BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR RURAL ELECTRIFICATION

IN

WESTERN SAMOA

(SUPPLEMETARY SURVEY)

APRIL 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of Western Samoa, the Government of Japan decided to conduct a Basic Design Study on the Project for Rural Electrification in Western Samoa and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Western Samoa a study team headed by Mr.Munekazu URANO, Electric Power Technology Division, Agency of Natural Resources and Energy, the Ministry of International Trade and Industry from October 9 to November 11, 1989, and a supplementary survey team headed by Mr. Shinichi SUZUKI, Resident Representative of JICA Samoa Office from October 8 to November 1, 1991.

The teams exchanged views on the Project with the officials concerned of the Government of Western Samoa and conducted a field survey. After the teams returned to Japan, further studies were made. Draft Final Basic Design Reports were submitted to the Government of Western Samoa on Mar. 1993 and carefully explained by a Mission headed by Mr. Futoshi TAKAHASHI, Grant Aid Division Economic Cooperation Bureau, Ministry of Foreign Affairs. The report has been finalized thereafter.

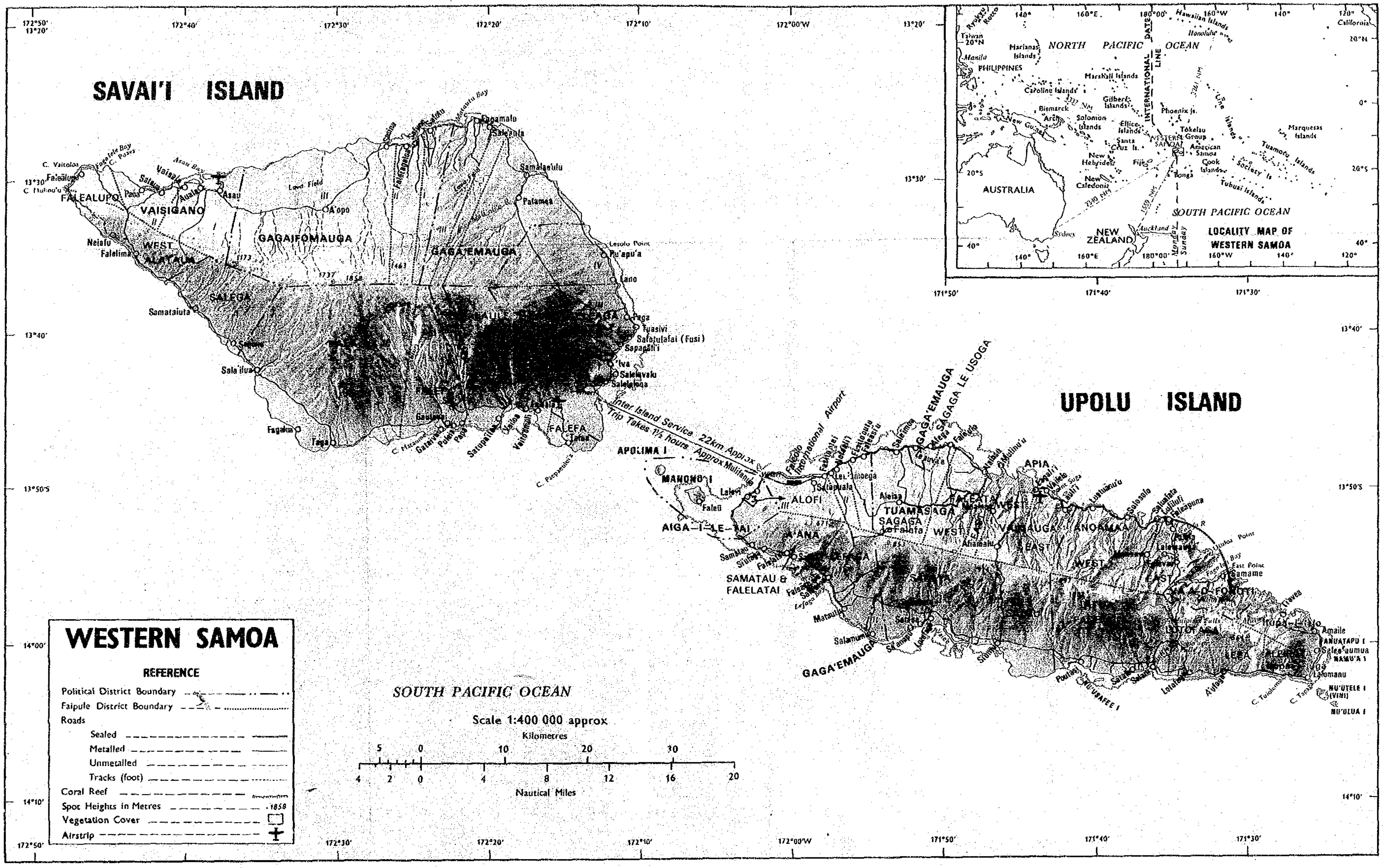
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Western Samoa for their close cooperation extended to the teams.

April, 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



SAVAI'I ISLAND
UPOLU ISLAND
WESTERN SAMOA
REFERENCE
Political District Boundary
Faipule District Boundary
Roads
Sealed
Metalled
Unmetalled
Tracks (foot)
Coral Reef
Spot Heights in Metres
Vegetation Cover
Airstrip
SOUTH PACIFIC OCEAN
Scale 1:400 000 approx
Kilometres
Nautical Miles
LOCALITY MAP OF WESTERN SAMOA
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
AUSTRALIA
NEW ZEALAND
PHILIPPINES
INTERNATIONAL DATE LINE
Inter Island Service 22km Approx
Trip Takes 1½ hours Approx
APIA
APOLIMA I
MANONO I
FALEALUPO
VAISIGANO
GAGAIFOMAUGA
GAGA'EMAUGA
SALEGA
FALEATA
TUAMASAGA
AIGA-I-LE-TAI
SAMATAU &
FALELATAI

SUMMARY

SUMMARY

In order to achieve economic independence and improve public welfare, the Government of Western Samoa decided, in the Sixth Development Plan (1988 ~ 1990), to develop hydroelectric energy to save foreign exchange, to obtain a reliable energy supply for developing medium to small scale industries and to improve public welfare and rural industries (forestry, tourism, etc.) by developing rural electrification to prevent concentration of the population in the capital of Apia.

The Electric Power Corporation (EPC) of Western Samoa is already proceeding with construction of a hydroelectric power station (output 4MW) in the Afulilo valley in the eastern part of Upolu island with financial assistance from Asian Development Bank (ADB), International Development Association (IDA), European Investment Bank (EIB), European Development Fund (EDF) and Australian Government (AIDAB), to develop a source of electric energy, to satisfy future increments in power demand and to change the source of electric energy from imported oil to hydroelectric energy.

At the same time EPC is proceeding with rural electrification to improve rural industries as a principal objective of the said development plan. However, because of financial problems and the difficulties of construction on the lava beds, the Government of Western Samoa requested grant assistance from the Government of Japan.

In response to the official request, the Government of Japan decided to conduct a basic design study on the Project for rural electrification and Japan International Cooperation Agency (JICA) dispatched to Western Samoa the Basic Design Study Team from October 9 to November 11, 1989, and a Supplementary Survey Team from October 8 to November 1, 1991.

While the teams were in Western Samoa, it conducted site investigations of the project sites and collected relevant data for making the basic design for the Project. Further, the teams exchanged views with EPC the executing agency of Western Samoa and prepared the minutes of meeting.

Through the site investigation by the teams, the following were found;

(a) The local people in the areas being electrified wish to receive EPC's electric power supply which is low cost and of high reliability.

(b) The local people living along with the planned routes are voluntarily doing tree trimming on the routes. It is thereby confirmed that the local people are enthusiastic for rural electrification.

(c) The Government of Western Samoa provides fund for rural electrification schemes as required.

(d) It is confirmed by EPC that restoration works for damaged distribution lines by the cyclone in 1991 will not hinder erection works under the Project as the restoration works will be completed within 4 to 5 months.

(e) It is confirmed that EPC is capable of erecting the distribution lines if the required materials, route survey and detailed design are done by a Japanese Consultant.

Based on the site investigation and study made by the teams in Japan, a basic plan for the Project was formulated as summarized below.

Table-1 Request from Western Samoa and Basic Design

Particulars	Request from Western Samoa			Basic Plan		
	Upolu	Savaii	Total	Upolu	Savaii	Total
66kV T/L	50km	---	50km	---	---	---
66kV S/S	1 lot	---	1 lot	---	---	---
22kV D/L	170km	99.5km	269.5km	78km	75km	153km
L.V. D/L	Required length for distribution			67km	46km	113km

Notes : T/L : Transmission line
S/S : Substations
D/L : Distribution line

The request from Western Samoa was for a 66kV transmission line (50km), 66kV substation facilities in Upolu island, 22kV distribution line (269.5km) and low voltage distribution lines associated with 22kV distribution lines on both islands. However, for the following reasons, part of the request was modified and the basic plan was formulated as summarized in Table-1.

