N=18).

Table 3-4: Record of newly established training program by certified trainers

<Basic Maintenance Work on Transmission Lines>

No.	Period	Trainees (Number)	Total Number. of Trainees
1	19-30 January 2015	Transmission System Unit of Transmission Dept. (6)	6
2	30 March–10 April. 2015	Transmission System Unit of Transmission Dept. (3), Business and Distribution Dept. (1), Siem Reap Province (1), Prey Veng Province (1)	6

<Circuit Breaker Inspection >

No.	Period	Trainees (Number)	Total Number. of Trainees
1	13-22 October 2014	Transmission System Unit of Transmission Dept. (3)	3
2	19-27 January 2015	Relay Protection Office of Transmission Dept. (1), Chak Angre Kroam Branch (1), Siem Reap Province (1)	3
3	20-28 April 2015	Relay Protection Office of Transmission Dept. (1), Siem Reap Province (1)	2

Although the issues such as lack of clear human resource development approach of EDC's operation and maintenance of TL and SS, such as division of roles between OJT and group training in IES and collaboration system between technical departments and IES, it is concluded that training capacity of operation and maintenance of TL and SS at IES was enhanced.

Based on the confirmation above, it is evaluated that the degree of achievement of Output 1is high. It is also expected that the Project considers systematic dissemination flow of the transferred technologies from C/Ps (including certified trainers) to the other staff in EDC and raises the degree of achievement of Output 1 further before the completion of the Project.

(2) Output 2

Currently, the status of indicators suggests high achievement level of Output 2 as seen below.

Narrative Summary	**Achievement**
Basic capacity of enhanced power system operation such as planning, scheduling and actual execution is strengthened.	High
Verifiable Indicators	**Achievement**
2.1 EDC staff is able to operate power system and control facilities complied with the formulated rules such as power system operation, demand & supply control, and coordination of planned outage, and make the plan of power system operation which includes indication of issues of power system configuration. (Firm information sharing and its conveyance through reciprocal coordination among relevant departments.)	Mostly Achieved:
2.2 Work procedure and training of relay setting is properly carried out.	Mostly Achieved
2.3 Three (3) trainers for power system operation at relevant departments of EDC.	Achieved

Activities and achievements:

Rules and standards for operation and planning of power system operation were formulated as shown in Table 3-5. Although the SCADA system was not fully operated due to complex telecommunication problems, the rules and manuals were formulated to be applied to fully operated National Control Center (NCC) with SCADA system in the future. Through formulation process, such as modifying and translating the draft rules to reflect the current and expected status in EDC, C/Ps enhanced not only their knowledge, but also technical skills how to apply the data analysis software , i.e. Power System Simulation for Engineering (PSS/E) to operation and planning of power system practically. The rules were approved by the Chairman of EDC in July 2014, published, and distributed to the relevant departments.

Table 3-5: List of the rules and manuals in the Project

No.	Title	Contents supported by the Project
1	Rules for Power System Operation	· Rules for Load Dispatching Operation · Rules for Coordination of Planned Outage · Rules for Demand & Supply Plans · Manual Rules for Voltage Control · Rule for Data Management

C/P and relevant staff of NCC were also dispatched to Thailand for technical transferring. After formulation of the rules, the Project has organized seminars several times since June 2014 and started to make power system plan and control the facilities based on the new rules. Although at the beginning it was difficult to collect necessary data for power system planning based on the new rules, due to weak inter-departmental collaboration, insufficient understanding of the rules, the issues, such as no data collection and management in the relevant department and section, information sharing and its conveyance through reciprocal coordination among relevant departments has been getting firm lately. For example, monthly power outage request have not been submitted by the deadline (10th day of every month) in the past, but after the rules were made known through the seminar and Working Group activities, the requests were submitted as scheduled by the rules. For demand and supply control , NCC currently enables to formulate demand and supply plan by week, month and year by themselves and for example a regular meeting on Thursday for controlling demand and supply by NCC and relevant divisions is already mainstreamed in EDC. The Project also formulated Power System Operation Plan of 2015 which includes indication of issues of power system configuration. Thus it is concluded that EDC staff is able to operate power system and control facilities complied with the formulated rules, including making the plan of power system operation. (indicator 2.1)

As for the relay protection, the following rules were formulated and approved by the Chairman of EDC.

Table 3-6: List of the standards and rules in the Project

No.	Title	Contents supported by the Project
1	Standard and Rule Protection Transmission line and Busbar 115kV-230kV	Standard of Protection Relay Type Selection Standard of Protection Relay Setting Rules for Work Procedures of Protection Relay setting

As for the field of relay protection, the Project collected necessary data of transmission, transformers and generators which consist of power system and calculated impedance and fault current to formulate impedance list and fault current map at the first time in EDC. According to situational changes of power

system operation, C/Ps are updating the above maps. However, due to a delay of sharing information about situational changes of power system operation, C/Ps are continuously encouraging the relevant departments and sections. Based on these maps, the Project reviewed relay setting of model facilities and revised inappropriate settings. Currently EDC is carrying out review of relay setting by themselves, and three facilities were completed. These facts indicates that relay setting is properly carried out based on the formulated standards and rules (indicator 2.2) .

As for TOT of power system operation, since there was no experienced C/Ps and staff in terms of power system operation in EDC, the Project focused on the relay protection technique as part of power system operation field, and designed fundamental program of relay protection for new staff and inexperience staff at IES, and TOT was conducted to the selected IES trainers. Certification and evaluation standards were formulated similarly to other training programs of TL and SS, and 4 trainers were certified. Based on the certification and evaluation standards, 4 trainers on were certified (indicator 2.3) At the time of the Study, first version of training materials were prepared and new training programs was conducted by the certified trainers as shown in Table 3-4. IES already inserted the training courses into the training schedule of 2015.

According to the results of questionnaire survey[6] by the Team, all trainees, who participated in the training program by the certified trainers, evaluated instruction of the trainers as "good", and answered that they are currently partially applying the knowledge acquired through the training on their field.

Table 3-7: List of training program by certified trainers

No.	Period	Trainees (Number)	Total Number. of Trainees
1	20-24 Oct. 2014	Protection Relay Office (6)	6
2	3-5 June 2015	Substation Unit (7), Siem Reap Province (1)	8

Based on confirmation above, it is evaluated that the degree of achievement of Output 2is high.

3-3 Achievements of the Project Purpose

Narrative Summary	**Achievement**
Electrical power is stably supplied in Phnom Penh bulk power system.	High
Verifiable Indicators	**Achievement**
1. Serious accidents or troubles* at TL and SS do not occur.	Achieved
2. The duration and the frequency of power outage are reduced.	Mostly Achieved

Note: *Serious accidents and troubles mean fire on transformer or cut of conductors

Achievements:

According to the power outage fault data in Phnom Penh bulk power system organized by the Project (NCC), it was reported that power outage caused by serious accidents and trouble such as fire on transformer or cut of conductors did not occurred during the period of cooperation. As aforementioned at the section of 3-2 (Achievement of Outputs), there were actual reports, for example, that an iron roof was removed to avoid cutting conductors as a result of patrolling; that broken insulators were found and repaired to prevent from ground fault and eventual power outage; and that serious problem was found in

[6] The number of trainees' answer was 6 (N=6).

spare circuit breaker as a result of the regular inspection. It was also reported that the project found inconsistency of relay setting in protected zone though reviewing the existing relay setting. If fault occurred before the review, it would cause another power outage in unnecessary section, and eventually a serious blackout could have occurred in the whole area of southern part of Cambodia. These examples show that the activities and achievements of Output 1 and 2 found problems which could lead to the serious accidents and troubles if any counter-measure were not taken, thus it contributed to the prevention of serious accidents and troubles (indicator 1).

As the result that the Project analyzed power outage fault data in terms of frequency and duration by causes of fault during period of cooperation, and estimated the effect of reduction in frequency and duration, it was estimated that both frequency and duration could have been reduced if accidents and troubles were prevented by patrol/inspection and review of relay setting. The result is summarized in Table 3-8 and 3-9.

Table 3-8: Summary of Power Outage in Phnom Penh bulk power system (Frequency)

Number of Actual Frequency				Number of Estimated Frequency		
Causes of Power Outage	2013	2014	2015*	2013	2014	2015*
Contact of substance (tree or something)	7	8	3	6	4	2
Maintenance	-	3	0	-	2	0
Others	8	6	3	6	5	1
Lightning	2	4	2	2	4	2
Total	17	21	8	14	15	5

Note: *January ~ May 2015
(Source: Document prepared by the Project)

Table 3-9: Summary of Power Outage in Phnom Penh bulk power system (Time)

Unit: minutes

Number of Actual Time				Number of Estimated Time		
Causes of Power Outage	2013	2014	2015*	2013	2014	2015*
Contact of substance (tree or something)	241	410	122	196	134	11
Maintenance	-	332	0	-	199	0
Others	222	344	131	108	326	9
Lightning	90	154	36	90	154	36
Total	553	1,240	289	394	813	56

Note: *January ~ May 2015
(Source: Document prepared by the Project)

According to the above estimation, for example, the frequency of power outage occurred due to contact of substance, such as tree, in 2013 could have reduced from 17 to 14 times (20%), if the substance were cautioned or removed by the patrol and power outage was prevented. In the same way, time of power outage was also estimated to be reduced.

