[資　料]

資料 1-1　調査団員名簿

Member of the Study Team

カンボディア国シアムリアップ電力供給施設拡張計画
基本設計調査
Basic Design Study on the Project for Siem Reap Generating Facilities

1.	団長 Leader	小森　克俊 Katsutoshi KOMORI	国際協力事業団 無償資金協力部　業務第三課 Third Project Management Division Grant Aid Management Department, JICA
2.	業務主任/電化計画 Chief Consultant /Power Supply Planner	砂川　義一 Yoshikazu SUNAGAWA	日本工営株式会社 Nippon Koei Co., Ltd
3.	発電施設計画 Generating Facility Planner	河上　博 Hiroshi KAWAKAMI	日本工営株式会社 Nippon Koei Co., Ltd
4.	送配電計画 Power Distribution and Transmission Planner	塚原　澄雄 Sumio TSUKAHARA	日本工営株式会社 Nippon Koei Co., Ltd
5.	運営維持管理/電力需要予測 Operation and Management Planner/Power Demand Forecast	山本　拓司 Takuji　YAMAMOTO	日本工営株式会社 Nippon Koei Co., Ltd
6.	積算/調達計画 Cost Estimator /Procurement Planner	江川　等 Hitoshi EGAWA	日本工営株式会社 Nippon Koei Co., Ltd

資料 1-2　調査団員名簿

Member of the Study Team

カンボディア国シアムリアップ電力供給施設拡張計画
基本設計調査
（ドラフト・レポート説明）
Basic Design Study on the Project for Siem Reap
Generating Facilities

1.	団長 Leader	和田　康彦 Yasuhiko WADA	国際協力事業団 無償資金協力部　計画課 Planning Division, Grant Aid Management Department, JICA
2.	業務主任/電化計画 Chief Consultant /Power Supply Planner	砂川　義一 Yoshikazu SUNAGAWA	日本工営株式会社 Nippon Koei Co., Ltd
3.	発電施設計画 Generating Facility Planner	河上　博 Hiroshi KAWAKAMI	日本工営株式会社 Nippon Koei Co., Ltd
4.	送配電計画 Power Distribution and Transmission Planner	塚原　澄雄 Sumio TSUKAHARA	日本工営株式会社 Nippon Koei Co., Ltd

資料 2-1　現 地 調 査 日 程（基本設計調査）

日順	月日	曜日	宿泊地	官団員	コンサルタント団員				
				小森 団長	砂川団員	河上団員	塚原団員	山本団員	江川団員
1	5月14日	月	バンコック	成田(NH915/10:00) →バンコック (14:25)	成田 (TG641/11:00)→バンコック (15:30)				
2	5月15日	火	プノンペン	バンコック (TG696/8:35) →プノンペン (9:50) 、 大使館表敬及びJICA事務所着任報告					
3	5月16日	水	プノンペン	鉱工業省表敬、実施機関 (EDC) とインセプションレポート内容及び調査日程等協議、既存発電所視察					
4	5月17日	木	シアムリアップ	EDC シアムリアップとインセプションレポート内容及び調査日程等協議、 既存発電機調査					
5	5月18日	金	シアムリアップ	シアムリアップ州知事表敬、EDC シアムリアップと協議、新規発電所建設候補地調査					
6	5月19日	土	シアムリアップ	新規発電所建設候補地及び既存配電線調査・測量					
7	5月20日	日	シアムリアップ	資料解析及び資料整理					
8	5月21日	月	シアムリアップ	国道6号線改修工事事務所と協議、EDC シアムリアップと協議					
9	5月22日	火	プノンペン	実施機関 (EDC) と現地調査結果について協議					
10	5月23日	水	プノンペン	ミニッツ案についてEDCと協議、ミニッツ案修正					
11	5月24日	木	プノンペン	ミニッツ署名					
12	5月25日	金	プノンペン	大使館及びJICAへ報告					
13	5月26日	土	プノンペン	プノンペン (TG697/10:50) →バンコック (11:55)、バンコック (NH916/22:15) →成田 (06:10、5/27)	データ解析・資料整理・調達運搬方法検討				
14	5月27日	日	プノンペン		データ解析・資料整理・調達運搬方法検討				
15	5月28日	月	シアムリアップ		EDC シアムリアップと協議			新規発電所候補地測量	新規発電所候補地測量・積算資料収集
16	5月29日	火	シアムリアップ		シアムリアップ市開発計画調査	発電機内部調査・発電機運転中調査	シアムリアップ市開発計画調査	新規発電所候補地測量	新規発電所候補地測量・積算資料収集
17	5月30日	水	シアムリアップ		アプサラと協議・変電所設備調査	発電機内部調査・発電機運転中調査	アプサラと協議	共通電気設備調査	積算資料収集・変電所設備調査
18	5月31日	木	シアムリアップ		既設発電所施設調査・変電所設備調査	発電機内部調査・発電機運転中調査	既設発電所施設調査	変電所設備調査	積算資料収集・変電所設備調査
19	6月1日	金	シアムリアップ		新規発電所候補地地質調査				
20	6月2日	土	シアムリアップ		資料解析・整理、新規発電所候補地調査				
21	6月3日	日	シアムリアップ		資料解析・整理、施工計画検討				
22	6月4日	月	シアムリアップ		・EDCと協議、JICAに現地調査報告	・EDCと協議、JICAに現地調査報告	・EDCと協議、JICAに現地調査報告	積算資料収集、JICAに現地調査報告	積算資料収集、JICAに現地調査報告
23	6月5日	火	プノンペン		EDCと協議、報告書作成	燃料油調査	財務調査	プノンペン (TG699/18:50) →バンコック (19:55) 、 バンコック (TG642/23:10) →成田 (7:30、6/7)	
24	6月6日	水	プノンペン		〃	〃	〃		
25	6月7日	木	プノンペン		〃	・教育・訓練センター調査	・教育・訓練センター調査		
26	6月8日	金	プノンペン		〃	報告書作成準備	報告書作成準備		

日順	月日	曜日	宿泊地	官団員	コンサルタント団員				
				小森 団長	砂川団員	河上団員	塚原団員	山本団員	江川団員
27	6月9日	土	プノンペン		プノンペン (FT996/8:40) →シアムリアップ (9:20) ・地質調査	資料整理	資料整理		
28	6月10日	日	プノンペン		・地質調査	〃	〃		
29	6月11日	月	プノンペン		シアムリアップ (FT997/7:20) →プノンペン (8:10) ・地質調査	報告書作成	報告書作成		
30	6月12日	火	プノンペン		報告書作成	〃	〃		
31	6月13日	水	プノンペン		〃	〃	〃		
32	6月14日	木	プノンペン		〃	〃	〃		
33	6月15日	金	プノンペン		大使館及びJICAへ調査結果報告				
34	6月16日	土	バンコック		プノンペン (TG699/18:50) →バンコック (19:55)				
35	6月17日	日			バンコック (TG772/07:35) →成田 (15:45)				

資料 2-2　　現地調査日程（ドラフト・レポート説明）

日順	月日	曜日	宿泊地	官団員	コンサルタント団員		
				和田団長	砂川団員	河上団員	塚原団員
1	8 月 22 日	水	バンコック		成田(TG641/11:00)－バンコック(15:30)		
2	8 月 23 日	木	プノンペン	バンコック(TG698/16:30) －プノンペン(17:45)	バンコック(TG696/08:35)－プノンペン(09:50)		
3	8 月 24 日	金	プノンペン	日本大使館、鉱工業省、EdC 表敬および JICA 事務所着任挨拶			
4	8 月 25 日	土	シアムリアップ	プノンペン(FT996/08:40)－シアムリアップ(09:20) 現地調査			
5	8 月 26 日	日	シアムリアップ	資料整理			
6	8 月 27 日	月	シアムリアップ	シアムリアップ州政府表敬 EdC シアムリアップと協議			
7	8 月 28 日	火	プノンペン	シアムリアップ(FT997/07:20)－プノンペン(08:00) EdC プノンペンと協議			
8	8 月 29 日	水	プノンペン	EdC プノンペンと協議 ミニッツ案について EdC と協議			
9	8 月 30 日	木	プノンペン	ミニッツ署名			
10	8 月 31 日	金	プノンペン	日本大使館および JICA へ報告 カンボディア開発評議会へ報告			
11	9 月 1 日	土	プノンペン	プノンペン(TG697/10:50)－バンコック(11:55)			
				バンコック(NH916/22:15)－			
13	9 月 2 日	日		成田(06:10)	バンコック(TG640/10:50)－成田(19:00)		

資料 3　相手国関係者ﾘｽﾄ
Person in Charge of Recipient Country

カンボディア国シアムリアップ電力供給施設拡張計画
基本設計調査

Basic Design Study on the Project for Siem Reap
Generating Facilities

No.	面会者	役職･担当
	MINISTRY OF INDUSTRY, MINES AND ENERGY （鉱工業･エネルギー省）	
1	ITH PRAING	Secretary of State
2	KHLAUT RANDY	Under Secretary of State of M.I.M.E
3	TUN LEAN	Director
	ELECTRICITY AUTHORITY OF CAMBODIA （電力局、プノンペン）	
4	TY NORIN	Chairman
	ELECTRICITE DU CAMBODGE （カンボディア電力公社）	
5	TAN KIM VINN	General Director
6	YIM NOLSON, P.E.	Deputy Managing Director Planning & Technique
7	SAN VIRYAN	Deputy Manager of Technics Office
8	HEU VANTHAN	Deputy Manager, Executive Director of Finance & Accounting
9	OUM THY	Power Plant Engineer Chief Division Project Manegement Office No.1Corporate Planning & Project Dept.
10	CHAN SODAVATH	Acting Executive Director Corporate Planning & Projects
11	CHHUNG UNG	Deputy Director of Commercial Department
12	ROS CHADA	Deputy Executing Director of Generation Department
13	LUEUNG KEOSELA	Corporate Planning and Projects Department Independent Power Producer Office
14	S.KBANSAL	Advisor
	Council for the Development of Cambodia Rehabilitation and Development Board （カンボディア国家開発評議委員会）	
15	HENG SOKUN	Director Bilateral Aid Coordination Dept. Japan - Asia Pacific - America
	EDC SIEM REAP （シアムリアップ電力局）	
16	OUK CHAMROEUN	Director
17	CHEAM KOSEN	Deputy Director of Administration & Accounting
18	KONG CHHON KHEMARIN	Deputy Director of technics
19	NONG SARAM	Chief of administration Section
20	SENG VIBOL	Chief of Distribution Section
21	MEY SEREBIBOTH	Assistance to Chief of Distribution Section
22	PRUM SOKUNNA	Deputy Director
23	LOU SATYA	Technical Staff
24	PHON PHEACHANY	Ditto
25	HIENG BORA	Ditto

No.	面会者	役職･担当
	Siem Reap Province （シアムリアップ州政府）	
26	EHAP NHATYVOUD	Governor
27	SUYSAN	2nd Deputy Governor
	EdC Trainning Center （EdC研修センター）	
28	CHAN KHEANG	Director
	CAMBODIAN MINE ACTION CENTER	
29	KHEM SOPHOAN	Director General
30	MEN SARUN	Co-director
31	JEAN PIERRE BILLAULT	Consul honoraire de France
	Apsara Authority	
32	DENG SAMBATH	Assistant Deputy Director of Apsara Authority

資料 4-1　カンボデイア経済の概要

項目		1995	1996	1997	1998	1999	2000
1.主要経済指標							
実質経済成長率	%	7.6	5.5	3.7	1.8	5.0	4.5
物価上昇率	%	3.5	9.0	9.1	12.6	0.0	4.0
国民 1 人当たりの GDP	US$	284	292	276	252	268	282
為替レート	リエル/$	2,560	2,713	3,400	3,800	3,775	3,800
2.国家財政							
国内収入	10^9 リエル	643.0	749.1	881.0	942.7	1,353.1	1,529.0
歳出総額	10^9 リエル	1,247.9	1,418.3	1,267.9	1,563.8	1,834.2	2,073.3
経常収支	10^9 リエル	-101.5	-79.9	52.7	-24.3	243.4	331.9
総合収支	10^9 リエル	-604.9	-669.3	-386.9	-621.1	-481.1	-544.3
3.貿易収支							
輸出	10^6 $	321	347	517	612	720	--
輸入	10^6 $	700	875	873	957	1,080	--
貿易収支	10^6 $	-379	-529	-356	-345	-361	--
再輸出	10^6 $	540	361	250	130	120	--
4.GDP 構成比							
農林水産業	%	44.6	42.7	42.8	39.3	37.0	--
鉱工業	%	18.7	20.6	19.8	19.5	19.8	--
サービス業	%	36.6	36.6	37.2	41.2	43.2	--