(a) 66 kV transmission line and 66 kV substations were excluded from the basic plan, because of the following reasons;

(i) Transmission facilities to transmit power generated at the Afulilo power station are planned to be constructed under the Afulilo Project. The requested 66 kV transmission line will, therefore, be required as a back up facility.

(ii) The requested 66 kV line is planned to string conductors on the existing 22 kV distribution line supports for saving costs, however, a new 66 kV facility on steel towers to increase in reliability of the line is recommendable to be constructed taking into account of heavy cyclones.

(b) The request of Western Samoa included some 22kV distribution lines constructed by EPC's own funds from 1989 to 1991. These were, therefore, also excluded from the basic plan.

In consideration of the scale of the Project and the erection capability of EPC's erection teams, it is proposed that the Project be implemented in two phases. The work volume to be executed in each phase will be as summarized in Table-2.

Table-2 Work Volume in Each Phase

Particular	First Phase	Second Phase	Total
22kV D/L	67km	86km	153km
L.V.D/L	63km	50km	113km
Total	130km	136km	266km

If the Project is implemented under the Grant Aid program of the Government of Japan, the following work assignment will be set out.

(a) Japan would undertake the route survey, preparation of tender documents, procurement of the required line materials and equipment shown hereunder and a part of construction supervision.

Materials and Equipment

22 kV distribution lines	80	km
22 kV/LV distribution lines	73	km
LV distribution lines	40	km
WHM Single phase	950	nos
Three phase	50	nos
Hydraulic Excavator	2	sets
Vehicle for support lifting	3	units
Trucks with hoist	3	units
Erection tools	1	lot

(b) Western Samoa would undertake erection works including unloading and inland transportation of imported materials and equipment and construction supervision of the distribution lines.

Upon completion of the Project in 1994, the electrification ratio will be increased from 75% to 92% in Upolu island and from 70% to 84% in Savaii islands respectively. Consequently, about 18,000 peoples will newly receive electric power. This means that development of essential infrastructure aimed as the principal objective of the Sixth Development Plan of Western Samoa will be completed.

Thus, substantial benefits are expected to result from implementation of the Project and the Project will have great significance if implemented under the Grant Aid Program of the Government of Japan.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

In order to achieve economic independence and improve public welfare, the Government of Western Samoa decided, in the Sixth Development Plan (1988-1990), to develop hydroelectric energy to save foreign exchange and to promote rural electrification for the purpose of improving public welfare for the people in rural areas.

In their quest for development of hydroelectric energy, the Western Samoa government has been promoting the Afulilo (4 MW) hydroelectric power Project on Upolu island with funds from the Asian Development Bank (ADB), International Development Association (IDA), European Investment Bank (EIB), European Development Fund (EDF) and Australian Government (AIDAB).

The Government was proceeding with their rural electrification scheme, for improvement of the distribution network in rural areas with by its own funds. However, the Government officially requested from the Government of Japan grant aid for procurement of distribution line materials and technical assistance for the rural electrification Project because of the difficulties in financing and insufficient engineers in EPC to implement the Project.

In response to the official request, the Government of Japan decided to conduct the Basic Design Study. Japan International Cooperation Agency (JICA), thereby, dispatched to Western Samoa a Basic Design Study Team headed by Mr. Munekazu URANO, Electric Power Technology Division, Agency of Natural Resources and Energy, the Ministry of International Trade and Industry for 34 days from October 9 to November 11, 1989. The team surveyed the Project areas, collected relevant data and information for reviewing the Basic Design, and discussed technical aspects of the Project with the Electric Power Corporation (EPC).

Based on the survey results above, the Basic Design Report was prepared on March 1990 and it was recommended to be confirmed the following points prior to conduct the Project;

(1) Financing situation for implementation of the Afulilo Project from ADB, IDA, EIB etc.
(2) Progress of restoration works for damaged distribution facilities by a strong cyclone visited Western Samoa at the beginning of 1990.

The Government of Western Samoa officially requested to the Government of Japan at the beginning of 1991 to proceed the Project suspended since 1990. In reply to the request, the Government of Japan decided to proceed the Project and JICA despatched a supplementary survey team headed by Mr. Shinichi SUZUKI, Resident Representative of JICA Western Samoa Office to confirm the above points for 25 days from October 8 to November 1, 1991. The Supplementary Survey team visited the site and discussed technical and financial aspects of the Project with the Electric Power Corporation (EPC).

The members and schedule of the teams and minutes of meeting, etc. are given in Appendices 1-1, 1-2 and 1-3.

The report includes conclusions & recommendations, a project evaluation and an implementation program referring to the review and study results for adequacy, technical aspects, and scale of the Project based on the analysis of the results of the site investigation.

CHAPTER 2

BACKGROUND TO THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Background of the Project

Population of Western Samoa was about 160,000 in 1986, about 32,000 out of 113,000 of the population in Upolu island are concentrated in the capital, Apia and about 44,900 are in Savaii island. This concentration of population in Upolu, especially in the capital of Apia has become a social problem in the country.

The Government of Western Samoa decided to proceed with the rural electrification scheme, as an objective of development, to improve the livelihood of the local people and to prevent concentration of people on Upolu island and to keep them in the rural areas by means of improvement of employment opportunities by maintaining medium and small-scale industries in the rural areas. However, the Government requires the following to implement such rural electrification scheme;

(1) Finance to procure distribution line materials
(2) Technical assistance for planning and designing distribution facilities

The electric power supply in Western Samoa is operated by EPC established in 1972, which is an agency under the Ministry of Public Works. The general operating policies of EPC are decided by a board of directors of which the chairman is the Minister of Public Works.

As regards the rural electrification planned in the Sixth Development Plan by the Government, a committee for rural electrification, headed by the Minister of Public Works, plans the scale, priorities, electrification programme, finance scheme, etc.. The official request for this Project has also been provided by the Committee.

EPC has two separate power systems, one in Upolu island and the other in Savaii. The power plants are directly connected to the distribution system and electric energy is distributed to consumers after being stepped down to low voltage at pole mounted distribution transformers.

The existing power facilities under EPC are refer to the attached Appendix-2.

2-2 Outline of Request

The Government of Western Samoa requested the Government of Japan to provide materials and equipment, and technical assistance for implementation of the following transmission and distribution system;

Transmission & Distribution Facilities	
66 kV transmission lines	about 50 km
66 kV substation equipment	1 lot
22 kV distribution lines	about 240 km
Construction Equipment	
Trucks with jinkers	3 sets
Rock drill and compressor	2 sets
Pickup trucks	6 sets
Line trucks	4 sets

2-3 Outline of the Project Area

The planned line routes are in the central, east coastal and north west inland areas of Upolu island and in the north coastal areas of Savaii island. Upolu and Savaii islands are interconnected by air and ferry boats.

The Project includes thirteen routes, mainly coastal routes and routes toward inland areas. These may be

classified as follows. Routes of the various lines are as shown on map Appendix 3-1 "The Planned Distribution Lines".

Upolu Island	
Tanugamanono-Siumu	Crossing at central
Saleapaga- Lefaga	East coastal route
Saluafata-Sauniatu	North inland route
Amaile-Afulilo	East inland route
Aleisa-Saleimoa	North inland route
Nuu-Faleula	North inland route
Lepale-Fasitoota	North inland route
Satuimalufilufi-Satapuala	West inland route
Savaii Island	
Puapua-Samalaelu	East coastal route
Sasina-Matavai	North inland route
Tafutafoe-Falealupotai	West coastal route
Tafuaufa-Tafuatai	South inland route
Patamea-Saleaula	North inland route

The planned routes in Upolu island are located within 40 km from the capital of Apia except for an east coast area and these are all comparatively accessible. The east coast area is about 70 km away from Apia. On the other hand, the planned routes in Savaii island are within 100 km from Salelologa where diesel power plants are installed.

The populations along the planned routes are about 18,000 which will be about 10 % of total population in Western Samoa. The planned routes are located in areas away from the major towns and there are only agricultural and forest industries. Owing to the limited opportunities for employment, young people in rural areas are tending to move to the capital, Apia, in search of employment. The Government of Western Samoa intends to develop small-scale

industries for improving employment opportunities to prevent this tendency.

CHAPTER 3

OUTLINE OF THE PROJECT

CHAPTER 3 OUTLINE OF THE PROJECT

3-1 Objective

The Gross National Product per head of Western Samoa in 1987 is presumed as US$660 (WS$1,300). The major industry of the country is agriculture. Industries other than agriculture are lagging and employment prospects for local people in the rural areas are poor. They tend to concentrate on Upolu island especially in Apia when seeking employment. To cope with this, the Project aims to promote economic independence of Western Samoa through (i) improvement of living conditions and (ii) settlement of the local peoples in the rural areas by improving employment opportunities by development of the industries other than the agriculture.

The Government of Western Samoa, however, has the shortage of funds for implementation of the Project and EPC has insufficient engineers to make detailed design and route survey. The objective of the Project is to implement the rural electrification scheme with assistance by the Government of Japan to the above problem.