With confirmation on the achievement of the indicators above, the Team assured that the Project purpose was satisfactorily achieved at the time of Study, and the degree of achievement would be higher by the end of the cooperation period.

3-3 Prospects for Achievements of the Overall Goal

Narrative Summary	Prospect of Achievement
Electrical power is stably supplied in Phnom Penh power grid.	High
Verifiable Indicators	**Prospect of Achievement**
1. SAIFI in Phnom Penh power grid	High
2. SAIDI in Phnom Penh power gird	High

Note: SAIFI: System Average Interruption Frequency Index; SAIDI: System Average Interruption Duration Index.

It is generally assumed that the overall goal is achievable by making efforts to prevent troubles and secure electric supply reliability which the Project established. As for the overall goal, the Team could not obtain liable statistical data of Phnom Penh power grid during the Study, because the SAIFI and SAIDI Report by the Load Dispatching Center, under the Business and Distribution Department of EDC only covers the power grid of Phnom Penh city, not the whole area which NCC is actually controlling after the Project started. Thus, the Study relies on a rough estimation based on past trends of SAIFI and SAIDI since the detailed planning of the Project, as summarized in in Table 3-10.

Table 3-10: SAIFI and SAIDI in 2012 -2014

	2012	2013	2014[7]
SAIFI	104.87	100.99	24.53
SAIDI	8,619.43	7,850.92	2,052.93

(Source: SAIFI and SAIDI Report)

In order to achieve the overall goal, the external factors such as that "Power plants in Phnom Penh power gird supply power as planned"; "Electricity is stably imported from neighboring countries"; and "Distribution facilities in Phnom Penh power grid are appropriately operated and maintained", need to be ensured. Any events hamper these factors have not occurred during the period of cooperation.

3-4 Implementation Processes of the Project

(1) Modification of the Project activities

At the 1st JCC meeting on December 13, 2013, the Project modified the indicators of the Outputs to specify the scope of the Project, set the target achievement level, and add some activities based on the results of review and baseline survey. The PDM Ver.1 was modified to PDM Ver.2 in order to change the indicator of Output 2 and add some activities in accordance with the progress of the Project. Most of the activities were carried out in a timely and efficient manner, as planned in the operational flow; except few activities mentioned below.

Although it did not hamper the overall implementation of the Project, the practical training of IES trainers for repair on transmission line using the provided transmission training facilities was started in a delay, since the procurement of the equipment and tools for training was delayed due to erroneous construction work of the supplier. In addition, the Project also took a flexible approach regarding the activities of power system operation using SCADA system, which has not been fully functioned until now due to the EDC's unsolved telecommunication problem. Once the full operation of the SCADA system was judged difficult, the Project altered the transferring technology applied in the daily operation at NCC

[7] From the middle of 2013, EDC had enough power supply because of new power plants (coal and hydropower).

into PSS/E software, which has been alternatively prepared by the JET, just in case of malfunction of the SCADA system. EDC also took an alternative measure such as purchase of additional license of the PSS/E software by their budget to avoid delay of technical transferring.

(2) Decision making and monitoring mechanism

The JCC, which is the decision-making authority of the Project, has been held twice to review the progress of Project activities, to approve the plans for the upcoming period, and make decisions on the issues related to the Project implementation. In addition, as for the approval of the formulated standards and rules in the Project, the responsible leaders such as Managing Director, Deputy Managing Director and Director made decisions in accordance with the contents and responsibilities.

Apart from JCC, it was found that the progress of activities was reported by JET (short-term) and C/P of the respective technical field to the respective Project Manager or Co-Project Manager every time at the end of the Project activities in Cambodia (almost once a few months). The progress of activities was also monitored on a daily basis by the long-term expert. During interviews, the both Project Mangers acknowledged with appreciation the efforts made by the JET to keep them informed about the Project activities and the progress in the field.

Although it did not create crucial problems in the overall implementation of the Project, the Team regrets that no general or technical project meeting was organized to share and discuss the progress of activities, in which all of the C/P in Transmission Dept. and IES can participate. During interviews, the Team shared the view with both Project Managers that collaboration between Transmission Department and IES in terms of training was necessary and should have been strengthened in the Project. The Team also found that monitoring has been relatively more conducted by JET.

(3) Relationship and communication among stakeholders of the Project

Despite relatively short and shuttle based dispatching of the short-term experts, the C/P and JET have been able to make good communication. Interviewed C/P in EDC and IES reported with appreciation to the Team that they had not problems in their working together with JET, because the planning and scheduling of activities was informed well in advance. It should be noted that the JET especially took into account the importance of making arrangement in advance to ensure the involvement of the C/P in the activities of the respective components. During the short-term experts were in Japan, C/P could communicate with them via email or even international call for reporting the progress of their assignment and asking the questions.

During interviews, both the C/P and JET acknowledged the different perception about the Project; for example, some of the interviewed C/P perceived the Project as one of training program at the beginning, and thus just their Project activities was perceived as participation to the prepared training program, not as implementation of formulation of their own rules and so forth by themselves. On the other hand, the interviewed JET shared the view with the Team that the recognition of EDC's own mission i.e. Stable Supply of Electric Power, and activities to follow the mission, which became basis of the Project activities, was generally weak at the beginning, and thus participation of some C/Ps and other departments was rather passive and dependent. It should be noted that the JET especially made the efforts to explain the objectives of the Project and technical transferring approach in which the C/P and C/P organization became a center of the Project activities, through the activities including Working Group activities. Most of C/Ps and relevant departments understood the concept and became more active compared to the beginning of the Project, and the relationship between C/P and JET altered to active and less dependent.

4. Results of the Evaluation based on the Five Criteria

Through the Study, the relevance, effectiveness, efficiency, impact and sustainability of the Project were assessed, the major findings of which are described in the section below.

4-1 Relevance

The relevance of the Project is evaluated as **High** based on the following confirmations:

(1) Relevance to the national development policies and sector policies

In the rectangular strategy for growth, employment, equity and efficiency phase III, i.e. the "Socio Economic Policy Agenda" of the Royal Government of Cambodia (RGC), "electricity power development" is regarded as strategic area under the Development of Physical Infrastructure. Capacity development and institutional reform in EDC to improve supply and the management's efficiency is emphasized in the National Strategic Development Plan (NSDP) 2014-2018. Thus the Project is considered to be very much consistent with these policy directions of RGC.

(2) Consistency with the ODA policies of Government of Japan (GoJ)

In the Country Assistance Policy for the Kingdom of Cambodia which GoJ formulated in April 2012, economic infrastructure development is set as one of its four priority areas under the medium goal of strengthening economic base, and it is stated that improvement of stable electric power supply system is dealt with preferentially. Therefore, it is assessed that the relevance of the Project to the Japanese aid policies is secured.

(3) Adequacy of selection of target group

In Cambodia's electric power sector, electric power utilities such as EDC and IPPS supply electricity under the regulation of Ministry of Mines and Energy (MME) and Electricity Authority of Cambodia (EAC). In order to ensure stable power supply, the capacity development of the electric power utilities is essential, among of which EDC supplies approximately 90% of electric power in the country. It was appropriate to select EDC as a target group of the Project.

(4) Comparative advantage of Japanese technology

Annual average number and time of power outage in Japan are top level of the world. This was a result that Japanese electric power companies pursued operation and maintenance of utilities for stable power supply under the concept of preventive maintenance for many years and developed their capacities. The Project aims to transfer accumulated knowhow of Japanese electric companies, thus it has Japanese technical superiority.

(5) Ripple effects to other target groups

In Cambodia, it is regulated that EDC, who is licensed of National Transmission Line (NTL) alone in all electric power companies, makes power system operation plan and so forth after coordinating power outage requests submitted by other electric power companies. The formulated standards and rules of power system operation in the Project will be applied continuously to other electric power companies such as IPPs though the operation of power system by EDC, thus outcome of the Project will be spread to other target groups.

4-2 Effectiveness

The effectiveness of the Project is assessed as **High** through the following observations:

(1) Achievement of the Project purpose

The Project purpose is to supply electrical power stably in Phnom Penh bulk power system. Through formulation of rules and standards of O&M of transmission line and substation facilities; strengthening the abilities of patrol/inspection and relay protection; and establishing the basis of power system operation, EDC's capacity to supply electric power in a stable manner was enhanced. Good examples of prevented serious troubles and accidents were reported from the Project, and reduction effects by patrol/inspection and relay protection of the facilities were also estimated based on the power outage and fault records accumulated by the Project (NCC). With confirmation as above, Project purpose would satisfactorily be achieved by the end of the cooperation period.

(2) Contribution of outputs to the achievement of the Project purpose

Towards the stable supply of electric power, technologies related to preventive maintenance i.e. Output 1, and technologies related to power system operation to ensure supply reliability i.e. Output 2, were transferred by the Project, and these Outputs contributed to achieve the Project purpose as mentioned above. However in order to establish the stable supply of electric power completely, early restoration from power outage is common sense in the electric power sector. Although it was originally not included within a scope of the Project, an action plan for early restoration from power outage was made, as a result of the Project raised awareness of stable supply of electric power through the Working Group activities and Working Group proposed a Road Map for Stable Power Supply.