註：　2000 年の数値は暫定値

出典：大使館資料その他

資料 4-2　カンボデイアの社会経済状況

国名：カンボデイア王国

一般指標				
政体	立憲君主制		首都	プノンペン
元首	ノロドム・シハヌーク国王		主要都市名	シハヌクビル､シアムリアップ
独立年月日	1953 年		経済活動可能人口	504 万人
人種(部族)構成	クメール人		義務教育年数	9 年
言語・公用語	クメール語		初等教育就学率	78.3%
宗教	小乗仏教(95%)		初等教育終了率	11%
ASEAN 加盟	1998 年		識字率	65.9%
国連加盟			人口密度(1998)	6.3 人/km^2
世界銀行			人口増加率(1998)	2.4%
IMF 加盟			平均寿命	54.4 歳
面積	181,350km^2		5 歳未満児死亡率	18.1%
人口(1998)	1,143 万人		カロリー供給率	

経済指標				
通貨単位	リエル		貿易量	
為替(1US$)(2001 年 6 月)	3,950		輸出(1999)	720 百万ドル
会計年度	1 月 1 日-12 月 31 日		輸入(1999)	1,080 百万ドル
国家予算			輸入カバー率	67%
歳入	1,529x10 億リエル		主要輸出品目	縫製品、木材、タバコ
歳出	2,073x10 億リエル		主要輸入品目	石油、縫製用布、精密機械
国際収支	-361 百万ドル		日本への輸出	21 億円(1998)
ODA 受取額(1999)	401 百万ドル		日本からの輸入	58 億円(1998)
国内総生産（GDP,2000）	3,240 百万ドル			
			外貨準備総額	
GDP の産業別構成	農業：37%		対外債務残高	2,146 百万ドル(1998)
	鉱工業：19.8%		対外債務返済率	13%(1998)
	サービス業：43.2%		インフレ率	4.0%(2000)
産業別雇用				
	農業		国家開発計画	第 2 次 5 個年計画
	鉱工業			
	サービス業			
経済成長率(2000)	4.5%			

気象(1998 年 - 2000 年)　場所：シアムリアップ飛行場（標高 15m）													
月	1	2	3	4	5	6	7	8	9	10	11	12	平均/計
最高気温	35.0	36.5	38.2	39.2	37.5	35.6	34.9	34.5	33.8	33.3	33.5	33.3	35.4℃
最低気温	17.4	17.8	20.9	22.7	23.4	23.5	23.5	22.6	22.9	21.5	19.2	15.1	20.9℃
平均気温	27.4	27.9	29.9	30.2	29.7	29.0	28.4	28.7	27.9	27.4	26.4	25.2	28.2℃
降水量	1.0	1.4	5.7	63.9	165.7	235.5	217.1	141.2	258.7	251.9	117.5	11.7	1,471㎜
雨季/乾季	乾季					雨季					乾季		

カンボデイアに対する我が国における ODA の実績				
	1997	1998	1999	2000
技術協力	27.1	18.5	23.3	未決
無償資金協力	41.8	78.2	86.0	82.1
有償資金協力	0	0	41.4	0
総額	68.9	96.7	150.7	---

OECD 諸国の経済協力実績(1999 年)　(支出総額、単位：百万ドル)						
	贈与(1)		有償資金協力(2)	政府開発援助（ODA）(1)+(2)=(3)	その他政府資金及び民間資金（４）	経済協力総額(3)+(4)
		技術協力				
二国間援助 (主要供与国)	―	―	―	―	―	―
1.アメリカ	―	―	―	―	―	23.0
2.フランス	―	―	―	―	―	16.6
3.オーストラリア	―	―	―	―	―	13.2
4.スウェーデン	―	―	―	―	―	10.8
5.日本	―	―	―	―	―	89.0
多国間援助 (主要援助機関)	―	―	―	―	―	―
1.国連	―	―	―	―	―	53.3
2.世界銀行	―	―	―	―	―	34.8
3.ADB	―	―	―	―	―	26.9
その他	―	―	―	―	―	133.1
合計	―	―	―	―	―	400.7

援助受け入れ窓口機関	
技術協力	外務省
無償協力	国際協力事業団
協力隊	国際協力事業団

出典：1．カンボデイア王国案内：日本国大使館、2001 年 4 月

2. カンボデイア国の概要：日本国大使館、2001 年 4 月

3. 開発途上国国別経済協力シリーズ、カンボデイア：国際協力推進協会、2000 年 4 月

Minutes of Discussions
On the Basic Design Study
On the Project for Siem Reap Generating Facilities
In the Kingdom of Cambodia

In response to a request from the Government of the Kingdom of Cambodia (hereinafter referred to as "Cambodia"), the Government of Japan decided to conduct a Basic Design Study on the project for Siem Reap Generating Facilities (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Cambodia the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Mr. Katsutoshi KOMORI, Third Project Management Division, Grant Aid Department, JICA and is scheduled to stay in the country from May 15 to June 16, 2001.

The Team held discussions with the officials concerned of the Government of Cambodia and conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Phnom Penh, May 24, 2001

小森　克俊

Katsutoshi Komori
Leader,
Basic Design Study Team,
Japan International Cooperation Agency

Ith Praing
Secretary of State,
Ministry of Industry, Mines and Energy

Tan Kim Vinn
Managing Director,
Electricite du Cambodge

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve the standard of living of inhabitants in the Project site by installing new generating facilities.

2. Project site

The site of the Project is shown in Annex-1.

3. Responsible and Implementing Agency

The responsible agency is the Ministry of Industry, Mines and Energy. The Implementing agency is the Electricite du Cambodge (EDC). The organization charts of EDC, whole organization and Siem Reap, are shown in Annexes 2-1 and 2-2.

4. Items requested by the Government of Cambodia

After discussions with the Team, the following components were finally requested by the Cambodian side;

1) Construction of a 10MW new power plant in Siem Reap,
2) Expansion of 22kV line to connect the new power plant with the existing system (if necessary),
3) Consultant's services including the training of maintenance staff of the power plant in Siem Reap.

JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

5-1. The Cambodian side understood the Japan's Grant Aid scheme explained by the Team, as described in Annex-3.

5-2. The Cambodian side will take the necessary measures, as described in Annex-4, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the Study

6-1. The consultant will proceed to further studies in Cambodia until June 16, 2001.

6-2. JICA will prepare the draft report in English and dispatch a mission in order to explain its

contents around August.

6-3. In case that the contents of the report is accepted in principle by the Government of Cambodia, JICA will complete the final report and send it to the Government of Cambodia by November, 2001.

7. Other relevant issues

7-1. The Cambodian side will provide necessary data and information for the study.

7-2. The Cambodian side will secure personnel and budget necessary for the Project.

7-3. The Cambodian side will take all possible measures to secure safety of the concerned people during the study and implementation of the Project on condition that the Grant Aid by the Government of Japan is extended to the Project.

7-4. The Cambodian side requested to build a new power plant in the suburb of the Siem Reap City based on the future plan. The Team will review the location of the new power plant in Japan from the point of view of economy, technology, future expansion plan of the power system, and environmental protection, and inform the Cambodian side the result with the mission dispatched around August. In case that the new power plant is constructed in the land different from the place where the existing power plant is built, the Cambodian side will complete necessary measures described as follows prior to the implementation of the Project;

(1) To take necessary procedures for land acquisition and compensation, including to obtain necessary approval from related agencies,

(2) To construct approach road.

7-5. The Cambodian side will remove all UXOs and mines in accordance with the results of the UXO and mine search. The search and removal work by the Cambodian side will be completed prior to the commencement of the detailed design and construction of the new power plant, respectively. While executing the Basic Design Study, the Cambodian side will also secure safety survey condition regarding all UXOs and mines.

7-6. The Cambodian side requested to build the distribution line via the entrance of Angkor Wat to the Siem Reap Airport. The Team explained that the distribution line would not be included in the components of this Project because the population in the area along the distribution line is not much and the benefit to cost is estimated low.

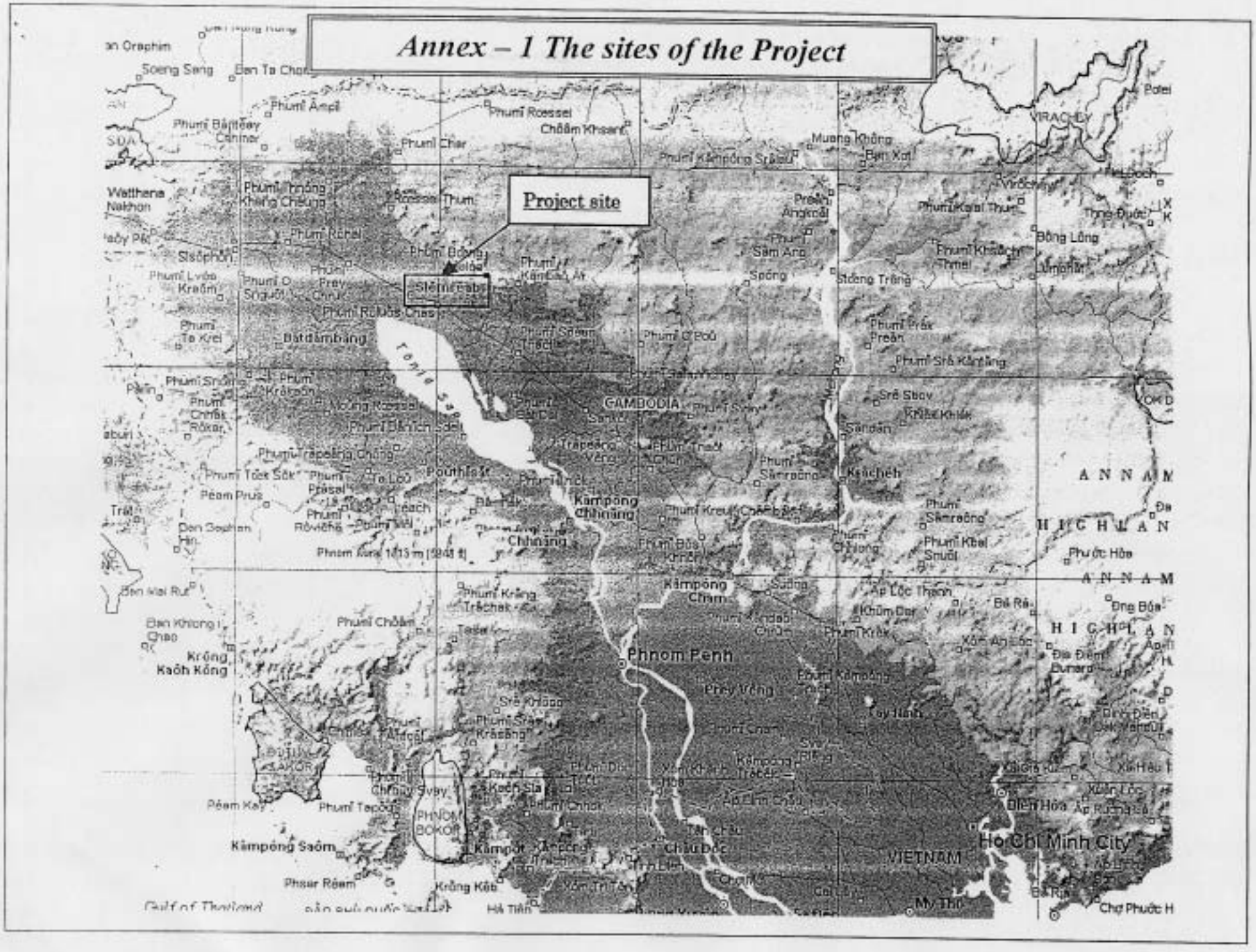
7-7. The training of the maintenance staff of Electricity Siemreap Unit is indispensable to ensure smooth operation of the new power plant provided under the Project. EDC Headquarter will keep close cooperation with Electricity Siemreap Unit and take necessary measures for the staff training on condition that the Grant Aid by the Government of Japan is extended to the

Project. The Team will consider the plan of consulting services for training of maintenance staff of Electricity Siemreap Unit and will prepare the draft of the plan with the mission dispatched around August.

7-8. The Cambodian side requested to consider use of heavy oil, not light oil, as fuel of generating facilities because of economy. The team will review type of the fuel in Japan from the point of view of economy and maintenance, and inform the Cambodian side the result with the mission dispatched around August.

7-9. The both sides confirmed the Cambodian side's intention that even if the plan to purchase 115kV power from Thailand by construction of a transmission line is realized, the new power plant will remain as the main electricity resource to Siem Reap and the purchase from Thailand is a backup resource.