3-2 Study and Examination on the Request

(1) Developing Plans of Western Samoa

At the Project areas, the overlapping and related development were planned as described below.

(a) EPC's plans with his own funds

At the time of the Preliminary Study, the Project included about 22 km of Siumu-Lotofaga line in the south coastal area of Upolu island and about 7 km of Safa-Vaiola line in the east coastal area of Savaii island in the grant aid.

However, it was discovered at the time of the supplementary survey that EPC completed erection work on these distribution lines because of strong requests from the local people and erection funds had been given by the Government and a church. These lines were therefore excluded from the grant aid application after exchanging views with EPC.

(b) Electrification plan in north coastal area of Savaii

The unelectrified areas remain mainly in the north coastal area of Savaii island where the objective population of about 6,000 is living and EPC was therefore keen to electrify these areas. The Government of Western Samoa therefore requested to an European country for an electrification plan by construction of distribution lines in 1988. Unfortunately, no assistance was provided. EPC, therefore, completed the line by their own fund.

(c) The Sixth Development Plan

The following development plans have been included in the Sixth Development Plan made by the Government;

(i) Road Project including renovation works

Lemafa road (distance about 22km)
Richardson road (distance about 30kW)
Apia-Faleolo road (distance about 30 km)
Apia-Siumu road (distance about 22 km)
Salelologa-Asau road (about 90 km)

Each of these roads will be the routes of the Project or will be utilized for transporting

distribution line materials for the Project. Therefore, after renovation, it is expected that these roads will contribute to transportation of construction materials, erection works, etc..

(ii) Development of communication system
(iii) Other development plans

The Government of Western Samoa planned to promote the following small-scale industries for the purpose of economical independence and improvement of the livelihood of the people:

- Refining of coconut oil
- Furniture and wooden goods
- Dried coconuts
- Tinned goods
- Flour milling
- Dairy products
- Electrical conductor manufacture

Detailed scales and locations are unknown. It is however expected that these will contribute development and growth of rural industries.

(2) Request of Western Samoa

The Government of Western Samoa officially requested the Government of Japan in 1989 a grant aid to procure distribution materials and to provide technical assistance for the rural electrification Project.

The following table shows the planned routes mentioned in the official request of the Government of Western Samoa, the routes were reviewed, discussed and confirmed between EPC and teams at the time of the

preliminary, basic design and supplementary study as shown below;

(a) Transmission and distribution lines

Upolu island	EPC's request	Pre'y study	Basic study	Supp'ry Study	Note
Tanugamanono-Afulilo	50 km	Excl.	Excl.	Excl.	#1
Tanugamanono-Siumu	12 km	]	25 km	21 km	
Sium-Lotofaga	20 km	]49 km	Excl	Complete	
Lotofaga-Afulilo	8 km	]	Excl.	Excl.	#2
Lotofaga-Amaile	30 km	]38 km	22 km	Complete	
Saleapaga-Lefaga	-	-	-	7 km	
Amaile-Afulilo	20 km	]	Excl.	18 km	#3
Leulumoega-Siumu	40 km	48 km	Excl.	Complete	
Siusega-Tanumalala	40 km	25 km	19 km	Complete	
Aleisa-Saleimoa	X	-	7 km	4 km	#4
Nuu-Faleula	X	-	3 km	3 km	#4
Lepale-Fasitoota	X	-	7 km	7 km	#4
Saluafata-Sauniatu	X	]99 km	7 km	7 km	#5
Satuimalafilufi-Faleatiu	X	]	13 km	11 km	#6
Total 170 km	170 km	259 km	103 km	78 km	

Savaii island	EPC's request	Pre'y study	Basic study	Supp'ry Study	Note
Puapua-Samalaeulu	28 km	12 km	17 km	17 km	
Samalaeulu-Sasina	19 km	Excl.	Excl.	Complete	
Sasina-Matavai	X	26 km	25 km	26 km	#7
Falealupo-Avata	7 km	Excl.	Excl.	Complete	
Neiafu-Tafuafoe	6.5 km]		15 km	15 km	
Tafuauta-Tafuatai	39 km	]20 km	7 km	7 km	
Patamea-Saleaula	X	]-	-	10 km	#8
Total	99.5 km	58 km	64 km	75 km	

(b) Substation facilities

Substations	EPC's request	Pre'y study	Basic study	Supp'ry Study	
66kV, 12.5MVA transformer	2 sets	Excl.	Excl.	Excl.	#9
66kV, 1MVA transformer	1 set	Excl.	Excl.	Excl.	#9
66kV circuit breaker/ protective equipment	2 sets	Excl.	Excl.	Excl.	#9

(c) Construction Equipment

Construction Equipment	EPC's request	Pre'y study	Basic study	Supp'ry Study	Note
Trucks with jinkers	3 sets		3 sets	3 sets	
Drill and compressor	2 sets		1 set	2 sets	
Pickup trucks	6 sets		Nil	Nil	
Line trucks	4 sets		3 sets	3 sets	

The reasons for additions and exclusions in relation to the request and at the time of the preliminary, Basic Design and Supplementary Study are as given below:

#1 The 66kV transmission line was planned to construct from Afulilo to Tanugamanono to transmit generated power at Afulilo. However, a 33 kV distribution system has been included in the Afulilo Project, the proposed 66 kV line is, therefore, not essential facilities to transmit power and will be utilized as a back up facilities. In addition, proposed line is planned to string conductors on the top of the existing 22 kV distribution line supports to save the cost, it is presumed that such 66 kV

line is not reliable to transmit the power from Afulilo taking account of cyclones visited in Western Samoa. It is concluded that the 66kV transmission line is excluded from the Project.

#2 Lotofaga-Afulilo line was excluded because the said line was included as a part of the Afulilo hydroelectric project which was underway with funds by ADB, IDA and EEC.

#3 Amaile-Afulilo line was excluded at the time of the preliminary study. The line was, however, included at the time of Supplementary Survey to response EPC's strong request.

#4 Aleisa-Saleimoa, Nuu-Faleula and Lepale-Fasitoota lines were planned under the Basic Design Study to branch from Siusaga-Tamunalala line, the plan, however, has been changed to branch from the north coastal line.

#5 Saluafata-Sauniatu line was added at the time of the preliminary study. According to the said study, Sauniatu had a reservoir of the existing Sauniatu power station and it was thereby confirmed that electric power was needed for the reservoir facilities and local people.

#6 Satuimalafilufilu-Satapuala line was added at the time of the preliminary study for distributing electric power to an inland part of north coastal area. However, following the survey, the route length of the line was reduced because it was judged to be enough to construct the line between Satuimalafilufilu and Satapuala due to small number of consumers.

#7 Sasina-Matavai line was added at the time of the preliminary study, at EPC's request.

#8 Patamea-Saleaula line was added at the time of the supplementary survey, because of that a loop line will be formed together with the existing distribution lines, Puapua-Samalaeulu and Sasina-Matavai lines under the Project.

#9 66kV substation facilities were proposed to deliver electric power from Afulilo power station by a 66kV transmission line. Because of the same reasons as #1, these facilities were also excluded from the Project.

(3) Review of the Request

(a) 66 kV transmission Facilities

As stated in the above sub-clause (2), (a), #1, 66 kV transmission facilities have been excluded from the Project.

(b) Service wire

Materials for service wires from low voltage line to consumers are excluded from the Project, which will be provided by EPC separately as confirmed between Preliminary Survey Team and EPC.

(c) Watthour Meter

Procurement of some watthour meters is included in the Project as requested by EPC.

(d) Construction Equipment

Some areas to construct distribution lines are covered lava bed. Hydraulic excavator to make hole for supports will be procured under the Project.

(4) Technical Assistance

EPC requested Survey Team to provide a foreman to establish a new erection team in addition to their three teams for improving progress of the works, however, it was mutually confirmed that no technical assistance is required because of the following;

(a) EPC has capable to supervise erection works with assistance of Consultant

(b) Erection equipment such as hydraulic excavators, support erection vehicle etc. for improving progress of the works are procured

(c) No additional erection team will be required taking into account of the above EPC capability and erection equipment.

(5) Necessity of Consultant

(a) Consultant

There is a shortage of engineer for planning, surveying, deigning of distribution facilities in EPC as mentioned in Clause 3-3-1, a consultant to do such engineering works is required, details are referred to Clause 4-3-2 "Implementation Plan" hereunder.

(b) O & M Guidance

Guidance service is to be provided for Operation and maintenance of erection equipment such as hydraulic excavator and support erection vehicles from the manufacturer in First Phase.

3-3 Project Description

3-3-1 Executing Agency and Operational Structure

EPC has a staff of about 250 of whom 200 are engineering/technical and the other 50 are accounting /administrative personnel. However, EPC has only a few graduated engineers under the General Manager. Furthermore, as they are responsible for operation and maintenance of the existing electric power facilities,

EPC cannot properly attend to planning and design of new electric power facilities.