(3) Analysis of factors

1) Promoting factor

The Project has conducted a baseline survey prior to determine the basic policy and plan of respective fields, then implement the activities according to the schedule, which was strictly followed by both the JET and C/Ps. In the Project, JET (short-term experts) was dispatched more than ten times. Timing and length of dispatch were carefully determined according to the progress of the Project and schedules and assignments of the Project were well informed in advance. The progress of the activities during absent period of JET was also followed up and supported by the long-term expert who stationed at EDC. EDC provided necessary input timely such as additional DGA test and license of PSS/E in order to promote efficient technical transfer. In addition to these efforts, in case which required urgent technical transferring during absence of JET, the Project held a technical meeting via TV conference system with full support of JICA Cambodia and Headquarter office. These efforts and support dedicated by all the stakeholders of the Project should be regarded as a promoting factor to the Project.

2) Hampering factor

Initially, the Project was planning to transfer the technique of power system operation with SCADA system to NCC, aiming to operate power system and control the facilities. However, it was found as a result of detailed study by Japanese expert on telecommunication that there was complicated telecommunication issue, limiting full operation of SCADA system. EDC is still making efforts to solve the problem with external support. Although this directive did not critically "hamper" the Project, it should be noted that the change of the technologies had required the Project to re-design the contents of the OJT training to a certain extent.

(2) External conditions

There has not been any notable influence caused by the changes of the external conditions, i.e. EDC appropriately allocates the budget for operation and maintenance for the facilities and staff training.

4-3 Efficiency

The efficiency of the Project is considered as **High**, based on the following consideration:

(1) Japanese experts

The Japanese experts in the relevant fields of expertise have properly played their expected roles in the course of the implementation of the Project, which have been appreciated by the C/P.

(2) Equipment

Although the equipment required for the Project activities and technical transfer have been provided late due to unexpected mistakes by the supplier, the Project implementation was managed without critical problems. The equipment are fully utilized in training, and kept in good conditions; however the Team recommends that all equipment is registered into inventory list so as to maintain properly.

(3) Training of the C/Ps in Third Countries

Those who have attended the overseas training under the arrangement of the Project generally assess the subjects of the training as relevant and adequate. The training participants on substation inspection unanimously appreciated the usefulness of the training and most reported that they have applied knowledge learnt in carrying out inspection and training activities. During the interview, however, some reported that part of skills learnt could not apply due to lack or difference of equipment. As for training of power system operation, C/Ps reported that training in Thailand provided eye-opening experience about international standards of power system operation, which actually the Project was introducing to EDC. After the training, it was reported that C/Ps reconsidered the importance of formulated standards and their activities became more active and accelerated.

4-4 Impact

It is assessed that the Project would bring about high and positive impacts, in view of the following aspects:

(1) Impact on the overall goal level

As examined in the previous section, both capacity of O&M of transmission line and substation facilities and basic capacity of power system operation have been improved, with the involvement of the relevant C/P from Transmission Dept. and IES. Average number and time of power outage has been decreased in Phnom Pehn city. It is expected that EDC would be able to continue their activities and even to enhance their activities to the other regional areas in the countries. Therefore, positive impacts of the Project are anticipated on the attainment of the overall goal, given that the necessary interventions for further scale up of achievements of the Project would continuously be extended through the future efforts by EDC.

(2) Negative impacts

There has not been any negative impact of notable degree observed or reported during the Study.

4-5 Sustainability

The Team could expect **High** sustainability in most of aspects, though organizational aspect needs

further reinforcement, as described in the following:

(1) Policy and institutional aspect

The Project is implemented in line with the current national development plan of RGC such as NSDP 2014-2018. In view of the policy, it is assumed that the policy support would continuously be secured for the coming years after completion of the Project.

(2) Organizational and Financial aspect

In 2007, EDC has established Transmission Department in charge of operation and maintenance of transmission facilities owned by EDC in order to manage rapidly growing transmission system in Cambodia. Transmission Department consists of Transmission System Unit (TSU), National Control Center (NCC) and Relay Protection Office (RPO). Currently EDC has 3,659 staffs including provinces, among of which 416 staffs including field staff at substations have been working under Transmission Department as of May 2015. Personnel turnover rate is less than 1%. It has been reported by Annual Report that EDC has been profitable and financial status has been healthy in recent years. It has generally been observed that both human and financial resources have been adequately allocated to Transmission Department and the expenses necessary for the activities has been borne by decision of top management of EDC. Therefore, the Team concludes that organizational and financial sustainability of EDC has been secured.

On the other hand, during the Study, it has been also observed that the existing working structure and division of roles, for example, different responsibilities of staff and cross-section work between NCC, RPO, and other divisions under TSU, have not been explicit and systematically organized. Having the new rules, standard and work procedure formulated by the Project, at personnel level, each C/P of Transmission Department enhanced their capacities of pursing respective duties and recognized their responsibilities and the roles in the system. However, it is essential for EDC to start consideration about division and allocation of roles and responsibilities of working sections and departments such as NCC and RPO, as well as further human resource development, in order to purse the effective and efficient operation and maintenance of transmission and substation faculties for stable supply of electric power in the future power system grid of Cambodia.

(3) Technical aspect

Since the Project has been emphasized implementation in addition to formulation of the standards and rules, EDC became able to implement their works applying transferred technologies for stable power supply in respective fields of the Project, i.e. transmission, substation, power system operation, and relay protection, independently. All the formulated standards and rules have been already approved by the Managing Director of EDC as internal official regulation.

As for dissemination of the technologies, the Project certified 10 trainers of transmission, substation, and relay protection in IES and established dissemination system by implementing the designed courses. The Team also confirmed that Transmission Department has been conducting technical training for new and inexperienced staff of substations about equipment, SCADA and telecommunication system, and relay protection. Director of the Transmission Department monitors training needs and current situation of each substation every two months, and decided the contents of technical training.

It is thus considered that the level of technical sustainability of the Project is high.

5. Conclusion

The Team has confirmed that the expected outputs have largely been achieved without any critical problem or notable delay in the implementation of the Project. Taking account of power development plan and expansion of power system network according to new high voltage transmission lines and substations construction plans, the achievements of the Project, i.e. "establishment of maintenance for preventing troubles and securing of power network and supply reliability", are significant and the relevance of implementing the Project is very high. The Team has confirmed that Cambodian C/Ps evaluated the transferred technologies as appropriate and effective, and Sustainability of the outcomes of the Project is assumed high. Therefore it is concluded that the Project would successfully achieve its expected purpose within the cooperation period.

6. Recommendation

6-1 Recommendation for Remaining Period of the Project

(1) Dissemination of the New Standards, Rules and Working Procedure

As aforementioned in the report, it is more effective to disseminate the outcome of the Project within responsible sections of Transmission Department, and other departments from the perspective of Sustainability and Impact of the Project.

It is recommended for C/Ps to continue lecturing and instructing the rules and working procedures to all the relevant staff, including filed and regional staff of the Project, in a systematic manner and in cooperation with IES. In addition, it is also recommended to notify the standards and rules to IPPs, continuously.

(2) Periodical Review of the Standards, Rules and Working Procedure

As it is regulated in the rules and manuals, it is essential to review the standards, rules or working procedures periodically to fit into the actual situation, and continue the improvement in the future, using practical knowhow and experiences of formulation and implementation within the Project.

It is recommended to conduct the periodical review of all the standards, rules and working procedure regulated by the rule.

6-2 Recommendation for Future

(1) Towards Stable Power Supply in Low Price

It is generally appreciated by the target groups that the Project has been successful in improving technical capacities of the staff in terms of "establishment of preventive maintenance" and "securing of power network and supply reliability".

However, it is recommended for EDC to set the "Stable Power Supply in Low Price" to the corporate goal, and take necessary actions at cooperate management level. For example, in terms of organizational perspective, it is recommended to strengthen the core organization for planning, construction, operation and maintenance of power network system, considering N-1 standard, early restoration of power outage, and least cost development and operation. In terms of human resource development perspective; it is recommended to formulate establishment of corporate human resource development section and its policy to enable collaboration between technical departments and training center more closely.

(2) Improvement of Power Statistics More Reliably

As key performance indicator to monitor the actual situation of Stable Power Supply in Low Price, it is recommended to improve power statistics more reliably including SAIDI and SAIFI.

(3) Accelerating Full Operation of NCC with SCADA system

Towards automation of power system, EDC has already been making great efforts to solve the telecommunication issue related to SCADA system.

In terms of Effectiveness of the Project, it is recommended to accelerate the process and allocate appropriate personnel to manage the telecommunication system.