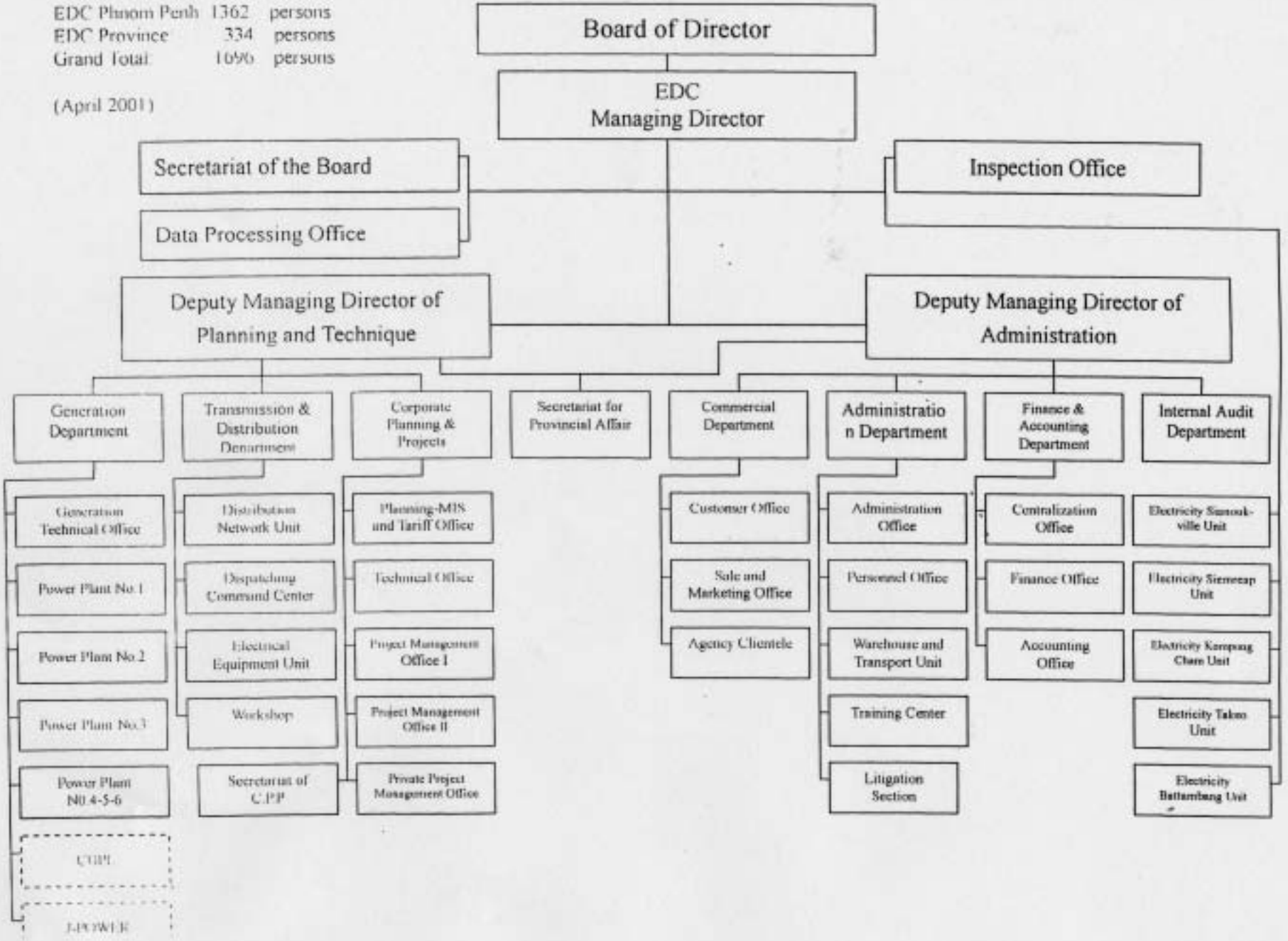
Annex – 1 The sites of the Project



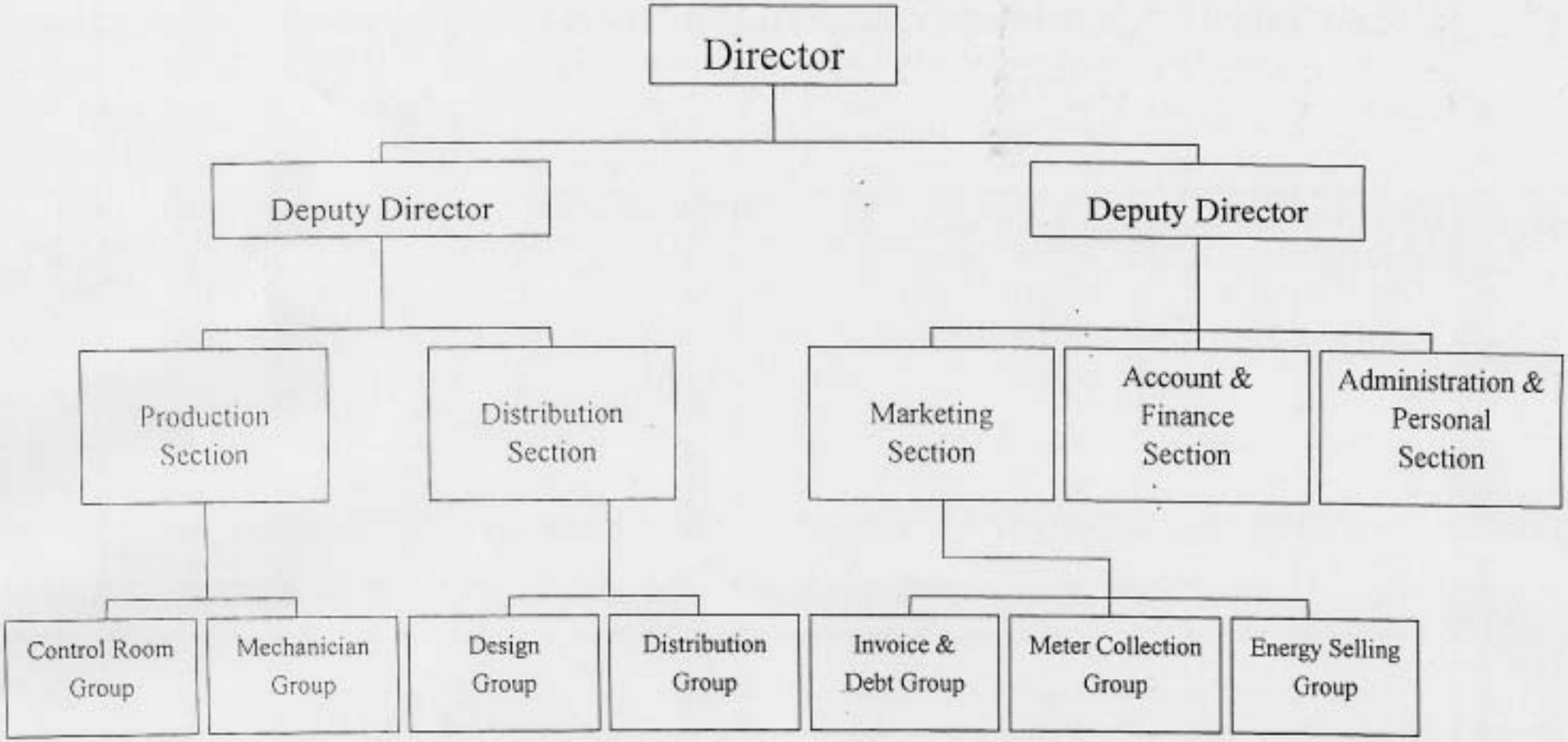
Annex2-1: Organization Chart of Electricite du Cambodge

Nos. of Staff
EDC Phnom Penh 1362 persons
EDC Province 334 persons
Grand Total 1696 persons

(April 2001)



Annex 2-2: Organization Chart of Electricity Siemreap Unit



Japan's Grant Aid

The Grant Aid scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

Japan's Grant Aid Scheme is executed through the following procedures.

Application	(Request made by a recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for the Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the recipient country.

Finally, for the smooth implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereafter referred to as "the Study"), conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

- Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.

- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.

- Preparation of a Basic Design of the Project

- Estimation of cost of the Project

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consulting firm(s) used for the Study is(are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3. Japan's Grant Aid Scheme

1) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

2) "The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consulting firm(s) and (a) contractor(s) and final payment to them must be completed.

However, in case of delays in delivery, installation or construction due to unforeseen factors such as natural disaster, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

3) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely, consulting constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

4) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

5) Undertakings required to the Government of the Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

① To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction,
② To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,
③ To secure buildings prior to the procurement in case the installation of the equipment,
④ To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid,
⑤ To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,
⑥ To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

6) "Proper Use"

The recipient country is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

7) "Re-export"

The products purchased under the Grant Aid should not be re-exported from the recipient country.

8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

Major Undertaking to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To construct the parking lot	●	
5	To construct roads		
	1) Within the site	●	
	2) Outside the site		●
6	To construct the buildings	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities		
	1) Electricity		
	a. The distributing line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm, sewer and others) to the site		●
	b. The drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
10	To accord Japanese nationals whose services may be required in connection with the supply of theproducts and the services under the verified contact such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.		●
12	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant.		●
13	To bear all the expenses, other that those to be borne by the Grant, necessary for construction of the facilities as well all for the transportation and installation of the equipment.		●

8/1
K. K.

Minutes of Discussions
on the Basic Design Study on the Project for Siem Reap Generating Facilities in the Kingdom of Cambodia (Explanation on Draft Report)

In May 2001, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a Basic Design Study Team on the Project for Siem Reap Generating Facilities (hereinafter referred to as "the Project") to the Kingdom of Cambodia (hereinafter referred to as "Cambodia"), and through discussions, field survey and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain and to consult on the components of the draft report, JICA sent to Cambodia the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Yasuhiko Wada, an officer of the Planning Division, Grant Aid Management Department, JICA, from August 23 to September 1, 2001.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Phnom Penh, August 30, 2001

和田康彦

Yasuhiko Wada
Leader
Draft Report Explanation Team
Japan International Cooperation Agency

Ith Praing
Secretary of State
Ministry of Industry, Mines and Energy

Tan Kim Vinn
Managing Director
Electricite du Cambodge

ATTACHMENT

1. Components of the Draft Report

The Cambodian side agreed and accepted in principle the components of the draft report explained by the Team.

2. Japan's Grant Aid Scheme

The Cambodian side understands the Japan's Grant Aid scheme and the necessary measures to be taken by the Government of Cambodia as explained by the Team and described in Annex-3 and Annex-4 of the Minutes of Discussions signed by both parties on May 24, 2001.

3. Schedule of the Study

JICA will complete the Final Report in accordance with the confirmed items and send it to the Government of Cambodia in around November 2001.

4. Other Relevant Issues

4-1. Considering the objective of the Project, which is to improve the standard of living of inhabitants in the Project area by installing new generating facilities, the Cambodian side shall provide electricity to the residential area as the top priority.

4-2. In order to achieve the objective of the Project mentioned above, proper operation and maintenance of the new generating facilities are indispensable. Therefore, EDC Headquarters will keep close cooperation with Electricity Siemreap Unit and take necessary measures for the training of operation and maintenance staff of Electricity Siemreap Unit.

4-3. On condition that the Grant Aid by the Government of Japan is extended to the Project, the Cambodian side will take necessary measures:

(1) to secure sufficient personnel and budget necessary for the Project in proper time;

(2) to secure safety of the concerned people during the implementation of the Project;

(3) to remove all UXOs immediately, if found during the construction of new power plant;

(4) to complete necessary measures described as follows prior to the implementation of the Project;

a) to obtain the permissions necessary for the construction from related agencies, including that of the environmental issues,

b) to take necessary procedures for land acquisition and compensation, including to obtain necessary approval from related agencies and

c) to construct access road.

(5) to obtain the permissions necessary for the transportation of disassembled engine generators from the unloading site of Tonle Sap lake to the new power plant site by a trailer from related agencies, including that of the exclusively use of road and

(6) to dispose the sludge produced from the heavy oil purifier unit in a proper manner and in compliance with the environmental requirement.