An organization chart of EPC which is the executing agency of the Government of Western Samoa is as shown in Appendix 3-2 "Electric Power Corporation Organization Chart". Operation and maintenance of the project facilities after completion will be executed by maintenance teams incorporated under the manager distribution as shown on the said organization chart. Each maintenance gang consists of a foreman, 6-8 electric technicians, and laborers when needed. Normally, two teams operate on Upolu island and one gang on Savaii island.

3-3-2 Location and Conditions of Project Site

As the result of site investigation by the Survey teams dispatched from JICA at the official request of Western Samoa, the following are the distribution lines to be constructed under Japanese Grant Aid.

Route	22 kV	22/LV	LV	Priority
Upolu island				
1.Tanugamanono-Siumu	12 km	9 km	3 km	1
2.Saleapaga-Lefaga	3 km	4 km	0 km	12
3.Saluafata-Sauniatu	3 km	4 km	7 km	9
4.Amaile-Afulilo	16 km	2 km	5 km	11
5.Aleisa-Saleimoa	0 km	4 km	3 km	7
6.Nuu-Faleula	0 km	3 km	2 km	7
7.Lepale-Fasitoota	0 km	7 km	5 km	7
8.Satulmafilufilu-Satapuala	7 km	4 km	5 km	13
Total Upolu Approx.	41 km	37 km	30 km	

Route	22 kV	22/LV	LV	Priority
Savaii island				
9.Puapua-Samalaeulu	10 km	7 km	1 km	8
10.Sasina-Matavai	16 km	10 km	1 km	10
11.Neiafu-Tafutafeo	3 km	12 km	4 km	4
12.Tafuauta-Tafuatai	5 km	2 km	1 km	5
13 Patamea-Saleaula	5 km	5 km	3 km	6
Total Savaii Approx.	39 km	36 km	10 km	
Grand Total Approx.	80 km	73 km	40 km	

The respective routes are shown in Appendix 3-1 "The Planned Distribution Lines".

The teams have exchanged views with the officials of the Government of Western Samoa and EPC and confirmed the appropriateness of the Project as mentioned below.

(a) The local people in the areas being electrified wish to receive EPC's electric power supply which is low cost and of high reliability.

(b) The local people living along with the planned routes are voluntarily doing tree trimming on the routes. It is thereby confirmed that the local people are enthusiastic for rural electrification.

(c) The Government of Western Samoa provides fund for rural electrification schemes as required.

(d) It has been confirmed by EPC that restoration works for damaged distribution lines by the cyclone will not hinder the erection works under the Project as the restoration works will be completed within 4 to 5 months.

(e) It has been confirmed that EPC is capable of erecting the distribution lines if the required

materials, route survey and detailed design are done by a Japanese Consultant.

3-3-3 Outline of Materials and Equipment

Taking account of EPC's erection capabilities, the following criteria were adopted for selecting the materials of the Project.

(1) Taking account of maintenance after the Project is completed, the technical specifications of the materials were adopted from the EPC's present specifications for the purpose of using the materials of the existing distribution lines or the distribution lines being constructed under the Project as spare parts.

(2) Materials not familiar to EPC will not be employed because erection works will be done by their own teams. However, for ease of foundation work in the lava beds, excavation equipment requested by EPC will be procured with sufficient guidance in operation and maintenance by a guidance engineer to be dispatched from the manufacturer.

(3) EPC has been procuring materials from neighboring countries such as New Zealand, Australia, etc.. In particular Australian made wooden poles have been used as supports in Western Samoa. Taking account of EPC's working capabilities and for reduction of initial cost (approx.seven million yen), wooden poles will be employed as supports and will be imported from Australia or New Zealand.

The materials necessary for the Project are outlined below.

(1) Supports

Supports	9 m	Low Voltage & Stay
Supports	12.5 m	22 kV Line
Supports	14 m	22 kV line

(2) Insulators and their accessories

22 kV pin type insulator
22 kV strain type insulator
L.V. pin type insulator
L.V. strain type insulator

(3) Conductors and their accessories

Aluminium conductor WASP (approx. 100 sq.mm)
Aluminium conductor FLY (approx. 50 sq.mm)
Insulated aluminium conductor FLY

(4) Distribution equipment

Step up transformers 6.6/22 kV, 450 kVA
Distribution transformers 22 kV/LV, 1-P, 15 kVA
Distribution transformers 22 kV/LV, 1-P, 25 kVA
Distribution transformers 22 kV/LV, 3-P, 50 kVA
Air break switches 22 kV, 400 A
Cutout switches
Lightning arresters

(5) Others

3-3-4 Operation and Maintenance Plan

EPC's working teams, although in principle set up for operation and maintenance of the distribution system, have completed a lot of distribution lines by own fund from 1989 to 1991 and concluded that EPC's working teams are capable to undertake the Project. After completion of the Project, the said working teams will be entrusted for operation and maintenance works as their primary task. It is therefore judged that there will be no problems in

regard to maintenance after completion of the Project as the teams will have been involved with its execution.

Distribution facilities of both Upolu and Savaii islands after the Project is completed are given below.

Lines	Existing	Under the Project	Total
22kV	371 km	153 km	524 km
L.V.	569 km	113 km	682 km

If two (2) patrol are organized in each maintenance team (two in Upolu & 1 in Savaii), and patrol is to be made once a month, one patrol team will have to be responsible for maintaining about 10 km of distribution lines per day, which maintenance works will be comparatively easy.

Further, EPC anticipated a marginal profit in 1988 because its annual income was WS$3,865,425 against expenditure of WS$3,346,971 in the same year. Although cannot be certain to obtain the marginal profit every year, it is considered that the expenditure necessary for maintaining the facilities after the Project is completed is covered by the profit on selling electric energy.

CHAPTER 4

BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Design Policy

EPC's capability to implement the erection works has been confirmed by the study team as mentioned in Chapter 3. It has been decided that the Government of Japan undertakes to procure the required materials/equipment and to provide assistance for route survey, detailed design and a part of the construction supervision on the distribution lines under the Project. The EPC's design conditions and standards will be used for the Project considering the capability of EPC's erection teams for the erection work.

(1) Natural Conditions

Natural conditions such as temperatures, wind velocity, earthquake and thunder will be taken into consideration in the design of the distribution lines to allow for the worst conditions in the past records from 1941 to 1985. However, no earthquake has been recorded in the past. Meteorological data in Western Samoa are referred to Appendices 4-1 to 4-4.

(2) Selection of Line Materials

It is considered that the distribution transformers to meet the demand in 2004 will be provided under the Project. Those transformers to be required for further power demand should be procured by EPC. Supports for the Project may be of wooden supports.

(3) Conditions of the Executing Agency

The EPC's existing design conditions and line materials familiar to EPC erection teams are assumed since the erection works will be done by EPC's own erection teams. The electrical facilities under EPC are influenced by the design practices of New Zealand.

4-2 Review of Design Conditions

(1) Natural Conditions

In Summary:

Conditions	Records	EPC Conditions	Applied
Min. Temp.	14.7 deg.C	15 deg.C	15 deg.C
Max. Temp.	33.8 deg.C	34 deg.C	34 deg.C
Wind Velocity (Gust Wind)	80 knot (1 knot = 1,853 m/hr =0.5147m/sec, 80 knot = 42 m/sec)	Nil	80 knot
Annual Rain Fall	-	2,800-3,000 mm	-
Ave. Humidity	-	76-82 %	-
Annual Thunder Days	-	117 days	-

Western Samoa is an island country and suffers from the effects of salt contamination, especially along the sea coast. There is also frequent interruption of the system by tree branches touching the line or falling down of trees. There have been few interruptions due to lightning strikes. In all there have been 64 interruptions over 23 months (3 times per month) from August 1987 to June 1988 due to collapse of line supports, breakage of conductors, and trees along the line routes, details of which are summarized below;

Reasons	Nos. of Interruption
Collapse of supports	2
Damage to arms	3
Breakage of conductors	2
Lightning strikes	1
Vehicles strikes	4
Trees (touch/down)	52
Total	64

The reason why interruption due to lightning is so infrequent is that lightning in Western Samoa seldom strikes the ground. There are also few interruptions due to salt contamination since the wind in Western Samoa is comparatively weak and salt adhering to insulators is washed off by rain water. Accordingly no ground wire is proposed for the distribution lines, nor is any provided for the existing lines.

(2) Design Standards

The Australian "CODE FOR OVERHEAD LINE CONSTRUCTION" for the distribution lines is applied to the design of distribution facilities by EPC. The ground clearance, conductor spacing, distance from buildings etc. for the facilities under the Project are designed to conform to the said code.

(3) Other EPC Design Standards

(a) Minimum temperature for conductor: 15 deg.C

The minimum temperature recorded between 1941 and 1987 was 14.7 deg.C recorded on August 1981.

(b) Maximum temperature for conductor: 50 deg.C

The maximum temperature of a conductor is calculated from the sum of the maximum ambient temperature and the temperature rise caused by the maximum load current under operation. The maximum ambient temperature of 33.8 deg.C was recorded in January 1948, and the allowable temperature rise due to the load current is calculated to be about 16 deg. C.