Annex 1: Project Design Matrix (PDM)

Project Design Matrix (PDM) ver.2

Project Name: Project for Improvement of Transmission System Operation and Maintenance
Project Period: 2 years and nine months (33 months)
Implementation Agency: Electricite du Cambodge: EDC
Project Site: Phnom Penh power grid area
Target Groups: Staff of Transmission Department, Generation Department, Business and Distribution Department, and Instructors of the EDC Institute of Electrical Science
Direct Beneficiaries: Transmission Department, Generation Department and Business and Distribution Department of EDC and the EDC Institute of Electrical Science
Indirect Beneficiaries: Electrical power users in Phnom Penh city
Date: June 2015

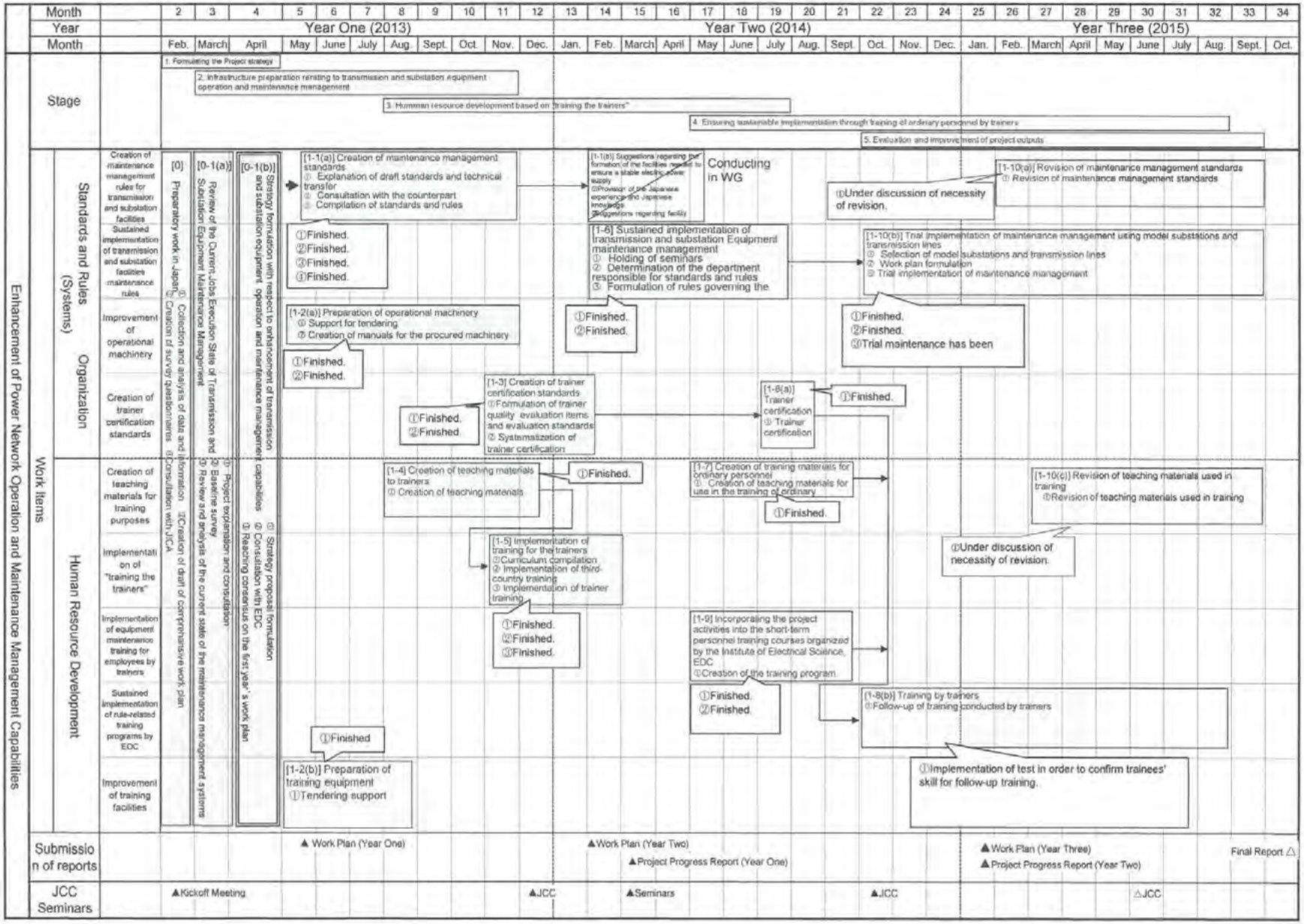
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal: Electrical power is stably supplied in Phnom Penh power grid.	1. SAIFI in Phnom Penh power grid 2. SAIDI in Phnom Penh power gird	Data from EDC	
Project Purpose: Electrical power is stably supplied in Phnom Penh bulk power system.	1. Serious accidents or troubles[1] at TL and SS do not occur. 2. The duration and the frequency of power outage are reduced. (Note: Since the causes of power outage vary and include issues such as balance of power demand and supply, JICA experts will review the detailed causes and judge whether this goal is fulfilled.)	• Reports on accident/troubles • Data from EDC	• Power plants in Phnom Penh power gird supply power as planned. • Electricity is stably imported from neighboring countries. • Distribution facilities in Phnom Penh power grid are appropriately operated and maintained.
Output: 1. Capacity of operation and maintenance of transmission line (TL) and substation facilities (SS) in Phnom Penh bulk power system is enhanced.	1-1. Patrol and inspection of TL and SS are safely practiced complied with formulated rules. 1-2. Accidents/troubles at TL and SS are prevented from occurring. 1-3. 6 trainers are certified as trainers	1-1. List of rules formulated/report on patrol and inspection 1-2. Report on accidents/troubles/ Assessment by JICA experts 1-3. Progress report/report on trainings	• EDC appropriately allocates the budget for operation and maintenance for the facilities and staff training.

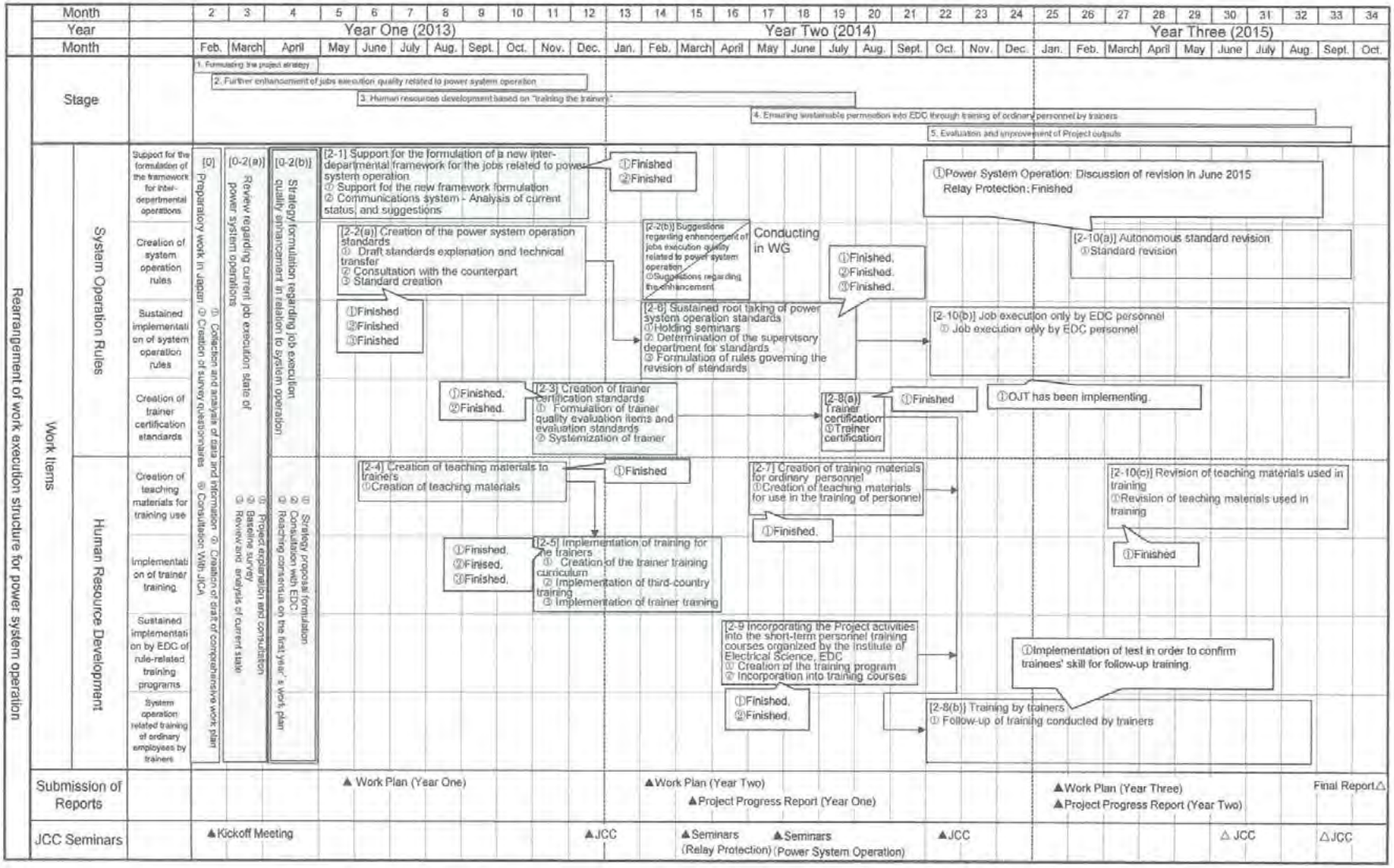
[1] Serious accident and troubles means fire on transformer or cut of conductors