資料 6　事業事前評価表（無償資金協力）

1. 協力対象事業名

カンボディア王国　シアムリアップ電力供給施設拡張計画

2. 我が国が援助することの必要性･妥当性

(1) 我が国は、アジア・太平洋地域の平和と安定及び発展に取りカンボディアの安定が不可欠であるとの認識の下、同国の復興及び民主化に向けた努力を積極的に支援し、DAC 新開発戦略の重点国として、我が国 ODA 大綱を踏まえつつ協力を行っている。我が国は「カンボディア復興国際委員会」の議長を 1993 年から 3 年間努め、「第 1 回カンボディア支援国会合（CG）」でも世銀と共同議長を務めた。その後の支援国会合においても、日本は中心的な役割を果たしている。

(2) シアムリアップはアンコールワット遺跡群で世界的に知られる。その既設発電所は、旧ソ連から支援を受けたソ連製発電機 4 台と、フランスからの支援による発電機 1 台からなるが、旧ソ連のものは老朽化し、長時間の運転及び十分なる出力を確保できないために予備機に回されており、フランス製の発電機は致命的な事故のため運転不可能な状態ある。カンボディア電力公社（以下「EdC」）では、現在発電機を民間からリースして電力を供給しているが、その供給力は現状の需要すら満足させるものではなく、ごく近い将来、大幅な電力不足が予想される状況にある。

(3) 当該国の社会・経済事情については、資料 4 の「当該国の社会・経済事情」参照

3. 協力対象事業の目的（プロジェクト目標）

本計画を実施することで、シアムリアップ市の電力供給不足が解消される。

4. 協力対象事業の内容

(1) 対象地域
シアムリアップ市

(2) アウトプット
シアムリアップ市郊外に新規発電所（約 10MW）が建設される。

(3) インプット

①10,500kW（3,500kW×3 台）の発電所の建設
②22kV 連系線を建設して既存のシアムリアップ配電系統に接続する。
③発電機の運転・保守に係る技術移転

(4) 総事業費
概算事業費 21.56 億円（日本側負担：21.32 億円、カンボディア側負担：0.24 億円）

(5) スケジュール
詳細設計を含めて 22 ヶ月間を予定

(6) 実施体制
監督機関：鉱工業エネルギー省
実施機関： カンボディア電力公社　(施設完成後の運営は、EdC シアムリアップ)

5. プロジェクトの成果

(1) プロジェクトにて裨益を受ける対象の範囲および規模

直接裨益人口：シアムリアップ住民 120 千人

(2) 事業の目的(プロジェクト目標)を示す成果指標

①電化世帯数の増加

	2000 年（実施前）	2007 年（実施後）
電化世帯数	42.1 千人	68.4 千人

②消費電力量の増加

	2000 年（実施前）	2007 年（実施後）
世帯数当たりの電力消費量	38kWh /年	100kWh /年

(3) その他の成果指標

観光客の増加

6. 外部要因リスク

(1) 運転・保守要員の確保

長期維持管理体制の自立を支援するため、運転。保守要員にソフトコンポーネントおよび発電機据付工事に参加してのオン・ザ・ジョブトレーニングの教育を実施する。運転・保守の核となる要員には、教育の内容が理解できる技術教育課程を履修した人材の確保が必要である。

(2) 適切な運転・維持管理体制の確立には、EdC プノンペン本部の関与と支援が必要である。

7. 今後の評価計画

(1) 事後評価に用いる成果指数

1） 電化世帯数

2） 世帯数当たりの電力消費量

(2) 評価のタイミング

施設建設後 3 年以降に事後評価予定

資料7　収集資料リスト

番号	資料の名称	形態	版型	ページ数	部数	収集先
1	Annual Report 1999	製本		3	1	EDC
2	Annual Report 2000	製本		9	1	EDC
3	EDC Design Standard	書類	A4	1	1	EDC
4	Agreement of Wholeselers	書類	A4	1	1	EDC
5	Agreement of IPPs	書類	A4	1	1	MINE
6	カンボディア国プノンペン市及びシアムリアップ市電力復興マスタープラン調査報告書	製本	A4		1	国際協力事業団
7	NZSIC STATISTIC 1997	書類	A4	14	1	EDC
8	NZSIC STATISTIC 1998	書類	A4	14	1	EDC
9	NZSIC STATISTIC 1999	書類	A4	17	1	EDC
10	カンボディア：開発途上国国別経済協力シリーズ第2版	製本	A4	96	1	国際協力推進協会
11	カンボディア地図（1万分の１）	書類	-	1	1	
12	カンボディア地図（5万分の1）	書類	-	1	1	
13	カンボディア地図（10万分の１）	書類	-	1	1	
14	Daily Load Curve in Oct 2000	書類	A3	1	1	EDC
15	Daily Load Curve of Siem Reap in 1997	書類	A3	2	1	EDC
16	Daily Load Curve of Siem Reap in 1998	書類	A3	2	1	EDC
17	Daily Load Curve of Siem Reap in 1999	書類	A3	2	1	EDC
18	Daily Load Curve of Siem Reap in 2000	書類	A3	2	1	EDC
19	Daily Output Power and DO Consumption Diagram(01-15/09/2001)	書類	A4	1	1	EDC
20	Daily Output Power and DO Consumption Diagram(16-30/09/2000)	書類	A4	1	1	EDC
21	Daily Output Power and DO Consumption Diagram(Jan,Feb and March in 2000)	書類	A4	6	1	EDC
22	Data of Energy and Fuel Consumption in Siem Reap	書類	A4	2	1	EDC
23	Distribution Facilities and Proposed Power Plant in Siem Reap	書類	A4	2	1	EDC
24	Organization Chart of EDC	書類	A4	5	1	EDC
25	General Population Census of Cambodia 1998 Final Census Results	製本	A4	P41-P289	1	Ministry Planning
26	Graphic of Power in 2000	書類	A4	2	1	EDC
27	Map of Distribution Facilities and Proposed Power Plant in Siem Reap	書類	A4	1	1	EDC
28	NZSIC STATISTIC 1997	製本	A4	14	1	EDC
29	NZSIC STATISTIC 1998	製本	A4	14	1	EDC
30	NZSIC STATISTIC 1999	製本	A4	17	1	EDC

資料7　収集資料リスト

番号	資料の名称	形態	版型	ページ数	部数	収集先
31	Organization Chart of EDS	書類	A4	1	1	EDS
32	Siem Reap Demand Forecast	書類	A4	1	1	EDC
33	Summary Data in 1995(Generation and Consumer)	書類	A4	1	1	EDC
34	Summary data in 2000(Generation,Consumer,Pealk Demand)	書類	A4	1	1	EDC
35	Summary of Existing Power Plant(Jan 2000)	書類	A4	4	1	EDC
36	Summary of Existing Power Plant(Feb 2000)	書類	A4	4	1	EDC
37	Summary of Existing Power Plant(Mar 2000)	書類	A4	4	1	EDC
38	Summary of Existing Power Plant(Apr 2000)	書類	A4	4	1	EDC
39	Summary of Existing Power Plant(May 2000)	書類	A4	4	1	EDC
40	Summary of Existing Power Plant(June 2000)	書類	A4	4	1	EDC
41	Summary of Existing Power Plant(July 2000)	書類	A4	4	1	EDC
42	Summary of Existing Power Plant(Aug 2000)	書類	A4	4	1	EDC
43	Summary of Existing Power Plant(Sep 2000)	書類	A4	4	1	EDC
44	Summary of Existing Power Plant(Oct 2000)	書類	A4	4	1	EDC
45	Summary of Existing Power Plant(Nov 2000)	書類	A4	4	1	EDC
46	Summary of Existing Power Plant(Dec 2000)	書類	A4	4	1	EDC
47	Summary of Existing Power Plant(Jan 2001)	書類	A4	4	1	EDC
48	Summary of Generation	書類	A4	1	1	EDC
49	Summary of Tariff in Siem Reap	書類	A4	1	1	EDC
50	Trend of Foreign Visitor Arrivals to Siem Reap in (1995-2000)by Air	書類	A4	1	1	EDC
51	Regulation of APSARA	製本	A4	6	1	APSARA
52	Regulation of Development in Siemreap	製本	A4	248	1	APSARA
53	Siem Reap 1998 Socio-Economic Indicators	製本	A4	20	1	Provincial Department
54	EDC SR Operations	製本	A4	18	1	ERNST&YOUNG

資料 8-1　カンボデイアの主要 4 系統の現行電気料金（リエル/kWh）

1. プノンペン（2000 年 9 月発効)

1) 住宅用：3 分類
- 月使用量 50kWh 以下　350
- 月使用量 50kWh　550
- 月使用量 100kWh 以上　650

2) 政府機関　700

3) NGO,外国人家庭、大使館　800

4) 商業用(ホテル、ゲストハウス、ナイトクラブ、店舗、銀行、会社事務所、等)及び産業・家内工業用：4 分類
- 月使用量 20,000kWh 以下　650
- 月使用量 20,000 ― 50,000kWh　600
- 月使用量 50,000kWh 以上　500
- 高圧受電 80,000kWh 以上　480

2. シアヌクビル（1999 年 2 月及び 7 月発効)

1) 住宅用：1 分類　500

2) 産業及び手工業用：4 分類
- 月使用量 20,000kWh 以下　670
- 月使用量 20,000 – 50,000kWh　670/610
- 月使用量 50,000 – 110,000kWh まで　670/560
- 月使用量 110,000kWh 以上　670/513

3) 商業用：4 分類
- 月当たり 20,000kWh まで　740
- 月当たり 20,000 – 50,000kWh　685
- 月当たり 50,000 – 110,000kWh まで　625
- 月当たり 110,000kWh 以上　570

4) ホテル及び外国人住宅用：4 分類
- 月当たり 20,000kWh まで　760
- 月当たり 20,000 – 50,000kWh　700
- 月当たり 50,000 – 110,000kWh まで　650
- 月当たり 110,000kWh 以上　610

5) 大使館、政府機関用：1 分類 760

3. **シアムリアップ**（1999 年 9 月発効）

- 月使用量 20,000kWh まで 875
- 月使用量 20,001 – 50,000kWh 735
- 月使用量 50,001 – 110,000kWh 670
- 月使用量 110,000kWh 以上 620
- 水道事業 740

4. コンポン・チャム（1999 年発効)

全種目一率 850 リエル/kWh の共通料金

資料　8-2　EdC の収支報告

1.　EdC 連結決算

1.1　バランス・シート

単位：千リエル

	2000		1999		1998
資産					
長期資産					
財産、機械、器具			458,743,268		401,949,507
コンピューターライセンス			51,742		71,146
小計			458,795,010		402,020,653
流動資産					
現金			9,763,663		7,022,377
受取勘定			53,773,685		30,531,593
在庫品			10,416,898		9,101,011
その他資産			8,991,647		120,084
小計			82,945,893		46,775,065
資産合計			541,740,903		448,795,718
負債及び自己資産					
長期負債					
長期借入金			225,011,847		165,397,416
据置交付金収入			1,340,420		1,473,650
小計			226,352,267		166,871,066
準備金			7,537,937		8,302,228
自己資産					
資本金			206,349,227		191,330,923
再評価余剰金			75,358,685		75,358,685
累積損金			(64,486,004)		(59,311,032)
小計			217,221,908		207,378,576
負債及び自己資産合計			541,740,903		448,795,718

注：EdC 監査済決算

1.2 収支勘定

単位：千リエル

項目	2000		1999		1998
総収入					
電力売上げ			147,934,370		113,526,394
接続費			13,038,080		4,211,410
材料販売			123,889		225,760
他のサービス			57,086		6,781
その他収入			407,847		450,009
合計			161,561,272		118,420,354
売上費用					
電力購入			75,777,028		59,536,242
燃料費			39,571,390		53,959,308
償却費			15,921,275		12,758,769
発電機貸借料			1,452,726		529,246
機器、消耗品費			4,639,156		1,284,126
その他費用			6,342,610		4,458,150
小計			143,704,185		132,525,841
運転費用					
償却費等			3,064,844		2,518,380
労務費			4,971,370		4,047,643
税金			5,984,090		7,775,949
その他費用			1,121,553		927,310
小計			19,224,481		31,753,975
その他費用			2,225,950		3,926,070
運転利益			(3,593,344)		(49,785,532)

注：EdC 監査済決算

2. シアムリアップ個別決算

2.1 バランス・シート

単位：千リエル

項目	2000		1999		1998
資産					
長期資産					
財産、機械、器具			28,181,505		7,509,275
コンピューターライセンス			25,383		34,901
小計			28,181,888		7,544176
流動資産					
現金			204,747		15,630
受取勘定			1,433678		1,008,165
保証預金			339,752		119,886
在庫品			254,090		86,228
その他資産			264,872		--
小計			2,497,139		1,229,909
全資産			30,704,027		8,774,085
負債及び自己資産					
長期負債					
据置交付金収入			1,340,420		1,473,650
長期借入金			18,003,545		265,638
小計			19,343,965		1,739,288
流動負債					
留保勘定			899,405		823,935
保証金			438,436		
留保税金			3,593		
小計			1,341,434		823,935
自己資産					
資本金			5,424,554		1,198,631
再評価余剰金			5,152,646		5,152,646
累積金			(558,572)		(140,415)
小計			10,018,628		6,210,862
負債及び自己資産合計			30,704,027		8,774,085

注：EdC 監査済決算

2.2 収支勘定

単位：千リエル

項目	2000		1999		1998
総収入					
電力売上げ	8,942,873		6,046,339		6,015,648
他のサービス	180,731		531,637		414
材料販売	--		6,220		890
その他収入	540,368		168,184		227,846
合計	9,663,972		6,752,380		6,244,798
売上費用					
燃料費	4,191,650		2,926,730		4,077,642
発電機貸借料	2,228,407		1,452,726		529,246
機器費	241,900		57,559		107,412
小計	6,661,957		4,437,015		4,714,300
運転費用					
償却費等	1,120,292		1,120,135		240,378
労務費	391,146		463,841		428,217
税金	85,893		23,902		11,100
その他費用	390,082		1,121,553		927,310
小計	1,987,413		2,729,431		1,607,005
費用合計	8,649,370		7,166,446		6,321,305
運転利益	1,014,602		(414,066)		(76,507)

注：1998 年と 1999 年分は監査済であるが、2000 年分は監査前のものである。

地質調査報告書

1-INTRODUCTION

For safety reason of construction, the soil under foundation should be investigated.