(c) EDS: 18% of breaking strength of conductor

Every Day Stress (EDS) provides a kind of safety factor for the conductor and is normally kept below 20 % of breaking strength. Thus EPC's EDS of 18 % is reasonable.

(d) Wind Pressure

Wind pressure on conductors and supports according to EPC's design conditions are 500 Pa (equivalent to 51 kg/m^2) and that on supports is 700 Pa (equivalent to 71 kg/m^2).

Taking into account of the cyclones visited Western Samoa recently, the wind pressures on distribution lines are recommended to be modified to withstand a similar cyclone as shown below;

Materials	Existing	Recommendation
Wind pressure on conductors	500 Pa (51 kg/m^2)	1160 Pa (118 kg/m^2)
Wind pressure on supports	700 Pa (71 kg/m^2)	725 Pa (74 kg/m^2)

Details of the recommendation is referred to the attached Appendices 4-5. The design wind pressures will be finalized at the time of preparation of Tender Document.

(e) Safety Factor of Supports

Wooden poles:	4	(Japan 4)
Concrete poles	2	(Japan 2)

(f) Span Length

Spans of the existing distribution lines are generally long and some parts of which are more than 100 m. while, the spans for the Project shall be taken into account of heavy wind velocity of the cyclone recently visited Western Samoa. Proposed design span is, therefore, calculated to be about 60 meter so as to keep the top load of supports within 6 kN (about 500 kg).

(g) Lightning Protection

Referring to the past records, annual thunder storm days are recorded to be 106 in 1947 which is comparatively high. While interruption of EPC's distribution system during 23 months from Aug. 1986 to June 1988 are 64 times as shown below;

Reasons	Nos. of Interruption
Destruction of support	2
Breaking cross arm	3
Breaking of conductor	2
Lightning strike	1
Traffic accident	4
Destruction of trees	52
Total	64

Main cause of interruption was destruction of trees, while direct lightning strike on distribution facilities was only once during 23 months. Lightning in Western Samoa is normally flashover in the sky and flashover to the ground is very rear cases according to the EPC information. No protection against lightning except arresters is considered for the Project accordingly.

(h) Salt Pollution

The Project area is closed to sea coast and it seems that distribution facilities may be polluted by salt, however, no interruption has been made as shown above item (g). According to the EPC's comment, the reasons of it are that the wind velocity is normally very light and rainfall is heavy, there is some rainfall even in dry season. No protection for salt pollution is, therefore, have been considered for the Project.

4-3 Basic Design

4-3-1 Planning of Facilities

(1) Line Routes

As a result of the field Survey Report, the line routes planned are as follows:

Line Routes	22 kV	22kV/LV	LV	Location
Upolu island				
Tanugamanono-Siumu	12 km	9 km	3 km	(1)
Saleapaga-Jefaga	3 km	4 km	0 km	(2)
Saluafata-Sauniatu	3 km	4 km	7 km	(3)
Amaile-Afulilo	16 km	2 km	5 km	(4)
Aleisa-Saleimoa	0 km	4 km	3 km	(5)
Nuu-Faleula	0 km	3 km	2 km	(6)
Lepale-Fasitoota	0 km	7 km	5 km	(7)
Satuimalufilufi-Satapuala	7 km	4 km	5 km	(8)
Total Upolu Island	41 km	37 km	30 km	
Savaii island				
Puapua-Samalaeulu	10 km	7 km	1 km	(9)
Sasina-Matavai	16 km	10 km	1 km	(10)
Tafutafoe	3 km	12 km	4 km	(11)
Tafuauta-Tafuatai	5 km	2 km	1 km	(12)
Patamea-Saleaula	5 km	5 km	3 km	(13)
Total Savaii Island	39 km	36 km	10 km	
Ground Total	80 km	73 km	40 km	

22 kV Lines : About 153 km

LV Lines : About 113 km

The locations of the respective lines are as shown on map Appendix 3-1 "Planned Lines"

(2) Power Demand Forecast

(a) Power Demand Forecast on Upolu Island

Generated energy, sold energy and numbers of consumer in Upolu island from 1982 to 1988 are as shown on Appendices 4-6"Generated Power", 4-7 "Sold Energy" and 4-8 "Numbers of Consumers". Generated energy and sold energy in 1988 were 40.73 GWh and 35.17 GWh respectively and the peak demand was 8,016 kW on the assumption that the load factor in 1988 was 57 %.

The power demand has been forecast using the following assumptions;

Domestic demand	
Annual increment of population	1.0%
Electrification ratio of First Phase	88.8%
Electrification ratio of Second Phase	92.0%
Numbers of families per consumer	11
Industrial demand	
Annual average demand increase	6.6%
Increment ratio of consumers	1.0%
Annual demand increase per consumer	5.6%
Commercial demand	
Annual average demand increase	5.6%
Increment ratio of consumer	1.2%
Annual demand increase per consumer	3.4%
Hotel demand	
Annual average demand increase	5.0%
Increment ratio of consumers	1.0%
Annual demand increase per consumer	4.0%
Religious demand	
Annual average demand increase	11.9%
Increment ratio of consumers	1.2%
Annual demand increase per consumer	10.6%
School demand	
Annual average demand increase	5.5%
Increment ratio of consumers	1.9%

Annual demand increase per consumer	3.6%
Lighting demand	
Average demand increase	3.4%

The annual average demand increases except for domestic demand have been estimated by reference to the records from 1982 to 1988.

The total system demand in Upolu island in 1999 and 2004 (5 and 10 years after completion of the Project) are forecast as follows:

Years	Energy Demand (MWh)	Peak Demand (kW)
1999	70.65	13,670
2004	93.95	17,875

Details of the above demand forecast are given in Appendix 4-9 "Power Demand Forecast on Upolu Island".

(b) Power Demand Forecast on Savaii Island

Generated energy and sold energy in 1990 were only 1.78 GWh and 1.48 GWh respectively and the peak demand was 550 kW on the assumption that the load factor was 35 %.

Up till now there has been no industrial demand in Savaii island but this has been assumed to commence in 1991. The power demand has been forecast using the following assumptions;

Domestic demand	
Annual increment of population	1.0%
Electrification ratio of First Phase	78.9%
Electrification ratio of Second Phase	90.0%
Numbers of families per consumer	18

Industrial demand	
Annual average demand increase	6.6%
Initial number of consumers	2
Increment ratio of consumers	2.0%
Annual demand increase per consumer	3.0%
Commercial demand	
Annual average demand increase	4.0%
Increment ratio of consumers	1.0%
Annual demand increase per consumer	3.0%
Hotel demand	
Annual average demand increase	7.1%
Increment ratio of consumers	3.0%
Annual demand increase per consumer	4.0%
Religious demand	
Annual average demand increase	11.1%
Increment ratio of consumers	1.0%
Annual demand increase per consumer	10.0%
School demand	
Annual average demand increase	5.1%
Increment ratio of consumers	2.0%
Annual demand increase per consumer	3.0%
Lighting demand	
Average demand increase	3.5%

The total system demand in Savaii island in 1999 and 2004 are forecast as follows:

Years	Energy Demand (MWh)	Peak Demand (kW)
1999	3.39	860
2004	4.72	1,171

Details of the above demand forecast are given in Appendix 4-10 "Power Demand Forecast in Savaii Island".

(c) Power Demand Forecast for Each Line

The power demand forecast for each line has been estimated to determine the design capacities and numbers of distribution transformers required.

There are no past records of power consumption because the distribution lines to be constructed under the Project are located in the areas not electrified. The power demand is therefore based on census records taken in 1986 for each village to be electrified, adjusted for population increases and demand per person estimated from the demand forecasts for Upolu and Savaii islands as appropriate. The transformer capacities and numbers required are designed so as to meet the demand in 2004, 10 years after the completion of the Project. Further transformers will have to be provided by EPC when demand increases. The initial demand in the Project areas, however, may be smaller than the forecast demand because the estimation of demand is based on the demand increase per consumer in the electrified area on Upolu. The demand forecasts for the each line are summarized below:

Upolu Island

1.	Tanugamanono-Siumu (including demand of Falealili, Safata)	2,000kW
2.	Lotofaga - Amaile (including demand of Amaile)	300kW
3.	Saluafata-Sauniatu	150kW
4.	Amaile-Afulilo	45kW
5.	Aleisa-Saleimoa	30kW
6.	Nuu-Faleula	50kW
7.	Lepale-Fasitoota	30kW
8.	Satuimalufilufi-Satapuala	50kW

Savaii Island

9.	Puapua-Samalaeulu (including demand of north coast)	500kW

10.	Sasina-Matavai	100kW
11.	Tafutaoe	70kW
12.	Tafuauta-Tafuatai	30kW
13.	Patamea-Saleaula	90kW

Details of the above demand forecast are given in Appendices 4-11 and 4-12 for Upolu and Savaii Islands respectively.