2. Basic capacity of enhanced power system operation such as planning, scheduling and actual execution is strengthened.	2-1. EDC staff is able to operate power system and control facilities complied with the formulated rules such as Power System Operation, Demand & Supply Control, and Coordination of Planned Outage, and make the plan of power system operation which includes indication of problems, regarding actual power system configuration. (Firm information sharing and its conveyance through reciprocal coordination among relevant departments) 2-2. Work procedure and training of relay setting is properly carried out. 2-3. 3 trainers for power system operation at relevant departments of EDC.	2-1. Assessment of JICA experts/Plan of power system operation 2-2. Assessment of JICA experts 2-3. Progress report/report on trainings/Assessment by EDC top management and JICA experts	
Activities 1-1. Review and analyze the current practice of operation and maintenance of transmission line (TL) and substation facilities (SS). 1-2. Formulate rules[2] for operation and maintenance for TL and SS 1-3. Procure the equipment and tools for TL and SS training facilities 1-4. Develop criteria to certify trainers 1-5. Conduct training of trainers (TOT) on how to apply the formulated rules. 1-6. Organize internal seminar to disseminate the existing and formulated rules to relevant staff of EDC (Trainers will be lecturers) 1-7. Develop the training materials of formulated rules in Activity 1-2. 1-8. Incorporate the revised program into the short course trainings at the EDC Institute of Electrical Science (EDC Training Center) 1-9. Conduct OJT on patrol, inspection, operational safety and usage of tools for EDC staff (conducted by trainers) 1-10. Conduct "Working Group" activity to discuss how to make a stable power supply system on a company-level in EDC 1-11. Make action plan for early restoration from power outage	Inputs Japanese side • JICA Experts ➢ Chief Advisor ➢ Transmission Line 1 (leader) ➢ Transmission Line 2 ➢ Transmission Line 3 ➢ Substation facilities 1 (leader) ➢ Substation facilities 2 ➢ Substation facilities 3 ➢ System management (leader) ➢ System management (SCADA) ➢ System management (Relays) ➢ System management (Communication) ➢ Organizational/Training Management ➢ Training Management/ Coordinator (long-term expert) • Overseas trainings • Provision of Equipment Cambodian side • Office space for JICA experts • Allocation and Assignment of counterpart personnel		• Trained staff of EDC is not transferred to other positions • Transmission line and substation facilities do not get damaged by sever natural disaster. Pre-conditions -

[2] The rules and training courses to be prepared: [TL] (1) patrol, (2) inspection, (3) repair, and (4) work safety. [SS] Inspection (regular, extraordinary, overhaul).

Annex 2: Operational Flowchart




Rearrangement of work execution structure for power system operation
Month
Year
Month
Year One (2013)
Year Two (2014)
Year Three (2015)
Feb. March April May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. March April May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. March April May June July Aug. Sept. Oct.
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
Stage
1. Formulating the project strategy
2. Further enhancement of jobs execution quality related to power system operation
3. Human resources development based on "training the trainers"
4. Ensuring sustainable permeation into EDC through training of ordinary personnel by trainers
5. Evaluation and improvement of Project outputs
Work Items
System Operation Rules
Human Resource Development
Support for the formulation of the framework for inter-departmental operations
Creation of system operation rules
Sustained implementation of system operation rules
Creation of trainer certification standards
Creation of teaching materials for training use
Implementation of trainer training
Sustained implementation by EDC of rule-related training programs
System operation related training of ordinary employees by trainers
[0] Preparatory work in Japan
① Collection and analysis of data and information ② Creation of survey questionnaires ③ Consultation With JICA ④ Creation of draft of comprehensive work plan
[0-2(a)] Review regarding current job execution state of power system operations
① Project explanation and consultation ② Baseline survey ③ Review and analysis of current state
[0-2(b)] Strategy formulation regarding job execution quality enhancement in relation to system operation
① Strategy proposal formulation ② Consultation with EDC ③ Reaching consensus on the first year's work plan
[2-1] Support for the formulation of a new inter-departmental framework for the jobs related to power system operation
① Support for the new framework formulation
② Communications system - Analysis of current status, and suggestions
①Finished
②Finished
①Power System Operation: Discussion of revision in June 2015
Relay Protection: Finished
[2-2(a)] Creation of the power system operation standards
① Draft standards explanation and technical transfer
② Consultation with the counterpart
③ Standard creation
①Finished
②Finished
③Finished
[2-2(b)] Suggestions regarding enhancement of jobs execution quality related to power system operation
①Suggestions regarding the enhancement
Conducting in WG
①Finished.
②Finished.
③Finished.
[2-10(a)] Autonomous standard revision
①Standard revision
[2-8] Sustained root taking of power system operation standards
①Holding seminars
② Determination of the supervisory department for standards
③ Formulation of rules governing the revision of standards
[2-10(b)] Job execution only by EDC personnel
① Job execution only by EDC personnel
①Finished.
②Finished.
[2-3] Creation of trainer certification standards
① Formulation of trainer quality evaluation items and evaluation standards
② Systemization of trainer
[2-8(a)] Trainer certification
①Trainer certification
①Finished
①OJT has been implementing.
[2-4] Creation of teaching materials for trainees
①Creation of teaching materials
①Finished
[2-7] Creation of training materials for ordinary personnel
①Creation of teaching materials for use in the training of personnel
①Finished.
[2-10(c)] Revision of teaching materials used in training
①Revision of teaching materials used in training
①Finished
①Finished.
②Finished.
③Finished.
[2-5] Implementation of training for the trainers
① Creation of the trainer training curriculum
② Implementation of third-country training
③ Implementation of trainer training
[2-9 Incorporating the Project activities into the short-term personnel training courses organized by the Institute of Electrical Science, EDC
① Creation of the training program
② Incorporation into training courses
①Finished.
②Finished.
①Implementation of test in order to confirm trainees' skill for follow-up training.
[2-8(b)] Training by trainers
① Follow-up of training conducted by trainers
Submission of Reports
▲ Work Plan (Year One)
▲Work Plan (Year Two)
▲Project Progress Report (Year One)
▲Work Plan (Year Three)
▲Project Progress Report (Year Two)
Final Report△
JCC Seminars
▲Kickoff Meeting
▲JCC
▲Seminars (Relay Protection)
▲Seminars (Power System Operation)
▲JCC
△ JCC
△JCC

Annex 3: Evaluation Grid

Project for Improvement of Transmission System Operation and Maintenance (Terminal Evaluation)

Item	Evaluation Questions	Sub-questions (indicators)	Basis for Judgment	Required Data	Source of Information	Collection Method
Verification of Performance	**Achievement of Overall Goal (Prospect)** Electrical power is stably supplied in Phnom Penh power grid.	1. SAIFI in Phnom Penh power grid	• Changes and prospects of SAIFI • Degree of contribution of the Project to the above changes	• SAFI Report (in recent years) or data	Annual report/ documents and relevant dept. of EDC, Japanese experts, CP	Report reviewing, interview
		2. SAIDI in Phnom Penh power gird	• Changes and prospects of SAIDI • Degree of contribution of the Project to the above changes	• SAIDI Report (in recent years) or data		
	Achievement of Project Purposes Electrical power is stably supplied in Phnom Penh bulk power system.	1. Serious accidents or troubles[1] at TL and SS do not occur.	• Occurrences of serious accidents or troubles at TL and SS • Degree of contribution of the Project to the above changes	• Indicators set after project started • Results of evaluation and observations by Japanese experts	Annual report/ documents and relevant dept. of EDC, project progress report, Japanese experts, CP	Report reviewing, interview and questionnaire
		2. The duration and the frequency of power outage are reduced[2].	• Degree of reduction of power outage • Degree of contribution of the Project to the above reduction			
	Achievement of the Outputs 1. Capacity of operation and maintenance of transmission line (TL) and substation facilities (SS) in Phnom Penh bulk power system is enhanced.	1.1 Patrol and inspection of TL and SS are safely practiced complied with formulated rules.	• Progress of formulation of the rules (comparison b/w plan and achievement) • Situation of applying the formulated rules for TL and SS activities	1.1 List of rules formulated/report on patrol and inspection • Process of formulating the rules • Records of TL and SS activities • Perception on the improved TL and SS activities based formulated rules by CP	Report/document by EDC, Project documents/ progress report, Japanese experts, CP	ditto
		1.2 Accidents/troubles at TL and SS are prevented from occurring.	• Whether appropriate measures are taken or not to prevent accidents /troubles at TL and SS • Degree of contribution of the Project to the prevention	1.2 Report on accidents/troubles/ Assessment by JICA experts • Perception on effects of the Project for prevention of accidents/ troubles by CP • Evaluation of the detailed cause and judge by Japanese experts		
		1.3 6 trainers are certified as trainers	• Contents/ process of technical certification of trainers • Comparison b/w plan and achievement	1.3 Project documents such as progress report, annual report, periodical reports • Reports on criteria/ results of technical certification • Records of trainers' experiences • Comments by Japanese experts		

[1] Serious accident and troubles means fire on transformer of cut of conductors

[2] Since the causes of power outage vary and include issues such as balance of power demand and supply, JICA experts will review the detailed causes and judge whether this goal is fulfilled.