The main objectives of the soils investigations showed that the Engineer's method define type of foundations (Strip footing, mat foundation, foundation piers, and foundation piles...).

On 09Th June 2001, ***Research And Design Enterprise of Soil Testing Laboratory*** has been awarded a contract to undertake the soil investigation for **New Power Plani Project,** located at **Khum Chreal, Siem Reap District, Siem Reap Province, Kingdom of Cambodia.**

The field works have been carried out from 09th to 10th June 2001 and laboratory testing from 12th to 18th June 2001.

This report presents the ground conditions, mechanic of the soils, results of Standard Penetration Test (SPT) and field log recording.

2- SCOPE OF WORK

The scope of work for investigation included the following:

2.1-FIELD WORK

All field works activities were supervised by:

- Mr. KONG Sangva - Engineer of Geology
- Mr. SIENG Peou -Master Engineer of Geology

Two boreholes of 120mm nominal diameter and 20 m depths with Standard Penetration Test (SPT) where carried by rotary auger machine model **УГВ-50М** (Russian equipment) with a maximum capacity 35m depths.

The positions of boreholes are shown in the location plan (Figure 1).

2.2-STANDARD PENETRATION TEST (SPT)

Standard Penetration Test was carried out **1.50m** intervals inside the boring hole. A standard split spoons of **50.8**mm diameter with a ball check valve on the top and harden steel cutter. A Standard spilt spoon was installed and drives into the soil by a **63.5**Kg, automatic drop hammer falling freely from a fixed height of **760**mm along a guide rod.

The blow counts defined for each 150mm penetration of the seating drive. Total penetration of the spoon is **450mm** and the numbers of blow N-value for last **300mm**. Penetration was recorded as the **N**- value of the soil stratum encountered which indicated the relative density of non-cohesive soil as well the consistency of the cohesive soil.

2.3-SAMPLING

-Undisturbed samples

Undisturbed samples were taken in the natural state of the soil from **firm to stiff clay** and **sandy clay** for testing undrained direct shear test, unconfined compression test, consolidation test...The undisturbed samples were taken by thin wall tube sampler.

-Disturbed samples

The disturbed samples were taken at a rate of 1.5m to 3m and all strata in the borehole. The disturbed samples were also collected in soft to stiff clay and sandy soil for laboratory testing.

3- LABORATORY TESTING PROGRAM

The Laboratory Testing Program Included:

-Natural water contents determination

-Density and dry density determination

-Atterberg limit tests of selected cohesive soil or sandy sieving pass 425 micrometers

-Sieves distribution Test

-Unconfined compression Test

-Specific gravity Gs

The testing-procedure was conducted in accordance with **ASTM** Standard and classified soil by **USCS** (Unified Soil Classification System).

Mr. **SIENG PEOU** (Master engineer of geology) prepared this present report.

Summary of testing results was presented in the table *characteristic of Soil Mechanic*.

4- RELATIVE DENSITY AND CONSISTENCY

The relationship between Standard Penetration Test result and consistency clay, silt soil (Cohesive soil) and relative density for sandy soil (non-cohesive soil) are shown in the table No 1 and 2.

RELATION BETWEEN S.P.T RESULTS and CONSISTENCY

for CLAY, SILT, CLAYEY-SILT and SILTY-CLAY

(COHESION SOILS)

Table 1

S.P.T N Value (blows/ 300mm)	CONSISTENCY
2 to 4	Soft
4 to 8	Medium
8 to 15	Stiff
15 to 30	Very Stiff
30 over	Hard

RELATION BETWEEN S.P.T RESULTS and RELATIVE DENSITY

for SAND and GRAVEL.

(COHESIONLESS SOIL)

Table 2

S.P.T N Value (blows/ 300mm)	RELATIVE DENSITY
Less than 4	Very loose
4 to 10	Loose
10 to 30	Medium dense
30 to 50	Dense
Over 50	Very dense

5- GROUND CONDITION AND SOIL PROPERTIES

Ground condition from the ground surface to 20m depths for this site consisted of filling process of geology was in 4th Era (Young alluvium) by Geologic Map of Cambodia showing location of litho-logic section.

The soil condition encountered on boreholes have been into strata as follows:

BOREHOLE No 1

Stratum No	Description of soil strata	N-value blows/300mm
1-	Farm Soil, encountered from top to 0.50m depth.	
2-	Yellow white loose silty FINE SAND, encountered from 0.50m to 2.50m.	N-5
3-	Yellow white loose clayey FINE SAND, encountered from 2.50m to 3.70m.	N-6
4-	White grey clayey silty medium dense MEDIUM SAND, encountered from 3.70m to 5.30m.	N-11
5-	White grey clayey silty loose COARSE SAND, encountered from 5.30m to 7.00m.	N-4
6-	White grey clayey silty loose FINE SAND, encountered from 7.00m to 9.80m.	N-5 N-6
7-	White grey medium dense clayey MEDIUM SAND, encountered from 9.80m to 12.80m.	N-13 N-10
8-	White grey medium dense clayey silty FINE SAND, encountered from 12.80m to 15.50m.	N-24 N-27
9-	White grey clayey medium dense FINE SAND, encountered from 15.50m to 20.00m.	N-19 N-23 N-30

BOREHOLE No 2

Stratum No	Description of soil strata	N-value blows/300mm
1-	Farm Soil encountered from top to 0.50m depth.	
2-	Yellow white very loose clayey silty MEDIUM SAND, encountered from 0.50m to 4.00m.	N-1 N-1
3-	White grey clayey medium dense MEDIUM SAND, encountered from 4.00m to 5.00m.	N-13
4-	White grey clayey silty loose MEDIUM SAND, encountered from 5.00m to 6.50m.	N-8
5-	White grey clayey loose FINE SAND, encountered from 6.50m to 11.50m.	N-7 N-6 N-5
6-	White grey medium dense clayey MEDIUM SAND, encountered from 11.50m to 12.60m.	N-13
7-	White grey clayey silty medium dense FINE SAND, encountered from 12.60m to 20.00m.	N-25 N-16 N-24 N-24 N-23

6-GROUND WATER CONDITION

The investigation of the ground water is one of importance for soil investigation, because the variation of the ground water level, the characteristic of soil mechanic can be change.

The ground water is divided into two kinds and two seasons:

6.1-Water strikes and Ground water level

-During boring activities, water is found at a greater depth (**Water strike**).

-But a few hours or 24 hours after the boring completed, water is stabilized at a higher level (**Ground water level**).

6.2-The ground water by season

The ground water varies according to the season:

-In dry season the ground water level is **decrease**.

-In rainy season the ground water level is **increase**.

Table No 3

Borehole No	Boring started date	Boring finished date	Water strike (m.)	Water level (m.)	Date measured
BH-1	09/06/2001	09/06/2001	3.00	0.50	10/06/2001
BH-2	10/06/2001	10/06/2001	1.00	0.50	10/06/2001

6.3-Ground Water analysis

Results of Ground Water analysis show in table No 4.

Table No 4

Item	Unit	Amount	Standard
		BH-1	
pH	-	5.07	6.5 to 8.5
SO4	mg/l	8.376	25 to 500
Cl	mg/l	1.403	25 to 350
Na	mg/l	2.989	150 to 200

7-CONCLUSION AND RECOMMENDATION

Based on the soil data from 2 boring holes, the following recommendation can be presented:

1-For this project ***pile foundation*** should be recommended.

2-The allowable bearing load for pile foundation was presented in the Table No 5.

TABLE No 5

Borehole No	Pile size	Pile depth	Pile length	End bearing capacity	End bearing load	Friction load	Allowable bearing Load
	(m^2)	(m)	(m)	(kN/m^2)	(KN)	(KN)	(KN)
BH-1	0.20x0.20	4.50	4.00	1100	44	10.56	54.56
BH-1	0.30X0.30	13.50	12.00	1834	165.11	62.10	227.21
BH-2	0.20x0.20	4.50	4.00	1300	52.0	4.0	56.0
BH-2	0.30x0.30	13.5	12.00	1881	169.34	56.19	225.53

Phnom Penh, June 20, 2001

Master engineer of Geology

Mr. SIENG PEOU

8- GENERRAL

The analysis and recommendation submitted in this report are based on available information. Since significant variations in soil conditions may occur between the boring, it is recommended that pile experienced soil engineer to assure that the bearing capacity conform to the design and specifications.

The suggestion and recommendation herein are based on available data obtained from limited specified soil information, the homogeneity of soil formation assumption, and equations involved in the calculation, which are believed to be reliable. However, such prediction or recommendations should be verified by full-scale test of investigation during construction period to obtain more precise reliable data. Construction method must be adopted to best suit the analysis method assumption .We do not make any representations as to its accuracy or completeness .Any, data or design criterion is only current solutions which are subjected to change or revise.

This report has been prepared in order to aid in the evaluation of the site conditions only, to assist the engineer in the design of the project, based on our understanding of the design details, criteria & utilization of the project as outlined herein. If our understanding of the design and utilization is not correct, we should be promptly informed of the correct data so that we may revise our recommendations as appropriate.

RESEARCH AND DESINGN ENTERPRISE

SOIL TESTING LABORATORY

FIELD BORING LOG

SITE : New Power Plan Siemreap(Phum Kna Khum Chreal) | EQUIPMENT rotary auger | SHEET 1 | DATE : 09.06.2001

ELEVATION : | BOREHOLE N° 1

DEPTH (m)	SAMPLE N°	DIST SAMPLE	UNDIST SAMPLE	DESCRIPTION OF STRATA	DEPTH & THICK	LEGEND of SOIL	S.P.T (N) N/150mm No	N1	N2	BLOWS/300mm N	N values 10 20 30 40 50	Testing interval (M)	RECOVERY RATIO (MM)
				Farm Soil	0.50								
1					0.50								
2	1	D	-	Yellow white loose silty FINE SAND	2.00		1	1	4	5		1.5to1.45	350/450
3	2	D	-	Yellow white loose clayey FINE SAND	2.50 1.20		1	2	4	6		3.0to3.45	360/450
4					3.70								
5	3	D	-	White grey clayey silty medium dense MEDIUM SAND	1.60		2	5	6	11		4.5to4.95	300/450
6					5.30								
7	4	D	-	White grey clayey silty loose COARSE SAND	1.70		1	1	3	4		6.0to6.45	200/450
8	5	D	-	White grey clayey silty losse FINE SAND	7.00		1	2	3	5		7.5to7.95	40/450
9	6	D	-		2.80		2	3	3	6		9.0to9.45	140/450
10					9.80								
11	7	D	-	White grey medium dense clayey MEDIUM SAND	3.00		4	7	6	13		10.5to10.95	170/450
12	8	D	-				3	5	5	10		12to12.45	240/450
13					12.80								
14	9	D	-	White grey medium dense clayey silty FINE SAND	2.70		17	14	10	24		13.5to13.95	80/450
15	10	D	-				8	11	16	27		15to15.45	240/450
16	11	D	-	White grey clayey medium dense FINE SAND	15.50								
17							5	9	10	19		16.5to16.95	100/450
18	12	D	-		4.50		5	11	12	23		18.to18.45	90/450
19													
20	13	D	-		20.00		6	12	18	30		19.5to19.95	80/450

FIGURE 3

LEGEND

D- disturbed sample
U- Undisturbed sample.
W- water sample .
Ground water after boring 0.5m
W.S-water strike 3.0m

STARTED :09.06.2001

FINISHED :09.06.2001

N <2 very soft , 2<N <4 soft
4<N <8 medium , 8<N < 15 stiff
15<N < 30 very stiff , N>30 hard

0<N <4 very loose , 4<N<10 loose
10<N <30 medium dense
30<N <50 dense , N>50 very dense

RESEARCH AND DESINGN ENTERPRISE

SOIL TESTING LABORATORY

FIELD BORING LOG

SITE : New Power Plan Siemreap(Phum Kna Khum Chreal)

EQUIPMENT: rotary auger

SHEET: 1

DATE : 10.06.2001

ELEVATION :

BOREHOLE N° 2

DEPTH (m)	SAMPLE N°	DIST SAMPLE	UNDIST SAMPLE	DESCRIPTION OF STRATA	DEPTH & THICK	LEGEND of SOIL	S.P.T (N) N/150mm No	N1	N2	BLOWS/300mm N	N values 10 20 30 40 50	Testing interval (M)	RECOVERY RATIO (MM)
				Farm Soil	0.50								
1					0.50								
	14	D	-				1	0.5	0.5	1		1.5to1.45	450/450
2				Yellow white very loose clayey silty MEDIUM SAND	3.50								
3							1	0.5	0.5	1		3.0to3.45	350/450
	15	D	-										
4					4.00								
	16	D	-	White grey clayey medium dense MEDIUM SAND	1.00		4	7	8	13		4.5to4.95	230/450
5					5.00								
	17	D	-	White grey clayey silty loose MEDIUM SAND	1.50		3	5	3	8		6.0to6.45	220/450
6					6.50								
7													
	18	D	-				2	3	4	7		7.5to7.95	120/450
8													
9	19	D	-	White grey clayey losse FINE SAND	5.00		2	3	3	6		9.0to9.45	90/450
10													
	20	D	-				2	2	3	5		10.5to10.95	130/450
11					11.50								
12	21	D	-	White grey medium dense clayey MEDIUM SAND	1.10		2	7	8	13		12to12.45	110/450
13					12.60								
	22	D	-				6	11	14	25		13.5to13.95	240/450
14													
15	23	D	-				4	6	10	16		15to15.45	110/450
16	24	D	-	White grey clayey silty medium dense FINE SAND	7.40								
17							4	10	14	24		16.5to16.95	100/450
	25	D	-										
18							6	10	14	24		18.to18.45	100/450
19													
	26	D	-				9	11	12	23		19.5to19.95	160/450
20					20.00								

FIGURE 4

LEGEND

D- disturbed sample

U- Undisturbed sample.