(3) Distribution Line Materials and Equipment

The materials required for the Project are supports, conductors, insulators, accessories and equipment. The following study is made for selection of the materials.

(a) Supports

Wooden poles imported from Australia are being used by EPC. There are alternative supports such as concrete poles and steel poles. Comparison of merits of these poles are as summarized below;

Comparison Items	Wooden	Concrete	Steel
Cost	Y71,000	Y85,000	Y115,000
Weight	700 kg	1,100 kg	200 kg
Life Time	30 years	45 years	15 years
Handling	Easier	Difficult	Easiest

Cost, life time and handling are important items in selection of the supports. On such terms concrete poles are the most economical taking into account their potential life time of 45 years as compared to 30 years for the wooden poles. However, for the following two reasons wooden poles were selected for the Project.

a.Initial Investment

The total cost of the concrete poles would be about 330 million yen, while that for wooden poles is about 260 million yen. The initial investment for the wooden poles is therefore less by about 70 million yen.

b.Maintenance

Although normally no maintenance work is required on the concrete poles, poles may be damaged by traffic accidents etc., and the maintenance will have to be done by EPC. The supports should therefore be of materials familiar to EPC maintenance team and be easily procurable by EPC's own funds.

(b) Conductors

The conductors used by EPC are All Aluminium Conductors "FLY" and "WASP" based on British Standard (BS-215). WASP conductor will be applied to the line from Tanugamanono to Siumu and FLY conductor to all other lines under the Project.

The line from Tanugamanono to Siumu will have heavy demand especially at Siumu, Lotofaga and Amaile. The demand of the line ten(10) years after completion of the Project is estimated at 2,000 kW in total consisting of 550 kW from the section of Tanugamanono - Siumu, 700 kW from the section of Siumu - Lotofaga and 750 kW from the section of Lotofaga - Amaile. Because the load current of the demand is about 58A against 120A of the allowable current carrying capacity of conductor WASP, the selected conductor will be able to be used more than 10 years after completion of the Project. When Afulilo Hydropower Station is realized, electric power

will be supplied directly to Lotofaga and Amaile which are located close by.

Among the other lines, the line with the heaviest demand will be that from Puapua to Samalaeulu, the demand of which will be 500 kW (current :about 15A) while the allowable current of the conductor FLY is 100 A which will be sufficient enough for future demand increase.

(c) Insulators

22 kV pin type insulators and strain insulators are proposed. No detailed study for the insulators is required.

(d) Distribution Transformers

The capacity and numbers of distribution transformers have been selected by reference to the forecast demand summarized above. The distribution transformers have been selected on the basis of the following basic criteria:

* At least one distribution transformer is to be installed in each village.
* The distribution transformer capacities will be classified into three categories: 15 kVA, 25 kVA and 50 kVA as at present.
* 50 kVA three-phase transformers will be installed at villages where churches and hospital are located. If the demand is more than 50 kVA, single-phase 15 kVA and 25 kVA transformers will be also installed after confirming the demand in the villages.

The required distribution transformers for the Project have been selected, as summarized below, on the basis of the above criteria:

Transformers	Upolu	Savaii	Total
1-P, 15 kVA	27	38	65 (1,650 kVA)
1-P, 25 kVA	22	1	23 (875 kVA)
3-P, 50 kVA	10	0	10 (1,100 kVA)
Total	59	39	98 (3,625 kVA)

(e) Air Break Switches

When any fault is occurs in a distribution line, air break switches isolate the faulty section from the healthy sections without interrupting the power supply to the healthy sections. The switches will be installed at (a) branch points and (b) every 2 km on a distribution line. The required air break switches are as follows:

Lines	Length	Branch	Section	Total
Upolu Island				
Tanugamanono-Siumu	21 km	2	10	12
Lotofaga-Amaile	7 km	1	2	3
Salafata-Sauniatu	7 km	1	2	3
Siusega-Tanumalala	18 km	1	8	9
Aleisa-Saleimoa	4 km	1	1	2
Nuu-Faleula	3 km	1	1	2
Lepalu-Fasitoota	7 km	1	2	3
Sauimalufilufi-Satapuala	11 km	1	4	5
Savaii Island				
Puapua-Samalaeulu	17 km	3	7	10
Sasina-Matavai	26 km	2	11	13
Tafutafoe-Falearupotai	15 km	1	6	7
Tafutauta-Tafuatai	7 km	1	2	3
Patamea-Saleaula	10 km	2	4	6
Total		16	61	77

(f) Cutout Switches

Cutout switches are provided on both primary and secondary sides of the distribution

transformers and the required numbers of such switches are as follows:

Transformers	Upolu	Savaii	Total
1-P, 15 kVA	54	76	130
1-P, 25 kVA	44	2	46
3-P, 50 kVA	30	0	30
Total	128	78	206

(g) Lightning Arresters

Lightning arresters are installed on the primary side of the distribution transformers, the numbers of which are same as the primary cutout switches.

(h) Step up Transformers

The distribution line from Salelologa power station on the east coast of Savaii island is at 6.6 kV at present. The line from Puapua, at an end of the existing 6.6 kV line, to Samalaeulu will be of 22 kV to be constructed under the Project. There are two ways to connect the existing lines (6.6kV) and the line to be constructed (22 kV). One is that the existing 6.6 kV line is to be replaced by a 22 kV line and other is that the existing line voltage of 6.6 kV is to be stepped up to 22 kV by a step up transformer at the connecting end of Puapua.

The second way is proposed for the Project, because it would be necessary to install only a 500 kVA step-up transformer to 22kV at the 6.6 kV existing line end, while, it would otherwise be necessary to install a step-up transformer to 22kV at the power station and to replace all the existing 6.6kV distribution transformers by 22 kV for the first way.

(i) Watthour Meters

It was originally proposed that watthour meters be provided by EPC, but EPC requested the Government of Japan to provide watthour meters for the Project. The number of such meters required is estimated at 2,000 by reference to the number of consumer in 2004 under the Project. However, on the assumption that consumers will be connected to the EPC's distribution system gradually, only about 1,000 watthour meters will be required initially.

(j) Construction Equipment and Tools

Construction equipment held by EPC become very old, the following equipment are required to be procured for implementation of the Project;

Hydraulic excavator Capable Depth:about 4.5 m Packet Width:about 70 cm	2 unit
Lift for installation poles Hoist capacity:about 2 tons Max. lift:8 m	3 units
Rock breakers with Compressors	3 units
Trucks with hoist (10 tons) Hoist:2 tons	3 units
Wire puller, testers etc.	1 lot

(4) Specification of Equipment and Materials

Western Samoa has close relations politically and economically with New Zealand and Australia and EPC is also influenced by these countries. Accordingly, equipment and materials for distribution lines are imported from these countries in large volume and the applicable standards and regulations on power facilities are also same as these countries. Procurement method

for equipment and materials must be decided after taking into account of this situation.

The following criteria are proposed for the specifications for the equipment and materials under the Project.

(i) Design standards and regulations in Australia and New Zealand to be applied to the distribution facilities under the Project .

(ii) British standards for the distribution line equipment and materials are to be applied to the Project, however, Japanese manufacturers can cope with these easily. Standards to be applied to the Project will be as summarized below;

Equipment/Materials	Applied Standards
Supports	AS-2209
Insulators	AS-1137/equivalent standards
Insulator accessories	AS-1154/equivalent standards
Conductors	BS-215
Conductor accessories	AS-1154/equivalent standards
Transformers	BS-171/equivalent standards
Switches	BS-5419/equivalent standards
Lightning arresters	BS-2914/equivalent standards

(5) Basic Design Drawings

The basic design drawings showing all materials necessary for finding material quantities were provided for each type of distribution line to be constructed under the Project. The basic design drawings are reproduced in Appendix 4-14 "Distribution Line Supports".

4-3-2 Implementation Plan

(1) Implementation Plan

From the site investigation, it was confirmed that EPC, the executing agency in Western Samoa, has the capability to erect the distribution lines if a Japanese Consultant will assist them on the route survey, planning and design. Erection works of the Project will be executed by EPC themselves. The implementation plan for the Project will be as given below;

(a) Procurement of Equipment and Materials

It was decided that the wooden poles should be used as supports for the Project because about Yen 70 million would be saved. Wooden poles are not available in Japan and shall therefore be procured from third countries. Procurement of materials and equipment will be made as mentioned below;

Supports	Third country
Conductors	Third country or Japan
Others	Third country or Japan

(b) Transportation of Materials and Equipment

Transportation from ports of manufacturers country to Apia in Western Samoa shall be undertaken by supplier, that from Aipa to EPC warehouse, the warehouse to Savaii island and erection site shall be carried out by EPC (Government of Western Samoa)

(c) Work of the Japanese Consultant

As stated above, EPC has the capability for erection of the distribution lines, but the Government of Western Samoa has requested the Government of Japan to provide technical assistance for survey, planning and design.

There are no consultants or construction companies who can do such work in Western Samoa, since the country is very small.