	2. Basic capacity of enhanced power system operation such as planning, scheduling and actual execution is strengthened.	2.1 EDC staff is able to operate power system and control facilities complied with the formulated rules such as Power System Operation, Demand & Supply Control, and Coordination of Planned Outage. (Firm information sharing and its conveyance through reciprocal coordination among relevant departments)	· Progress of formulation of the rules (comparison b/w plan and actual implementation) · Situation of applying the formulated rules for power system operation · Observation by Japanese experts (comparison b/w initiation of the project and now)	2.1 List of rules formulated/report on patrol and inspection · Process of formulating the rules · Records of power system operation · Perception on the improvement of power system operation based formulated rules by CP	Report/document by EDC, Project documents/ progress report, Japanese experts, CP	Report reviewing, interview and questionnaire
		2.2 Work procedure of relay setting is properly carried out.	· Progress of formulation of the rules (comparison b/w plan and actual implementation) · Situation of applying the formulated rules for relay protection · Observation by Japanese experts (comparison b/w initiation of the project and now)	· Records of relay setting work		
		2.3 3 trainers for power system operation at relevant departments of EDC.	· Status of trainer development · Evaluation by EDC and Japanese experts · Training experiences	· Records of training of trainers · Comments by EDC and Japanese experts · Records trainers' experiences		
Verification of Implementation Process	**Implementation status of activities** Progress of activities	Were the activities conducted as planned?	· Comparison between plan and actual implementation	· Activity reports, records · If changed in schedule/ activities, countermeasures regarding the changes.	Project progress report, Japanese experts, CP	ditto
	Project management structure	Is monitoring mechanism appropriate?	· Presence/absence of problem in monitoring · Presence/absence of problem in decision making	· Holistic monitoring system and its monitoring diagram, monitoring records · Contents changed if any. · The way of feedback of activities	ditto	ditto
		Is the monitoring system appropriate?				
		Is decision making process appropriate? (Does the appointed decision maker make decisions?)				
	Relationship between CP and Japanese experts	Appropriateness of selected C/Ps	· Appointments of Experts and CP with appropriate technical capacity · Presence/absence of problem in communication · Degree of enthusiasm activeness, and participation of CP · Degree of commitment	· Frequency and methods of communication (reporting, meetings and etc.) and methods · Appropriateness of capacity/ experience of Experts and CP · Countermeasures against problems or change in plan · Level of participation by C/P to the project activities	ditto	ditto
		Status of communications				
		Ways to handle challenges and problems				
		Change in C/Ps' attitude (Independence and activeness)				
	Ownership of C/P organizations	Change in involvement and commitment of EDC Executives	· Degree of perception, commitment, and gaps between	· Content of contribution/ supports by EDC to the project	ditto	ditto

		Change in attitude and awareness of staff of each unit such as Transmission, Substation and NCC (Are they willing to work for the project?) Appropriateness of allocation and assignment of C/Ps Budget allocation, Support in kind	expectation and realities of EDC top management and other regular staff of Transmission dept. ・ Presence/absence of problem in CP assignment ・ Status of budget allocation	activities ・ Level of participation to the meetings, trainings, and seminars by each target group ・ Assignment records of C/P ・ Budget allocation to the project activities		

5 Evaluation Criteria

Item	Evaluation Questions	Sub-questions	Basis for Judgement	Required Data	Source of Information	Collection Method
Relevance	Is the Project (Overall Goals and Project Purposes) consistent with the national development plan and national energy policy?	Consistency of the Overall Goal with the national development plan and national energy policy Consistency of the Project Purpose with the national development plan and national energy policy Priority of Transmission System O&M and training in energy sector policy Consistency with support from other development partners	・ Consistency with the policies	・ National Development Strategy ・ National Energy Policy and Strategy ・ Current situation of interventions by other Development Partners	Detailed Planning Survey Report, National Development Plan, Policy documents related to energy sector,	Report reviewing and interviews
	Was the selection of the target group appropriate?	Is the development highly needed in Energy sector? Does EDC play an important in Energy sector? Are the project's components highly needed by EDC? Is the size of the target group appropriate?	・ Consistency with the needs	・ Power sector training situation and its issues ・ Role and capacity of EDC (current situation and prospects) ・ Beneficiaries	Detailed Planning Survey Report, Project documents, Japanese expert, CP	Report reviewing, interview and questionnaire
	Is the Project consistent with Japan's foreign aid policy?	Is the Project related with any prioritized areas of ODA strategy?	・ Consistency with assistance policy	・ Priority areas in Japan's ODA policy ・ Priority areas in Japan's energy sector assistance policy	Detailed Planning Survey Report, Japan's country assistance policy	Report reviewing
Effectiveness	Is the achievement level of the Project Purpose adequate at this stage?	Prospect of the achievement of the Project Purpose	・ Refer to "the verification of achievement" for details.	・ Please refer to "the verification of achievement" for details.	Project documents, Japanese experts, CP	Report reviewing, interviews and questionnaires

	Were the outputs sufficient to achieve the Project Purposes?	Numbers, contents and qualities of the outputs	・ Appropriateness of numbers, contents and qualities of the outputs ・ Correlation between the Project Purpose and Outputs ・ Comparison of effects before/after the Project	・ Status of improvement before/after the Project	ditto	ditto
	What are the hampering factors for the achievement of the Project Purposes?	Any changes in external factors	・ Appropriateness of external factors ・ Presence/absence of hampering factors	・ Current status of important assumption (external factors) of outputs ・ Details of hampering factors	ditto	ditto
	What are the promoting factors for the achievement of the Project Purposes?	Any changes in external factors	・ Possibility to fulfill the external factors ・ Presence/absence of promoting factors	・ Current status of important assumption (external factors) of outputs ・ Details of promoting factors	Project documents, Japanese experts, CP	Report reviewing, interviews and questionnaires
Efficiency	Is the achievement level of the outputs adequate at this stage?	Adequacy of the achievement level of the outputs	・ Refer to "the verification of achievement" for details.	・ Refer to "the verification of achievement" for details.	ditto	ditto
	Are the activities adequate and enough to produce outputs?	Numbers, contents and qualities of the activities	・ Appropriateness of numbers, contents and qualities of the activities ・ Correlation between the Outputs and activities	・ Adequacy of activities in number, contents and quality (additional activities are included that are not indicated in the PDM?) ・ Correlation between outputs and activities	ditto	ditto
	Is the output production adequate compared to the inputs?	Adequacy of human resources, trainings and equipment invested	・ Presence/absence of problems in order to implement activities	・ Human recourses (Japanese experts) ・ Training courses in Japan ・ Equipment	ditto	ditto
		Level of utilization of inputs (human resources, trainings, equipment)	・ Presence/absence of problems in terms of utilization			
		Adequacy of timing of inputs	・ Presence/absence of problems in terms of timing of inputs			
	What are the hampering and promoting factors?	Any changes in external factors	・ Presence/absence of hampering and promoting factors	・ Current status of important assumption (external factors) ・ Details of hampering and promoting factors (if any)	ditto	ditto
Impact	Are there prospects that the Overall Goal "Electrical power is stably supplied in Phnom Penh power grid." will be achieved?	・ Prospect to achieve the Overall Goal as an effect of the Project ・ Are there any hampering factor or external factors?	・ Refer to "the verification of achievement" for details. ・ Presence/absence of hampering factors ・ Level of possibility that eternal factors are fulfilled	・ Refer to "the verification of achievement" for details.	ditto	ditto

	Are there any ripple effects to people or organizations other than the target groups?	Are there any ripple effects/ positive influence by the Project?	• Presence/absence of ripple effects/ influence	• Cases of ripple effects/ influence	ditto	ditto
	Any other impacts, either positive or negative?	Cases of any other impacts (Policies, society, environment, technological change, economic influence, etc.)	• Presence/absence of positive/negative impacts • If any negative impacts, presence/ absence of mitigation measures	• Cases of positive/negative impacts	ditto	ditto
Sustainability	By considering policies, are there prospects that the sustainability is secured?	Will EDC have policy support to be responsible for transmission of electric power including power system operation in the country?	• Expected role of EDC • Prospect for continuity of policy support	• Expected role of EDC • Energy Sector Policy	National Development Plan, Policy Documents related to Energy Sector, Japanese experts, and CP	Report reviewing, interviews and questionnaires
	By considering organizational and institutional aspects, are there prospects that the sustainability is secured?	Does EDC develop enough capacity to continue supplying transmission of electric power stably?	• Degree of organizational capacity (enough number, expertise and etc. of EDC staff)	• Organizational characteristics (number and expertise of staff, etc.) • Government support to electric power transmission	Project documents, Japanese experts and CP	ditto
		Are institutional supports from the Government expected?	• Presence/absence of institutional support by Govt.			
	By considering financial aspects, are there prospects that the sustainability is secured?	Are financial situations of EDC sound enough?	• Situation of revenue	• Financial report/data of EDC	EDC financial documents, project documents, CP	ditto
		Is EDC likely to secure budget (incl. personnel expenses) to continue promoting short-term and long-term trainings to transmission system O&M?	• Scale and continuity of budget allocation			
	By considering technical aspects, are there prospects that the sustainability is secured?	Are appropriate technologies developed and transferred, in consideration of the technical level of EDC?	• Process of technical transferring to EDC staff	• Technologies gained during the project by OJT and trainings and seminars • Continuous activities experienced though project implementation • List and maintenance report of the provided equipment/ machinery, and budget for maintenance	Project documents, Japanese experts and CP	ditto
		Have CPs acquire knowledge and the transferred technology enough?	• Technical capacity of EDC staff			
		Will the dissemination mechanism be continued after completion of project?	• Capacity of EDC trainers, training activity plan			
		Will the transferred technology and equipment be used widely?	• Usage and maintenance status of the provided equipment/ machinery			