W- water sample .

Ground water after boring 0.5m

W.S-water strike 1.0m

STARTED :10.06.2001

FINISHED :10.06.2001

N <2 very soft , 2<N <4 soft

4<N <8 medium , 8<N < 15 stiff

15<N < 30 very stiff , N>30 hard

0<N <4 very loose , 4<N<10 loose

10<N <30 medium dense

30<N <50 dense , N>50 very dense

RESEARCH AND DESIGN ENTERPRISE

SOIL TESTING LABORATORY

Date 17/06/01

Sheet No 1

SUMMARY OF LABORATORY TESTING RESULTS

BOREHOLE No 1

Project name: New Power Plan Siem Reap.

Site: Siem Reap Province.

SAMPLE	DEPTH		DESCRIPTION OF STRATA	WATER CONTENT	ATTEBERG	LIMIT	PLASTIC INDEX	LIQUITY INDEX	DENSITY	OF SOIL	PARTICAL SIZE DISTRIBUTION			UNDRAINED SHEAR STRENGTH				SPECIFIC GRAVITY	SOIL CLASS	Void ratio	CONSOLIDATION			SPT
														DIRECT SHEAR		UNCONFINED COMPRESSION	POCKET PENETRATION							
No	From	to		W	L.L	P.L	IP	IL	B.D	D.D	M&C	Sand	Gravel	C	ϕ	Qu/2	Qp/2	Gs		e	CV	MV	K	N-Value
	(M).			%	%	%	-	-	KN/m³	KN/m³	%	%	%	kN/m²	Degree.	kPa	kPa				m²/s	m²/MN	m/s	blows
-	0.00	0.50	Farm soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	0.50	2.50	loose silty fine sand	12.51	-	-	-	-	14.22	16.00	23.05	76.95	-	-	26	-	-	2.70	SM	0.90	-	-	-	5
2	2.50	3.70	Loose clayey fine sand	16.07	20.60	12.08	8.49	-	14.64	17.00	30.04	69.96	-	-	26	-	-	2.69	SC	0.83	-	-	-	6
3	3.70	5.30	Clayey silty medium dense	15.28	24.00	17.96	6.01	-	15.61	18.00	12.51	87.49	-	-	29	-	-	2.70	SM	0.73	-	-	-	11
			medium sand																SC					
4	5.30	7.00	Clayey silty loose coarse sand	17.70	20.40	15.73	4.71	-	13.59	16.00	13.79	86.21	-	-	26	-	-	2.70	SM	0.98	-	-	-	4
																			SC					
5	7.00	9.80	Clayey silty loose fine sand	16.34	19.90	14.20	5.66	-	13.75	16.00	27.60	72.40	-	-	26	-	-	2.70	SM	0.96	-	-	-	5
6																								6
7	9.80	12.80	Clayey medium dense medium	13.58	23.00	14.43	8.56	-	15.84	18.00	21.24	78.76	-	-	30	-	-	2.68	SC	0.69	-	-	-	13
8			sand																					10
9	12.80	15.50	Clayey silty medium dense	12.13	20.30	13.77	6.51	-	17.83	20.00	34.80	65.20	-	-	31	-	-	2.68	SM	0.50	-	-	-	24
10			fine sand																SC					27
11																								19
12	15.50	20.00	Clayey medium dense fine sand	16.91	29.50	16.93	12.58	-	16.25	19.00	34.54	65.46	-	-	32	-	-	2.69	SC	0.65	-	-	-	23
13																								30

GEOTECHNICAL ENGINEER

SIENG PEOU

RESEARCH AND DESIGN ENTERPRISE
SOIL TESTING LABORATORY

Date 17/06/01
Sheet No 1

SUMMARY OF LABORATORY TESTING RESULTS

BOREHOLE No 2

Project name: New Power Plan Siem Reap.
Site: Siem Reap Province.

SAMPLE	DEPTH		DESCRIPTION OF STRATA	WATER CONTENT	ATTEBERG				DENSITY		PARTICAL SIZE			UNDRAINED SHEAR STRENGTH				SPECIFIC GRAVITY	SOIL CLASS		CONSOLIDATION			SPT
											DISTRIBUTION			DIRECT SHEAR		UNCONFINED COMPRESSION	POCKET PENETRATION							
No	From	to		W	L.L	P.L	IP	IL	B.D	D.D	M&C	Sand	Gravel	C	ϕ	Qu/2	Qp/2	Gs		e	CV	MV	K	N-Value
	(M).			%	%	%	-	-	KN/m³	KN/m³	%	%	%	kN/m²	Degree.	kPa	kPa				m²/s	m²/MN	m/s	blows
-	0.00	0.50	Farm soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	0.50	4.00	Very loose clayey silty	15.38	18.90	12.07	6.79	-	11.26	13.00	22.69	77.31	-	-	25	-	-	2.68	SM	1.37	-	-	-	1
15			medium sand																SC					1
16	4.00	5.00	Clayey medium dense medium sand	16.78	26.40	15.35	11.08	-	15.41	18.00	30.05	69.95	-	-	30	-	-	2.69	SC	0.74	-	-	-	13
17	5.00	6.50	Clayey silty loose medium sand	15.96	29.70	16.28	4.37	-	14.66	17.00	15.80	84.20	-	-	28	-	-	2.68	SM	0.83	-	-	-	8
																			SC					
18																								7
119	6.50	11.5	Clayey silty loose fine sand	14.91	21.60	12.10	9.44	-	14.79	17.00	30.69	69.31	-	-	27	-	-	2.70	SC	0.82	-	-	-	6
20																								5
21	11.50	12.6	Clayey medium dense medium sand	13.19	21.90	13.18	8.70	-	15.90	18.00	22.64	77.36	-	-	30	-	-	2.70	SC	0.70	-	-	-	13
22																								25
23																								16
24	12.60	20.0	Clayey silty medium dense	14.21	20.30	14.55	5.72	-	16.63	19.00	32.23	67.77	-	-	32	-	-	2.69	SM	0.61	-	-	-	24
25			fine sand																SC					24
26																								23

GEOTECHNICAL ENGINEER

SIENG PEOU

環境評価報告書

環境評価報告書（要約）

カンボディアでは 1996 年に環境法が施行されて、環境省が発足した。全ての環境影響評価は環境省の監督下で行うよう規制されている。この法律の細則に従って、MINE 及び EdC は環境評価委員会を設置している。

ディーゼル発電所では騒音、振動、地下水汚染、大気汚染等の公害が懸念される。発電計画の環境評価は、環境法付則“ 発電プラントの環境影響評価（EIA）報告のガイドライン ”に従って行う必要がある。

発電所予定地は、シアムリアップ市の中心部から 3.5km ほど離れており、また国道からも離れている、周辺には人家もない荒地である。また、動植物体系についても、カンボディア国では、国際機関によって登録されている絶滅危惧種が数 10 種類生息していると言われているが、周辺を調査した限りでは、周囲 3km 以内において、野生動物の生息や生息場所は確認されなかった。

ディーゼル発電所は機関を冷却する、冷却水を必要とするが、発電所予定地の周辺には恒久的な水道設備あるいは河川もない。従って、本計画では、冷却水として井戸を掘削して地下水を使用するものとする。尚、冷却システムもラジエター循環方式を採用するなどして、水の使用量も最小限（1 日あたりの使用量 200～300 リッター）に抑えられるように配慮している。また発電所からの排水処理についても、オイル-水の分離槽を設置するように設計しており、発電所周辺の水資源の汚染防止には最大限に配慮している。

以上により、周辺地域の社会環境に影響を及ぼす事はほぼ無いと考えられる。従って、具体的に環境への影響を詳細に検討しなければならないものは、発電所運転によるⅰ)排出ガスに含まれる窒素酸化物（NO2）および硫黄酸化物（SO2）による大気への影響、ⅱ)騒音レベルおよび振動レベルの 4 項目となる。

ⅰ)NO2 および SO2 による大気への影響

NO2 および SO2 の発生現からの距離とその着地濃度を予想する式として、一般にサットンの式が使われる。それによる検討の結果、NO2 および SO2 の着地濃度が最大になる場所は発電所より風下方向 1167m において発生し、その着地濃度と国の基準を比較した結果を以下に示す。

NO2 および SO2 の着地濃度

カンボディアの許容濃度基準		**プロジェクト予想値**
NO2	0.300mg/m^3	0.0274mg/m^3
SO2	0.500mg/m^3	0.0200mg/m^3

上記より、NO2 および SO2 の、いずれも着地濃度もカンボディアの基準を満たしていることが分かる。

ⅱ)騒音レベルおよび振動レベル

騒音レベルについて、音源となるディーゼル発電機より 100m 離れた直近の人家がある場所にて騒音レベルを予想したところ、49.9dB(A)となる。この数値は一般的には静かな事務所並の音量と定義されている。

振動についても震源となるディーゼル発電機より 100m 離れた人家がある場所にて、振動値を予想したところ、39.1dB(A)となる。この数値は一般的には人が感知出来るような振動では無いと定義されている。以上より騒音および振動レベルについては全く問題の無いことが分かる。

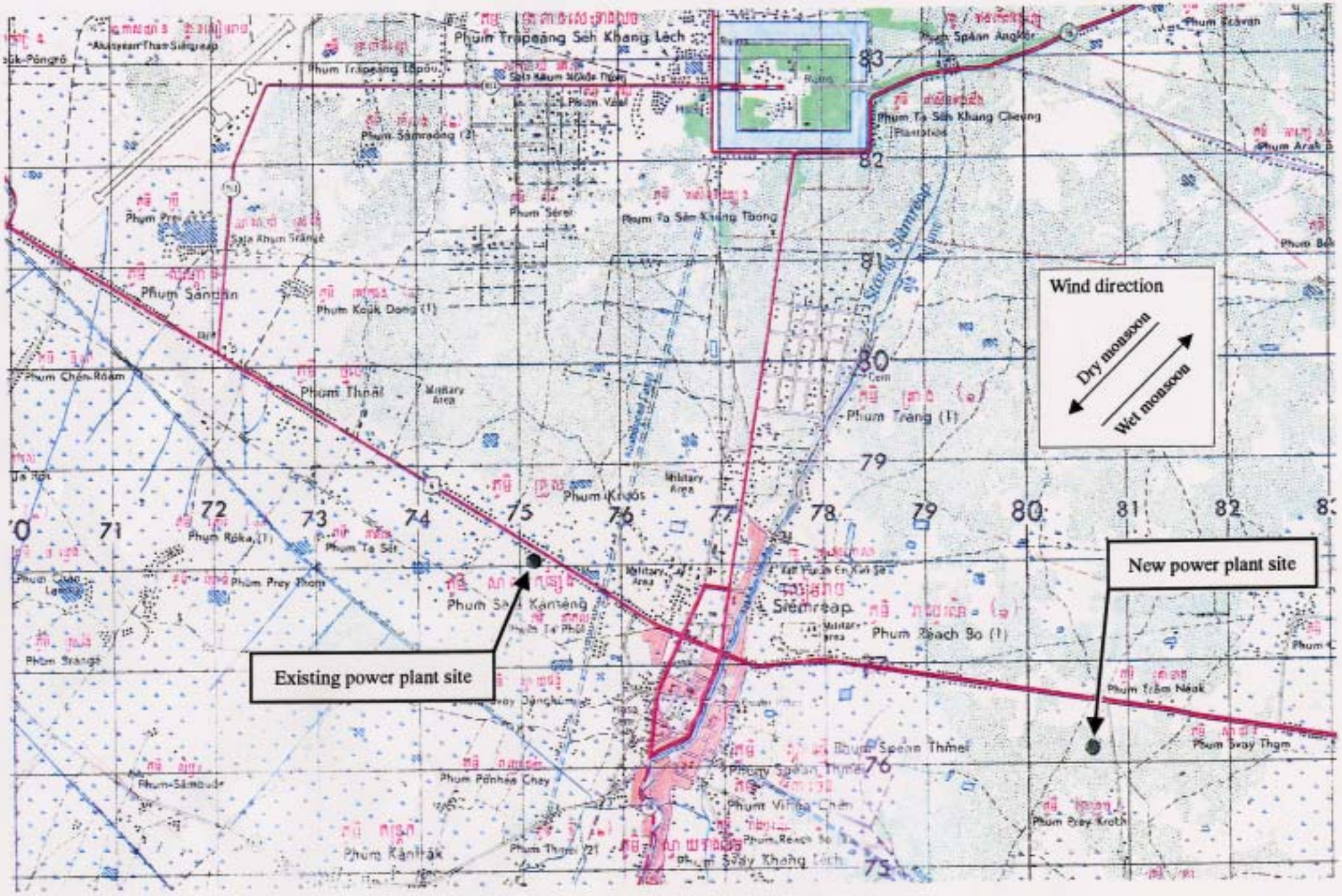
以上の考察結果から、本ディーゼル発電所建設による環境への影響は、ほとんど無いものと言える。

BASIC DESIGN STUDY
ON
THE PROJECT FOR SIEM REAP GENERATING FACILITIES
IN
THE KINGDOM OF CAMBODIA

ENVIRONMENTAL STUDY REPORT

OCTOBER 2001

Location Map of the Project Site



CONTENTS

1. General

The Japan International Cooperation Agency (JICA) conducted, upon a request of the Government of Cambodia (GOC) to the Government of Japan (GOJ), a Master Plan Study on the Rehabilitation and Reconstruction of Electricity Supply in Phnom Penh and Siem Reap in 1993 and a Feasibility Study for the urgently required power generation and distribution facilities identified in the Master Plan.