It is essential therefore to provide a Japanese consultant for route survey, planning, design and some construction supervision under the Project. Two consulting engineers will be required for the Project, one as the representative, and the other is an engineer and survey expert for the route survey, taking into account the fact that the site is spread over two islands.

(d) Works of Government of Western Samoa

All the erection works including unloading of the equipment and materials at the port of Apia, inland transportation, and clearing of trees along the planned lines is to be carried out by EPC.

EPC will have responsibility for the following;

a. Assistance to the Japanese Consultant to help in their preparatory work to establish office and living accommodation at the sites
b. Right of way of line routes and clearing of trees along the lines
c. A person for public relations
d. Unloading and storage of plant and materials at Apia harbor, warehouse and sites.
e. Inland transportation from the port to the construction sites including transport to Savaii island
f. Erection of the lines
g. Manpower supply for the erection works
h. Selection of engineer in charge of erection team

i. Construction supervision of the works after Japanese Consultant left Western Samoa
j. To provide funds for taxes, duties and bank charges for the plant
k. Others matters not covered under the Japanese Grant Aid

(2) Erection Plan

Because the alignments of the distribution lines in Upolu and Savaii islands are covered by lava, it is very difficult to excavate holes for installing poles. At present this lava is blasted but this gives rise to unnecessarily large holes and the progress of the erection works is disturbed by the blasting which is very dangerous for the public. It is proposed therefore that a hydraulic excavator be used to make holes for support foundation. Each one excavator will, therefore, be procured for each island so that the erection works can be carried out safely and smoothly. In procurement of the machine, it is essential that a manufacturer's guidance engineer train local operators in operation and maintenance of the machine for at least one month in every construction phase and that nominal spare parts be procured for the first phase.

(3) Plan of Supervision Work

Erection will be done by EPC's own erection teams. The person in charge of the erection works is the Chief of Distribution Line in accordance with EPC's organization chart as shown in Appendix 3-2 "EPC Organization". However, it was decided between EPC and the study team during site investigation that the engineer in charge of the erection works should be selected by EPC for good communication and liaison between EPC and the Japanese Consultant.

(4) Implementation Schedule

Taking into account of work volume of about 168 km of 22kV and 22kV/LV lines and of about 62 km of low voltage lines mentioned in Chapter 4-3-1 "Planning of Facilities" and the erection capability of EPC, the Project is proposed to be implemented in two phases. The works for 22 kV, and LV lines to be implemented in each phase will be as summarized below;

First Phase

Upolu Island	22 kV	22 kV/LV	LV
Tanugamanono-Siumu	12 km	9 km	3 km
Aleisa-Saleimoa	0 km	4 km	3 km
Nuu-Saleula	0 km	3 km	2 km
Lepale-Fasitoota	0 km	7 km	5 km
Total Upolu	12 km	23 km	13 km
Savaii Island	22 kV	22 kV/LV	LV
Tafutafoe	3 km	12 km	4 km
Tafuauta-Tafuatai	5 km	2 km	1 km
Patamea-Saleaula	5 km	5 km	3 km
Total Savaii	13 km	19 km	8 km
Total First Phase	25 km	42 km	21 km

Second Phase

Upolu Island	22 kV	22 kV/LV	LV
Saleapaga-Lefaga	3 km	4 km	0 km
Saluafata-Sauniatu	3 km	4 km	7 km
Amaile-Afulilo	16 km	2 km	5 km
Satuimalufil.-Satapuara	7 km	4 km	5 km
Total Upolu	29 km	14 km	17 km
Savaii Island	22 kV	22 kV/LV	LV
Puapua-Samalaeulu	10 km	7 km	1 km
Sasina-Matavai	16 km	10 km	1 km
Total Savaii	26 km	17 km	2 km
Total Second Phase	55 km	31 km	19 km

From past experience of erection work by EPC's own erection teams, the teams are capable of

erecting about 4.5 km/month/team taking into account erection equipment to be procured under the Project. The working periods of first and second phases are estimated at 9.6 months and 10 months respectively, as mentioned below;

First Phase	22 kV Lines	67km
	Low Voltage Lines	63km
	Total	130km
	Erection Period:	
	130km/4.5km/3teams=9.6months	

Second Phase	22 kV Lines	86km
	Low Voltage Lines	50km
	Total	136km
	Erection Period :	
	136km/4.5km/3teams=10months	

The implementation schedule of the Project is shown in Appendix 4-13 "Implementation Schedule for Western Samoa Rural Electrification Project".

Erection of the distribution lines, whose costs including salary, labor charges, inland transport, operation & maintenance cost for construction equipment were estimated to be WS$1,800,000 for the First Phase and WS$1,700,000 for the Second Phase (Total:WS$3,500,000 equivalent Yen 220,000,000 : WS$1.0=Yen 61.96), will be undertaken by the Government of Western Samoa.

CHAPTER 5

PROJECT EVALUATION AND CONCLUTION

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

It is a major objective of the Government of Western Samoa to settle the local people in the rural areas by means of increasing their employment opportunities by developing and promoting rural industries and by improvement of living standards.

The Government of Western Samoa has been promoting rural electrification for the purpose of improving infrastructure, the livelihood of the local people and developing rural industries. In consequence, the electrification ratio of both Upolu and Savaii islands in 1990 reached 75% and 70% respectively. This Project is also planned as a part of the said rural electrification scheme. The electrification ratio is expected to be further increased after completion of the Project, as summarized below.

	Upolu Island			Savaii Island		
Year	Population	E/R (%)	Consumers (person)	Population	E/R (%)	Consumers (person)
1989	115,886	75.0%	85,915	46,291	70.0%	32,404
New up to 1992			9,150	-		-
Up to 1992		83.0%	96,065	-		-
1993	120,592	83.0%	99,966	48,171	70.0%	33,720
New consumers			6,700			2,050
Total 1993		88.0%	106,666		74.0%	35,770
1994	121,798	88.0%	112,054	48,653	74.0%	36,128
New consumers			4,450			4,950
Total 1994		92.0%	112,182		84.0%	41,078

Note E/R: Electrification Ratio

Upon completion of the Project, the electrification ratio of both Upolu and Savaii islands will be increased to 92% and 84% from 75% and 70% respectively. Consequently, about 18,000

people will newly receive electric power. This means that total electrification ratio of Western Samoa will reach 90% and development of essential infrastructure aimed as the principal objective of the Sixth Development Plan of Western Samoa will be completed.

Thus, substantial benefits are expected to result from implementation of the Project and the Project will have great significance if implemented under the Grant Aid Program of the Government of Japan.

APPENDIX 1

Basic Design Study on the Project
for
Rural Electrification in Western Samoa

MEMBERS OF THE STUDY TEAM

Team Leader	Munekazu URANO	Ministry of International Trade and Inderstry
Engineer for Network Planning	Yasuhiro HARADA	Nippon Koei Co., Ltd.
Engineer for Design	Kazuhiko KATO	Nippon Koei C., Ltd.
Engineer for Survey	Masahiro TANAKA	Nippon Koei Co., Ltd.
Engineer for Survey	Hiroyuki MORITA	Nippon Koei Co., Ltd.

Appendix 1-1B

Sapplemetary Survey on the Project
for
Rural Electrification in Western Samoa

MEMBERS OF SUPPLEMETARY SURVEY TEAM

Team Leader	Shinnichi SUZUKI	Manager of JICA Western Samoa Office
Engineer for Network Planning	Yasuhiro HARADA	Nippon Koei Co., Ltd.
Engineer for Site Survey	Toshiaki KOBAYASHI	Nippon Koei C., Ltd.

SCHEDULE OF THE BASIC DESIGN STUDY TEAM

Appendix 1-2A

Date	Mr.M.Urano	Mr.Y.Harada	Mr.K.Kato	Mr.M.Tanaka	Mr.H.Morita
Oct.9 (mon.)	Departed by JL773	Same as left	Same as left	Same as left	Same as left
10(tue.)	Curticy call to the Enbasy of Japan in New Zealand	Same as left	Same as left	Same as left	Same as left
11(wed.)	Left Auckland for Western Samoa by PH417	Same as left	Same as left	Same as left	Same as left
10(tue.)	Arrived at Faleolo airport in Western samoa.(Arrived on Oct.10 after passed the international date line.)	Same as left	Same as left	Same as left	Same as left
11(wed.)	Curticy call to EPC ,MOFA and JICA offices. Discussion with EPC	Same as left	Same as left	Same as left	Same as left
12(Thu.)	Site suevey of east coastal areas in Upolu island	Same as left	Same as left	Same as left	Same as left
13(fri.)	Site survey of north coastal ares in Savaii island	Same as left	Same as left	Same as left	Same as left
14(sat.)	Site survey of south coastal areas in Savaii island	Same as left	Same as left	Same as left	Same as left
15(sun.)	Market survey	Same as left	Same as left	Compiling data	Same as left
16(mon.)	Site survey of north-west areas in Upolu island	Same as left	Same as left	Same as left	Same as left
17(tue.)	Discussion with EPC on the minutes of meeting	Same as left	Same as left	Compiling data collected	Same as left
18(wed.)	Signing the minutes of meeting	Preparation of the minutes of meeting	Compiling data collected	Site survey of Aleisa area in Upolu island	Compiling data and preparing site survey schedule
19(thu.)	Returned to Japan by PH741	Power demand analysis	Study on distribution line material	Site survey of Aleisa area in Upolu island	Compiling data