Annex 4: List of Japanese Experts

1. Expert (short term)

Assignment	Name	Organization	Period	Day	MM
Chief Advisor	Kenji Fujii	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.26	37	5.8
			2013.4.22 - 2013.5.2	11	
			2013.6.9 - 2013.6.22	14	
			2013.9.8 - 2013.9.28	21	
			2013.12.2 - 2013.12.14	13	
			2014.2.24 - 2014.3.8	13	
			2014.5.18 - 2014.6.3	17	
			2014.7.14 - 2014.7.26	13	
			2014.10.6 - 2014.10.28	23	
			2015.1.25 - 2015.1.29	5	
			2015.4.5 - 2015.4.11	7	
Deputy Chief Advisor Substation 1 (Leader) Organizational / Training Management	Masakazu Hirose	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.26	37	6.8
			2013.4.22 - 2013.5.2	11	
			2013.6.18 - 2013.6.29	12	
			2013.8.25 - 2013.9.14	21	
			2013.11.25 - 2013.12.14	20	
			2014.2.24 - 2014.3.8	13	
			2014.5.18 - 2014.6.7	21	
			2014.7.6 - 2014.8.2	28	
			2014.10.5 - 2014.10.28	24	
			2015.2.23 - 2015.3.12	18	
Substation 2 (Rule formulation 1/ Field work techniques 1)	Atsushi Fujii	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.16	27	2.7
			2013.6.18 - 2013.6.29	12	
			2013.9.2 - 2013.9.14	13	
			2013.12.1 - 2013.12.7	7	
			2014.2.24 - 2014.3.6	11	
			2015.1.18 - 2015.1.29	12	
Substation 3 (Rule formulation 2/ Field work techniques 2)	Hideki Hayashi	Chugoku Electric Power Co.,Inc.	2014.5.25 - 2014.6.7	14	1.8
			2014.10.5 - 2014.10.25	21	
			2015.2.23 - 2015.3.12	18	
Transmission Line 1 (Leader)	Masahiro Ogawa	Tokyo Electric Power Services Co.,Ltd.	2013.2.25 - 2013.3.5	9	1.4
			2013.4.21 - 2013.4.29	9	
			2013.6.11 - 2013.6.15	4	
			2013.8.22 - 2013.8.29	8	
			2013.12.11 - 2013.12.17	7	
			2014.5.27 - 2014.5.31	5	
	Hiroaki Yoshizawa		2014.7.6 - 2014.7.26	21	1.8
			2014.10.7 - 2014.10.25	19	
			2015.3.1 - 2015.3.14	14	
Transmission Line 2 (Rule formulation 1 / Field work techniques 1)	Naoto Kadoya	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.26	37	5.5
			2013.6.10 - 2013.6.15	6	
			2013.8.18 - 2013.8.30	13	
			2013.11.25 - 2013.12.14	20	
			2014.2.24 - 2014.3.8	13	
			2014.7.20 - 2014.8.9	21	
			2014.9.28 - 2014.10.25	28	
			2015.1.18 - 2015.1.31	14	
			2015.3.1 - 2015.3.14	14	

Transmission Line 3 (Rule formulation 2)	Satoshi Kobayashi	Tokyo Electric Power Company	2013.2.26 - 2013.3.16	19	2.5
			2013.6.10 - 2013.6.15	6	
			2013.8.18 - 2013.8.23	6	
			2013.12.9 - 2013.12.14	6	
			2014.2.26 - 2014.3.8	11	
			2014.5.26 - 2014.5.31	6	
			2014.10.6 - 2014.10.17	12	
			2015.1.13 - 2015.1.21	9	
Transmission Line 4 (Field work techniques 2)	Jiro Okamoto	Taguma Industries Ltd.	2014.8.3 - 2014.8.9	7	1.4
			2014.9.28 - 2014.10.25	28	
			2015.3.1 - 2015.3.7	7	
System operation 1 (Leader)	Masatoshi Akimoto	Tokyo Electric Power Services Co.,Ltd.	2013.2.18 - 2013.3.16	27	4.9
			2013.4.22 - 2013.4.26	5	
			2013.6.9 - 2013.6.20	12	
			2013.9.2 - 2013.9.14	13	
			2013.11.25 - 2013.12.7	13	
			2014.2.17 - 2014.3.8	20	
			2014.5.18 - 2014.6.7	21	
			2014.8.10 - 2014.8.30	21	
			2015.2.8 - 2015.2.21	14	
System operation 2 (Rule formulation 1 / System and demand-supply control)	Osamu Takahashi	Tokyo Electric Power Company	2013.2.26 - 2013.3.6	9	4.0
			2013.6.10 - 2013.6.15	6	
			2013.9.2 - 2013.9.14	13	
			2013.11.25 - 2013.12.6	12	
			2014.2.17 - 2014.3.5	17	
			2014.5.26 - 2014.6.7	13	
			2014.9.1 - 2014.9.19	19	
			2014.12.8 - 2014.12.19	12	
			2015.3.2 - 2015.3.21	20	
System operation 3 (Rule formulation 2 / Stoppage adjustment and data management)	Akira Hirano	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.26	37	5.5
			2013.6.9 - 2013.6.20	12	
			2013.9.2 - 2013.9.14	13	
			2013.11.25 - 2013.12.14	20	
			2014.2.17 - 2014.3.8	20	
			2014.5.18 - 2014.6.7	21	
			2014.9.28 - 2014.10.25	28	
			2015.3.29 - 2015.4.11	14	
System operation 4 (Rule formulation 3)	Yujiro Morihira	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.16	27	0.9
System operation 5 (Rule formulation 4 / Relay operation)	Shiro Kuba	Chugoku Electric Power Co.,Inc.	2013.2.18 - 2013.3.26	37	5.6
			2013.6.9 - 2013.6.29	21	
			2013.9.2 - 2013.9.14	13	
			2013.11.25 - 2013.12.7	13	
			2014.2.17 - 2014.3.8	20	
			2014.5.25 - 2014.6.14	21	
			2014.7.13 - 2014.7.26	14	
			2014.10.12 - 2014.10.25	14	
			2015.3.29 - 2015.4.11	14	
System operation 6 (Communication)	Hiroshi Kakizoe	Tokyo Electric Power Services Co.,Ltd.	2013.2.18 - 2013.3.16	27	1.3
			2013.6.9 - 2013.6.20	12	
Total			**51.9**		

2. Expert (long term)

Project Coordinator /Organizational and Training Management	Takeshi Naito	-	2013.5.7 - 20154.30	-	24
Total			**24.0**		

(By the end of April 2015)

Annex 5: Counterparts training in the Third Countries

Discussions with power utilities in Vietnam and Thailand for "Working Group" (17 ~ 27 September, 2013)

No.	Name	Position	Contents	Place to visit
1	Mr. Oum Piseth,	Director, Institute of Electrical Science (IES)	Discussion about "Power System Operation" and "Human Resource Development" with power utilities in neighbor countries	Related departments of "Power System Operation" and "Humanresource Development" of EVN (Vietnam) and EGAT (Thailand)
2	Mr. Hong Neang,	Deputy Chief of Technical Training Office, IES		
3	Mr. Iv Visal	Deputy Director, Distribution and Business Department (DBD)		
4	Mr. Or Vaddhana	Chief of Load Dispatching Center, DBD		
5	Mr. Ing Pror Seth	Deputy Director, Transmission Department		
6	Mr. Mak Thorn	Chief of Transmission Unit, Transmission Department		
7	Mr. Ty Soksan	Deputy Chief of Planning Division, Corporate Planning and Project Department		
8	Mr. Prum Channareth	Chief of Substation Section, Technical Office, Corporate Planning and Project Department		
9	Mr. Eang Chanthy	Chief of Generation Planning Division, Generation Department		
10	Mr. Lor Bunna	Chief of Technical Data Division, Generation Department		

Substation Course (18 ~ 28 May, 2014)

No.	Name	Position	Contents	Place to visit
1	Mr. Kea Sokun	Staff of Transmission System Unit, Transmission Department	Introduction of Inspection and Overhaul of Circuit Breaker and Introduction of Dissolved Gas Analysis (DGA)	EGAT (Circuit Breaker) and Daihen Electric Co., Ltd(DGA)
2	Mr. Kem Sophhanha	Staff of Transmission System Unit, Transmission Department		
3	Mr. Muon Vathana	Staff of Transmission System Unit, Transmission Department		
4	Mr. Meas Nimol	Staff of Transmission System Unit, Transmission Department		
5	Mr. Soeun Sophanith	Staff of Transmission System Unit, Transmission Department		
6	Mr. Phat Tech	Staff of Relay Protection Office, Transmission Department		
7	Mr. NeangVannent	Staff of Relay Protection Office, Transmission Department		
8	Mr. Chea Mareth	Trainer of Transmission Division, IES		
9	Mr. Chhan Bunthet	Trainer of Transmission Division, IES		
10	Mr. Chin Phimsokha	Trainer of Transmission Division, IES		