On the basis of the study results, GOC requested grant aid from GOJ for the project for rehabilitation and upgrading of electricity supply facilities in Phnom Penh. The project was conducted under two grant aid projects from GOJ in 1995/1996 for the project phase-I and in 1999 for the project phase-II to be completed in 2002.

Besides GOC requested Grant Aid from GOJ for the Project for Siem Reap Generating Facilities in 2000.

In response to the official request, GOJ decided to conduct a Basic Design Study to examine the viability of the Project. JICA dispatched a Basic Design Study Team in May 2001 to Cambodia. The team surveyed the Project area, collected relevant data and information for the formation of the Basic Design and discussed technical aspects of the Project with the officials of authorities concerned.

1.1 Project Description

The Project for Siem Reap Generating Facilities (the Project) aims to construct;

i) a diesel power plant having total installed capacity 10.5 MW in Siem Reap with 3-units of 3,500 kW each, 2-units for regular operation and 1-unit for standby, and

ii) 22 kV underground transmission line of 1.2 km in length to connect the new diesel power plant with the existing Siem Reap distribution network.

The project site is located in the Developing Area specified in the Siem Reap City Plan prepared in 2000.

The power plant site is about 4 km east of Siem Reap city, the provincial capital of Siem Reap province, by road, which is close to the National Route No.6 that links Phnom Penh (285 km away) to Thailand (150 km away). And the most famous building Angkor Wat is 8 km northwest of the plant site.

The location map of the project site is given in the Appendix.

1.2 Rationale of the Environmental Study

The Project is not likely to cause significant impacts on the environment in and around the project area considering its development component, scale, and location. However, an Environmental Study will be required, because it has project components which may bring about adverse environmental impacts on the natural and social environment, such as installation of diesel engine unit.

Consequently, the Environmental Study (the Study) is conducted in an Initial Environmental

Impact Assessment level by focusing on one project component which might bring about adverse environmental impacts, namely the construction of a diesel power plant having total installed capacity 10.5 MW in Siem Reap

1.3 Objectives and Strategies

The principal objectives of the Study are to clarify environmental impacts caused by the diesel power plant construction in Siem Reap, to evaluate those magnitudes, and to propose countermeasures, if any. This result shall provide necessary data and information for formulation of environmentally sound project design and guide a way to cope with possible impacts for implementation of the Project.

To attain the objectives mentioned above, the following strategies are taken in the Study:

- to collect and review relevant data and documents related to environmental aspects of the Project including laws and regulations concerned in Cambodia,
- to carry out a field reconnaissance in the existing and potential project sites for checking environmental sensitivity of the Project,
- to evaluate the magnitude of impacts preliminarily and to prepare the study report.

1.4 National Policy on the Environment in Cambodia

The Government of Cambodia issued “The Law on Environmental Protection and Natural Resource Management” on January 1997.

The purposes of the law are:

- to protect [and] promote environmental quality and public health though the prevention, reduction, and control of pollution
- to assess the environmental impact of all proposed projects prior to the issuance of a decision by the Royal Government
- to ensure the rational and sustainable conservation, development, management, and use of the natural resources of the Kingdom of Cambodia
- to encourage and enable the pubic to participate in environmental protection and natural resource management
- to suppress any acts that cause harm to the environment

The environmental study is carried out based on the above Law.

2. Initial Environmental Study

2.1 Environmental Items to be Studied

Although a lot of environmental items could be picked up in accordance with the Law on Environmental Protection and Natural Resource Management for Project, most of them would not be necessary or not have significant impact due to the specific conditions of the Project in

Siem Reap.

The followings are the key points for selection of environmental items to be studied in Environmental Impact Assessment.

(1) Meteorology

The climate of the area is strongly monsoonal. The cooler dry northeast monsoon (November to March) follows after the southwest monsoon with higher winds, and humilities and most of year's rainfall. Daily mean temperatures at the Project site range from about 24 in December and January to 29 in April. Average annual rainfall is about 1400 mm.

(2) Topography and geology

The power plant site is on plains between Lake Tonle Sap (10 km to the south) and the national route No.6 some 400 m to the north.

The power plant site is located in the Development Area classified in the Siem Reap City Plan.

The plains undulate gently, ranging in elevation from 9-10 meters. The soil at and around the power plant site are alluvial silts, sand and clays deposited by flood waters from adjacent rivers an Lake Tonle Sap. Groundwater levels around the power plant site are generally high and fluctuate from close to the surface in the wet season to about 4 meter below in the dry season.

Necessary acreage of the diesel power plant would be about 19,685 m^3, with plant trees area of 20 m wide around the area. The land area of new power plant is an uncultivated field. No there are houses and other obstacles in the area. Thus, displacement of the local peoples and houses are not required for the project. This means that the environmental impacts related to the project location would not be significant, and the Project is not situated in an environmentally sensitive area.

Besides, the power plant site is at an enough distance from the main roads and houses in the vicinities. So, the environmental impacts during the construction stage could be in minimum, and no serious adverse effects are expected.

(3) Underground water

There is no permanent water supply system and body in the vicinity of the power plant site. The Project will provide a water supply system by means of a deep well pumping system in the power plant site.

Diesel power plant to be installed by the Project is a open type generator with a closed circulation radiator type cooling system. Consequently, little amount (200 - 300 litters/day) of water will be used for cooling purpose. All drainage water from the power plant should be corrected to the oil-water separator pit for processing to separate oil from water.

Therefore, water quality pollution and impact on the social environmental in the surrounding of the power plant will not be expected by the operation of the power plant.

(4) Flora and Fauna

There are rich fisheries in Lake Tonle Sap, but only very poor ones in the rice fields and irrigation canals around the Project area. The wildlife around the Project area has never been studied in detail. However, about 100 mammals and 400 bird species inhabit the general area. A number of these are on international endangered species list (17 species of endangered mammals and 24 species of endangered birds, none of which been recorded in the close vicinity of the Project area). There are no natural or near natural forests within 3 km of the Project area.

Considering the given conditions mentioned above and a general project feature, it is considered that the Project is not environmentally sensitive. The possible environmental impacts to be studied are eventually four items during the operation stage, namely;

i) Air pollution by NO_2,

ii) Air pollution by SO_2,

iii) Noise, and

iv) Vibration.

2.2 Results of Initial Environmental Examination

2.2.1 Air pollution by NO_2 and SO_2

A diesel power plant with total installed capacity of 10.5 MW (3,500 kW x 2 unit for regular operation and 1 unit for standby), will be installed in the area of the new power plant in Siem Reap. The future NO_2 and SO_2 concentration is predicted by Sutton's formula as shown in Table-1.

(1) Prediction of NO_2

Air quality standards of NO_2 concentration in Japan, USA and Cambodia shown below. The maximum ground concentration of NO_2 would appear at the point of 1,116 m apart from the pollution source as shown in Table-2 and summarized below.

(One hour mean value)

Air Quality Standards		Predicted Value
Japan	0.082-0.123 mg/m^3	0.0274 mg/m^3
USA	0.102 mg/m^3	
Cambodia	0.300 mg/m^3	

NO_2 concentration is expected to increase about 0.0274 mg/m^3 by the Project. The predicted NO_2 value would be fairly below compared with these standards. The background NO_2 level around the project site is considered as a natural condition because there are no large scale point sources of air pollution. Thus, no significant environmental impact on air quality would be expected by NO_2 emission from the power plant.

(2) Prediction of SO_2

Air quality standards of SO_2 concentration in Japan, USA and Cambodia shown below. The maximum ground concentration of SO_2 would appear at the point of 1,116 m apart from the pollution source as shown in Table-2 and summarized below.

(One hour mean value)

Air Quality Standards		Predicted Value
Japan	0.114 mg/m^3	0.0200 mg/m^3
USA	0.362 mg/m^3	
Cambodia	0.500 mg/m^3	

SO_2 concentration is expected to increase about 0.0200 mg/m^3 by the Project. The predicted SO_2 value would be fairly below compared with these standards. The background SO_2 level around the project site is considered as a natural condition because there are no large scale point sources of air pollution. Thus, no significant environmental impact on air quality would be expected by SO_2 emission from the power plant.

2.2.2 Noise caused by the Operation of Diesel Power Generator

(a) Prediction Point

Two prediction points of noise are set on a line from the noise source (newly installed power plant) to a boundary of the plant site (about 60 m in distance) and other is the nearest house (about 100 m in distance) as shown in Table-3.

(b) Noise Level of the Power Plant

According to the general specification of a diesel power plant with capacity of regular operation (3,500 kW x 2 units), its noise level is 97.9 dB compounded with exhaust gas outlet, intake air filter, and radiator at the adjacent place of a plant as shown in Table-3.

(c) Prediction Noise Level

The prediction noise level at the prediction points by the operation of power plant is shown in Table-3 and summarized below:

	Noise Level (dB(A))		
Noise Source	Plant Site	Site Boundary (60 m)	Nearest House (100m)
Power Plant	97.9dB(A)	54.3 dB(A)	49.9dB(A)

(d) Evaluation

The future noise level caused by the operation of the newly installed power plant is assessed about 54.3 dB(A) at the site boundary and 49.9 dB(A) at the nearest house. It should be noted that the actual future noise level could be less than those of predicted level, because the existence of administration office, oil tanks, plant tree area and ground undulation in the

project site will reduce the noise level.

Table-5 shows general criteria related to noise. The assessed noise level could be almost a background noise level in common residential area. Moreover, no facilities which require calm conditions such as school, hospitals, and libraries are situated around the power plant site.

Therefore, relatively low magnitude of impact would be expected by the operation of the installed power plant.

2.2.3 Vibration caused by the Operation of Diesel Power Generator

(a) Prediction point

Vibration basically considered an annoying source for human which has the same origin and characteristic as noise. Therefore, the prediction of vibration level caused by the newly installed power plant is conducted taking similar approach used for the noise level prediction. Thus, the prediction point of vibration is the nearest house the same as noise (about 100 m in distance from Power plant).

(b) Vibration level of the Power Plant

The prediction result of vibration level at the prediction points by the operation of power plants is show in Table-4 and summarized below:

Noise Source	Plant Site	Site Boundary	Nearest House (100m)
Power Plant	83.0dB(A)	25.2 dB(A)	39.1dB(A)

(c) Evaluation

Table-6 shows general criteria related to vibration. The vibration level at the prediction points is very low, and these vibration values would be negligible for the most person. Therefore, no serious impact is expected by the operation of the newly installed diesel power plant.

3. Conclusion and Recommendation

3.1 Conclusion

Displacement of the local peoples and houses in the project area are not required. Water quality pollution and impact on the social environmental in the surrounding of the power plant will not be expected by the operation of the power plant as discussed in Section 2.1.

Minimal impacts are predicted during the project construction, provided that good construction standards and procedure are adopted under the contractual guarantees with contractors.

Eventually, four environmental items, namely i) NO_2, ii) SO_2, iii) Noise, and iv) Vibration, are selected as the principal subjects to be studied carefully considering feature and location of the Project.

The Environmental Study of the selected four items revealed that relatively low magnitude of impacts would be expected and no significant impacts be caused by the Project. Moreover, no complaints related to the environment could be found through the inquiry survey to the local people who live around the existing plant. Therefore, the Project is judged acceptable and no mitigation measure is required from the environmental viewpoints, conclusively at this stage.

3.2 Recommendation

Since no actual data of air quality, noise, and vibration are available in this Study, the verification of prediction results is crucial. To monitor and check the assessed values surely contributes to improve an assessment method in accuracy and to strengthen an environmental management capability of EDC's staff.

Table – 1 Calculation of Pollution Intensity of NOx and SOx

A diesel power plant with 10.5 MW (3,500 kW x 2 units for regular operation and 1 unit for standby) will be installed in the area of the new power plant in Siem Reap

Output	: 3,500kW/unit
Fuel consumption	: 189 g/kWh (Heavy oil)
Sulfur content	: 2 %
Intensity of the pollution source (Nm^3/s)	: 22,500Nm^3／h（wet）、21,300Nm^3／h（dry）
Height of emission outlet	: GL+15m,750A(ID=753mm)

The future NOx and SOx concentration is predicted by following Sutton's formula;

$$C(X)= (2Q/(\pi \cdot C_y \cdot C_z \cdot U \cdot x^{2-n})) \exp(-He^2/(Cz^2 \cdot x^{2-n})) \cdot 10^6$$

where

C(X)	:	Ground surface concentration at a point of X (m) apart from the pollution source (ppm),
x	:	Distance of leeward direction (m),
Q	:	Intensity of the pollution source (m^3/s),
U	:	Wind velocity (m/s), (applied 6.0 m/s),
Cz, Cy, n	:	Sutton's concentration parameter, Cz=0.07, Cy=0.07/0.15, n=0.25
He	:	Effective height of emission outlet (m), (applied 32.6m)

He = Ho+0.65(Hm+Ht)

Hm = $0.795\sqrt{Q'} \cdot V／(1+2.58／V)$

Ht = $2.01\times10^{-3}\times Q'\times(T-288)\times(2.30\log(J)+1/J-1)$

J = $1／\sqrt{Q'} \cdot V \cdot (1460－296V／(T-288))+1$

Ho : Actual height of emission outlet(m), (15m)

Q' : Intensity of the pollution source (15℃1atm,m^3/s),

V : Ex.Gas Velocity

thus

V = $22,500\times1／3600\times(273+365)／273／(\pi／4\times0.753^2)$
= 32 [m/s]

Q' = $22500\times1／3600\times288／273$
= 6.59 [m^3/s]

J = $1／\sqrt{6.59 \cdot 32} \cdot (1460-296\times32／(273+365-288))+1$
= 98.7

Hm = $0.795\times\sqrt{6.59 \cdot 32}／(1+2.58/32)$
= 10.6 [m]

Ht = $2.01\times10^{-3}\times6.59\times(273+365-288)\times(2.30\log98.7+1／98.7-1)$

$= 16.6$ [m]

He $= 15+0.65\times(10.6+16.6)$

$= 32.6$ [m]

Q $= 500\times10^{-6}\times21{,}300\times1/3600\times288/273$

$= 3.12\times10^{-3}$ [m^3/s] (SOx)

Q $= 950\times10^{-6}\times21{,}300\times1/3600\times288/273$

$= 5.93\times10^{-3}$ [m^3/s] (NOx)

Max ground surface concentration is calculated as follows:

Cmax : Max ground surface concentration

$= 1.72\times Q''/He^2$ [ppm]

Xmax : Distance between at a point of max ground surface concentration and the pollution source

$= 20.8\times He^{1.143}$ [m]

thus

SOx : Cmax $= 1.72\times21{,}300\times500\times10^{-6}/32.6^2$

$= 0.0172$ [ppm] $= 0.0491$ [mg/m^3]

NOx : Cmax $= 1.72\times21{,}300\times950\times10^{-6}/32.6^2$

$= 0.0327$ [ppm] $= 0.0672$ [mg/m^3]

Xmax $= 20.8\times32.6^{1.143} = 1116$ [m]

Above ground surface concentration show 3 minutes mean concentration. So one (1) hour mean concentrations are shown below;

Cmax(SOx 1hour) $= 0.0200$[mg/m^3]at 15℃

Cmax(NOx 1hour) $= 0.0274$[mg/m^3]at 15℃

The result of prediction is indicated in Table.2.

Table 2 (1)

Distance	Ground surface concentration			
X	NOx		SOx	
m	ppm	mg/m^3	ppm	mg/m^3
100	0.0000	0.0000	0.0000	0.0000
200	0.0000	0.0000	0.0000	0.0000
300	0.0000	0.0001	0.0000	0.0001
400	0.0013	0.0026	0.0007	0.0019
500	0.0060	0.0124	0.0032	0.0091
600	0.0134	0.0276	0.0071	0.0202
700	0.0208	0.0426	0.0109	0.0312
800	0.0264	0.0542	0.0139	0.0397
900	0.0301	0.0617	0.0158	0.0452
1000	0.0320	0.0657	0.0168	0.0481
1100	0.0327	0.0671	0.0172	0.0491
1116	0.0327	0.0671	0.0172	0.0491
1200	0.0325	0.0667	0.0171	0.0488
1300	0.0317	0.0651	0.0167	0.0476
1400	0.0306	0.0628	0.0161	0.0459
1500	0.0293	0.0601	0.0154	0.0440
1600	0.0279	0.0572	0.0147	0.0419
1700	0.0264	0.0543	0.0139	0.0398
1800	0.0251	0.0515	0.0132	0.0377
1900	0.0237	0.0487	0.0125	0.0356
2000	0.0224	0.0460	0.0118	0.0337
2500	0.0171	0.0350	0.0090	0.0256
3000	0.0133	0.0272	0.0070	0.0199
3500	0.0106	0.0217	0.0056	0.0159
4000	0.0086	0.0177	0.0045	0.0129
5000	0.0060	0.0124	0.0032	0.0091
6000	0.0045	0.0092	0.0024	0.0067
7000	0.0035	0.0071	0.0018	0.0052
8000	0.0028	0.0057	0.0015	0.0041
9000	0.0023	0.0046	0.0012	0.0034
10000	0.0019	0.0039	0.0010	0.0028

Table2(2) The result of ground surface concentration prediction

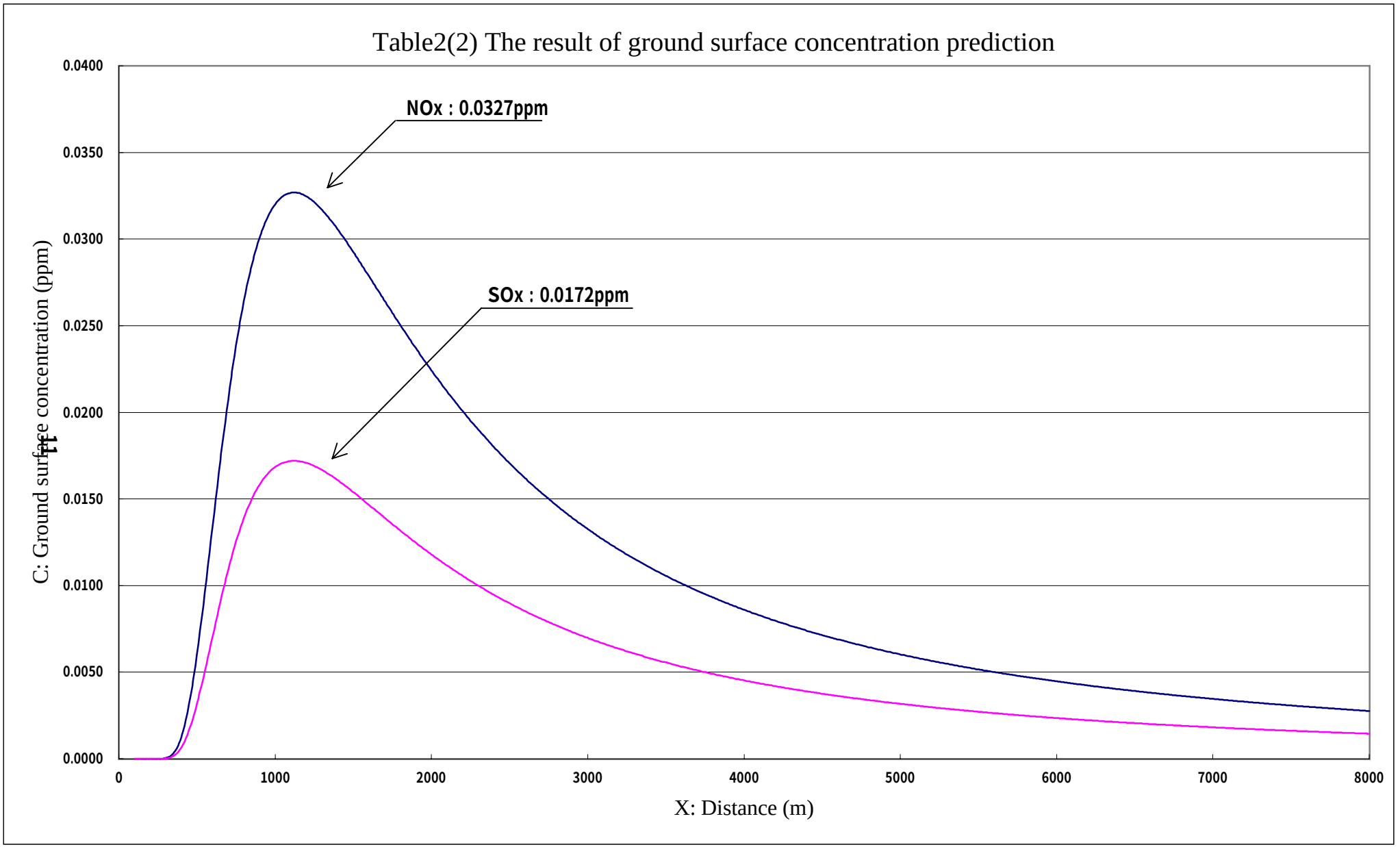


Table – 3 Calculation of Noise Level

According to the general specification of a diesel power plant with capacity of 3,500 kW, its noise level are shown below.

・Noise level at the power house :90dB(A)

・Noise level at Ex.Gas outlet :90dB(A)

・Noise level at Intake air filter :80dB(A)

・Noise level at Radiator :90dB(A)

The combined noise level of the above component is calculated below formula;

Lp =10log(Σ {10^(Li/10)})

=10log($10^{90/10}$+$10^{90/10}$+$10^{80/10}$+$10^{90/10}$)

= 94.9 dB(A)

where

Lp : Compound noise level of above component (unit noise level)

Li : Noise level by above each component

Thus, the noise level of the regular operation (3,500 kW x 2 units) is estimated 97.9 dB by compounding the unit noise level at the power plant based on the following compound formula:

Lw =10log(Σ {10^(Lp/10)})

= 97.9 dB(A)

The noise levels at the selected prediction points of site boundary (60 m) and the nearest house (100 m) are assessed by the following logical formula of propagation;

L =Lw-20logR-8

L_{60} =54.3 dB(A) at the site boundary, and

L_{100} =49.9 dB(A) at the nearest house.

Where

L : Noise level at the selected prediction point

Lw : Noise level of the source (94.9dB(A))

R : distance from noise source to prediction point (100m)

Table – 4 Calculation of Vibration Level

According to the general specification of a diesel power plant with capacity of 3,500 kW, its init vibration level should be less 80 dB at the adjacent place of a plant. Thus the vibletion level of the pollution source is estimated 83 dB(A)by compounding the unit noise level for the regular operation (3,500 kW x 2 units) of the power plant based on the following compound formula..

VLo =10log(Σ {10^(Li/10)})

= 83.0 dB(A)

where

VLo : Compound unit noise level (noise level of power plant)

Li : Unit noise level

Since the vibration propagated though the ground as a medium, the following logical formula of propagation is applied for the prediction of the vibration level at the prediction points caused by the operation of power plant.

VL =VLo – 20log(R/Ro)^n – 8.7*(R – Ro)*2

VL_{60} = 39.1 dB(A)

VL_{100} = 25.2 dB(A)

Where:

VL : Vibration level at the prediction point of “R” m apart from the point of VLo (dB),

VLo : vibration level at the point of “Ro” m apart from the source (dB),

R : Distance from the point of VLo to ther source,

Ro : Distance from the point of VLo to its source (= 1 m)

n Damped coefficient of ground (= 0.8),

a Damped coefficient of ground friction (= 0.03).

Table – 5 Provisional Conservation Criteria Related to Noise

Noise	
Level (dB(A))	Description
80	Air craft on taking off or landing
75	Indoor of a noisy factory
70	Ringing telephone
65	Indoor or an action-movie theater
60	Indoor of a noisy office
55	Background level in a common residence area
50	Indoor of a school or calm office
45	Indoor of a library

Table – 6 Provisional Conservation Criteria Related to Vibration

Vibration	
Level (dB(A))	Description
>75	Quaking houses, clattering doors and windows
70	Tangible for most person and awaking from deep sleep
65	Tangible for most person and awaking from light sleep
60	Tangible for most person in walking but not awaking from deep sleep
55	Tangible only for person in standing but no influence to sleep
<50	Intangible for most person