System Operation Course (18 ~ 24 May, 2014)

No.	Name	Position	Contents	Place to visit
1	Mr. Touch Samphors	Chief of Data Collection Division, NCC, Transmission Department	Introduction of "Generation Planning", "Generation Planning", "EMS Overview / Database Structure / Basic Operation" and "Switching Procedure / Blackout Restoration" in Power Sustem Operation	EGAT
2	Mr. Heng Ky	Shift No.1, NCC, Transmission Department		
3	Mr. Ang Solyvann	Staff of Data Collection Division, NCC, Transmission Department		
4	Mr. .Chhay Saoly	Staff of Data Collection Division, NCC, Transmission Department		
5	Mr. Hong Tino	Staff of Data Collection Division, NCC, Transmission Department		
6	Mr. Khim Piseth	Staff of Data Collection Division, NCC, Transmission Department		
7	Mr. Mean Ravy	Staff of Data Collection Division, NCC, Transmission Department		
8	Mr. Rin Vanny	Staff, Operation Planning, NCC, Transmission Department		
9	Mr. Som Chamnan	Staff of Data Collection Division, NCC, Transmission Department		
10	Ms. Cheak Chansophea	Staff of Data Collection Division, NCC, Transmission Department		

Substation Inspection Course (8 ~ 20 February, 2015)

No.	Name	Position	Contents	Place to visit
1	Mr. Meas Nimol	Staff of Transmission System Unit, Transmission Department	Practical training of Inspection for transformer, VT, CT, Storage battery, Power Cable", VCB and GCB	EGAT
2	Mr. Kem Sopanha	Staff of Transmission System Unit, Transmission Department		
3	Mr. Phat Tech	Staff of Relay Protection Office, Transmission Department		
4	Mr. Neang Vannet	Staff of Relay Protection Office, Transmission Department		
5	Mr. Hay Sokneth	Staff of Relay Protection Office, Transmission Department		
6	Mr. Ho Vibol	Staff of Relay Protection Office, Transmission Department		

Note: EVN = Electricity of Vietnam; EGAT=Electricity Generating Authority of Thailand

Annex 6 List of Provided Equipment

Japanese Fiscal Year 2014

No.	Name of Item	Manufacturer	Model	Qty	Place of Installmen	Unit Price (USD)	Total Price (USD)
1	Circuit Breaker	SMC	PME500-TR	1		19,830	19,830
2	Live line Indicator	HASEGAWA ELECTRIC	WM275	1		1,315	1,315
3	Checker for voltage detector	HASEGAWA ELECTRIC	CL-1-06	1		550	550
4	Earthing Device1	HASEGAWA ELECTRIC	MA121A45	2		7,330	14,660
5	Case of Earthing Device1	HASEGAWA ELECTRIC	Case:type 45	2		970	1,940
6	Hydraulic Compression machine	SANWA TEKKI	SEP-5A	1		12,687	12,687
7	Compression head	SANWA TEKKI	SR100C-2	1		6,161	6,161
8	Compression dice	SANWA TEKKI	Special order to SANWA TEKKFor ACSR 240 mm2	1		833	833
9	Wiring Ladder	FUJII DENKO	KM-3	1		2,081	2,081
10	Come Along Clamp	YASUDA	T103N	2		2,464	4,928
11	Hydraulic Cutter	IZUMI SEIKI	S-40B	1		1,565	1,565
12	Torque Wrench	TOHNICHI	QL100N4	1	IES	250	250
13	Torque Wrench	TOHNICHI	QL200N4	1		316	316
14	Chain Block	NAGAKI SEIKI	AX4108-	1		2,264	2,264
15	Alminium Cutter for	NAGAKI SEIKI	CT-1	1		2,272	2,272
16	Nylon Sling Belt	-	G50-10	3		40	120
17	Fook for lift tools	FUJII DENKO	FS-85	1		33	33
18	Tool bag	FUJII DENKO	P-276	4		47	188
19	Pully Block	DAIWA roller	No.120F	1		366	366
20	Shackle	-	SC-18	2		14	28
21	Safety belt	FUJII DENKO	CHUGOKU type	10		483	4,830
22	Safety rope	FUJII DENKO	CHUGOKU type	10		102	1,020
23	plier case	FUJII DENKO	P-256	10		52	520
24	Tool bag	FUJII DENKO	P-287	10		42	420
25	Safety Rope with Shock absorber1	FUJII DENKO	T-70	3		167	501
26	Safety Rope with Shock absorber2	FUJII DENKO	T-70	3		183	549
27	U-type Clevis	-	UCH-800	5		33	165
28	Wire with clamp	SUMIDENASAH	CE-82	1		2,557	2,557
29	Training Towers	EM Construction	Special order	1		144,045	144,045
Total						-	226,994

Annex 7: List of Counterpart Personnel

No.	Name	Position	Organization	Position in Project
1	H.E Chan Sodavath	Deputy Managing Director	Electricité du Cambodge (EDC)	Project Director (Feb. 2013 ~ Dec. 2014)
2	Dr. Praing Chulasa	Deputy Managing Director	Electricité du Cambodge (EDC)	Project Director (Jan. 2015 ~ Present)
3	Mr. Nou Sokhon	Director	Transmission Department	Project Manager
4	Mr. Ing Prorseth	Deputy Director	Transmission Department	System Operation
5	Mr. Mak Thorn	Chief	Transmission System Unit, Transmission Department	
6	Mr. Thourk Mony	Deputy Chief	Transmission System Unit, Transmission Department	Substation
7	Mr. Try Chhun Heng	Deputy Chief	Transmission System Unit, Transmission Department	Transmission Line
8	Mr. Chhay Sophea	Deputy Chief	Transmission Line Division, Transmission System Unit, Transmission Department	Transmission Line
9	Mr. Try Soban	Deputy Chief	Transmission Line Division, Transmission System Unit, Transmission Department	Transmission Line (~ Aug.2013)
10	Mr. Meas Mea		Transmission Line Division, Transmission System Unit, Transmission Department	Transmission Line
11	Mr. Meas Nimol		Substation Division, Transmission System Unit, Transmission Department	Substation
12	Mr. Kem Sopanha		Substation Division, Transmission System Unit, Transmission Department	Substation
13	Mr. Touch Samphors	Chief	Data Management & Operation Planning, NCC, Transmission Department	System Operation (NCC)
14	Mr. Heng Ky	Chief	Shift No.1, NCC, Transmission Department	System Operation (NCC)
15	Mr. Chan Samnang	Deputy Chief	Data Management, NCC, Transmission Department	System Operation (NCC)
16	Mr. Rin Vanny		Operation Planning, NCC, Transmission Department	System Operation (NCC)
17	Mr. Hak Hout	Deputy Chief	Data Collection Division, NCC, Transmission Department	System Operation (NCC)
18	Mr. Lors Pouthy	Deputy Chief	Relay Protection Office, Transmission Department	System Operation (Relay Protection)
19	Mr. Phin Chenda		Relay Protection Office, Transmission Department	System Operation (Relay Protection)
20	Mr. Phat Tech		Relay Protection Office, Transmission Department	Substation
21	Mr. Neang Vannet		Relay Protection Office, Transmission Department	Substation
22	Mr. Oum Piseth	Director	Institute of Electrical Science (IES)	Co - Project Manager
23	Mr. Meng Sokkheng	Deputy Director	Institute of Electrical Science (IES)	
24	Mr. Sok Pal	Chief	Electrical Department, IES	Trainer of Relay Protection
25	Mr. Chhan Buntheat	Trainer	Trainer of Transmission Division, Technical Training office, IES	Trainer of Transmission Line, Substation
26	Mr. Hong Neang	Trainer	Trainer of Transmission Division, Technical Training office, IES	Trainer of Transmission Line
27	Mr. Chhay Vichet	Trainer	Trainer of Safety Division, Technical Training office, IES	Trainer of Transmission Line
28	Mr. Chea Mareth	Trainer	Trainer of Transmission Division, Technical Training office, IES	Trainer of Substation
29	Mr. Chin Pim Shokha	Trainer	Trainer of Transmission Division, Technical Training office, IES	Trainer of Substation
30	Mr. Nong Vibol	Trainer	Trainer of Transmission Division, Technical Training office, IES	Trainer of Relay Protection
31	Mr. Chea Prach	Trainer	Trainer of Power plant protection Division, Technical Training office, IES	Trainer of Relay Protection
32	Mr. Su Tek Seng	Trainer	Trainer of Distribution Division, Technical Training office, IES	Trainer of Relay Protection
33	Mr. Chun Piseth	Director	Corporate Planning and Project Department	Member of Working Group
34	Mr. Aun Hemrith	Director	Generation Department	Member of Working Group
35	Dr. Chea Sin Hel	Director	Business and Distribution Department	Member of Working Group

Note: NCC is National Control Center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