Date	Mr.M.Urano	Mr.Y.Harada	Mr.K.Kato	Mr.M.Tanaka	Mr.H.Morita
20(fri.)		Preparation of power system drawing Power demand analysis	Study on distribution line material	Site survey of Sauniatu area in Upolu island	preparing site survey schedule
21(sat.)		Compilimg data collected	Preparation of spec. for distribution line materials	Compiling data collected	Compiling data
22(sun.)		Compilimg data collected	Compilimg data collected	Compilimg data collected	Compiling data
23(mon.)		Power demand analysis	Preparation of cost estimate for line materials	Site survey of Aleisa area in Upolu island	Left for Savaii island for site survey
24(tue.)		Collection of data for Afulilo project	Preparation of cost estimate for line materials	Site survey of Siusega area in Upolu island	Site survey of east area in Savaii island
25(wed.)		Collection of data for Afulilo project	Preparation of drawings of pole fittings	Site survey of Lotofaga area in Upolu island	Site survey of east area in Savaii island
26(thu.)		Preparation of field survey report	Preparation of drawings of pole fittings	Site survey of Sauniatu area in Upolu island	Site survey of north area in Savaii island
27(fri.)		Compiling data collected	Preparation of drawings of pole fittings	Site survey of Sauniatu area in Upolu island	Site survey of west area in Savaii island
28(sat.)		Preparation of field survey report	Preparation of drawings of pole fittings	Compiling data collected	Returned from Savaii island
29(sun.)		Compiling data collected	Compiling data collected	Compiling data collected	Compiling data collected
30(mon.)		Reporting to Mr.Mikami,diplomatic officiai,MOFA of Japan	Preparation of cost estimate for line materials	Field observation of EPC's stringing work	Same as left
31(tue.)		Construction cost estimate for distribution line	Preparation of cost estimate for line materials	Field observation of EPC's stringing work	Same as left
Nov. 1(wed.)		Construction cost estimate for distribution line	Preparation of cost estimate for line materials	Survey for EPC store and P/S	Compiling data collected
2(thu.)		Preparation of field survey report	Meeting on spec. of line materials	Assist to prepare field survey report	Compiling data collected
3(fri.)		Compiling data collected	Meeting on spec. of line materials	Site survey of north area in Savaii island	Same as left

Date	Mr.M.Urano	Mr.Y.Harada	Mr.K.Kato	Mr.M.Tanaka	Mr.H.Morita
4(sat.)		Compiling data collected	Meeting on spec. of line materials	Site survey of north area in Savaii island	Same as left
5(sun.)		Market survey	Market survey	Site survey of north area in Savaii island	Same as left
6(mon.)		Field survey of Tanuganono P/S	Same as left	Field observation of EPC's stringing work	Same as left
7(tue.)		Preparation of field survey report	Meeting on spec. of line materials	Field observation of EPC's excavation work	Same as left
8(wed.)		Preparation of field survey report	Compiling data collected	Compiling data collected	Compiling data collected
9(thu.)		Left Apia by PH741	Left Apia by PH741	Left Apia by PH741	Left Apia by PH741
10(fri.)		Arrived at Auckland by PH741	Arrived at Auckland by PH741	Arrived at Auckland by PH741	Arrived at Auckland by PH741
11(sat.)		Left Auckland by JL774	Left Auckland by JL774	Left Auckland by JL774	Left Auckland by JL774

Notes :

EPC : Electric Power Corporation
P/S : Power station
MOFA : Ministry of Foreign Affairs
JICA : Japan International Corporation Agency

SCHEDULE OF SAPPLEMETARY SURVEY TEAM

Appendix 1-2B

Date	Mr.S.Shimizu	Mr.Y.Harada	Mr.T.Kobayashi
Oct.8 (Teu)		Departed by NZ 090	Same as left
9 (Wed)	Joined with survey team at Apia and Meeting among team members. Visited EPC	Arrival at Western Samoa via New Zealand Same as left	Same as left
10 (Thu)		Visited Aflilo site, sinca General Manager is out of Apia	Same as left
11 (Fry)		Inspection of hydro-power station near Apia	Same as left
12 (Sat)		Meeting with General Manager	Same as left
13 (San)		Maket survey	Same as left
14 (Mon)		Preparation of Minutes of Meeting	Site survey at Southern costal area
15 (Tue)		Discussion with EPC about T/L facilities	Same as left
16 (Wed)		Meeting with EPC and Team. JICA Mr. Nishimiya jointed Finalization Minutes of Meeting	Same as left
17 (Thu)	Signing Minutes of Meeting between Government of Western Samoa and the team	Same as left	Same as left
18 (Fry)		Site survey of Tamugamanono P/S	Same as left
19 (Sat)		Site survey of Sauniatu, Lalomauga P/S	Same as left
20 (San)	Left Western Samoa for Japan	Data collection	Same as left
21 (Mon)		Visited Yazaki Factory	Same as left
22 (Tue)		Site survey at Savaii North coast	Same as left
23 (Wed)		Site survey at Savaii South coast	Same as left
24 (Thu)		Discussion with EPC	Same as left
25 (Fry)		Site survey at Upolu North coast	Same as left

Date	Mr.S.Shimizu	Mr.Y.Harada	Mr.T.Kobayashi
26 (Sat)		Data collection	Market survey
27 (San)		Data collection	Market survey
28 (Mon)		Discussion with EPC	Same as left
29 (Tue)		Left Apia for New Zealand	Same as left
30 (Wed)		Arrival Wellington via Auckland	Same as left
31 (Thu)		Visited Japanese Embassy, left for Sidney	Same as left
Nov.1 (Fry)		Arrival Tokyo by QF 021	Same as left

APPENDIX 1-3A

MINUTES OF MEETING BETWEEN THE GOVERNMENT OF WESTERN SAMOA AND PRELIMINARY SURVEY TEAM

MINUTES OF MEETING ON THE PROJECT FOR RURAL ELECTRIFICATION IN WESTERN SAMOA

In response to the request of the Government of Western Samoa, the Government of Japan decided to conduct a Preliminary Study on the project for Rural Electrification and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Western Samoa the study Team headed by Mr Saburo ITO, Deputy Director, Electric Power Technology Div., Agency of Natural Resources and Energy, Ministry of International Trade and Industry from June 12 to June 27, 1989.

The Team had a series of discussion on the Project with the officials concerned of the Government of Western Samoa headed by Mr Eric J Hussey and conducted a field survey in the Proposed area.

As a result of the study, both parties agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

June 22, 1989

Saburou Ito

Mr Saburou ITO
Leader
Preliminary Study Team
JICA

Hon Jack Netzler
Acting Minister of Works and
Electric Power Corporation

ATTACHMENT

1. The objective of the project is to improve the living standards of people who live in rural areas, by means of Rural Electrification.

2. The site of the Project is both islands, UPOLU and SAVAII. (Site map is attached as Annex II and III)..

3. The request of the Government of Western Samoa made on the Project for Japanese Grant Aid is as follows:

   (1) Provision of materials for the construction of 22 kV trunk line and low voltage line, (excluding service line for house connection) networks on UPOLU and SAVAII Islands: Cables, poles, transformers and others. (Priority of line route are indicated on the site map).

   (2) Provision of construction machinery and vehicles: Drilling Machine, pick-up truck and others.

   (3) Consultant Services for Detail Design and Construction Supervision.

4. The Government of Western Samoa requested the Team to convey their proposal to the Government of Japan in addition to the above items, that specification of electric poles for the line between Apia and Afulilo by way of south coast will be of sufficient height for future line addition of 66 kV.

5. Electric Power Corporation is responsible for the administration of the Project.

6. The Government of Western Samoa has understood Japanese Grant Aid System explained by the Team which includes a principle for the use of Japanese Consultancy Firm and General Contractors for the detail design, construction supervision and supply of materials.

7. The Government of Western Samoa will undertake items listed in Annex I when the Government of Japan decides to extend Grant Aid for the said Project.

8. The Government of Western Samoa in view of the priority of the rural electrification programme stressed the importance of implementing the physical construction work for the project in the 1990 calendar year and requested the Team to convey the same to the Government of Japan.

9. If it is found feasible as a result of the Preliminary Study, the Government of Japan will send the Basic Design Study Team in order to collect further information and data.

10. The Government of Western Samoa shall provide all necessary information and data when the Basic Design Study Team visit Western Samoa.

ANNEX I

UNDERTAKINGS BY THE GOVERNMENT OF WESTERN SAMOA

1. To secure and clear the lands for the construction.

2. To secure the temporary yard to store the material provided under Grant Aid.

3. To secure all local costs for the works: Labour cost, fuel for machines and vehicles, administration and others, not covered by Grant Aid.

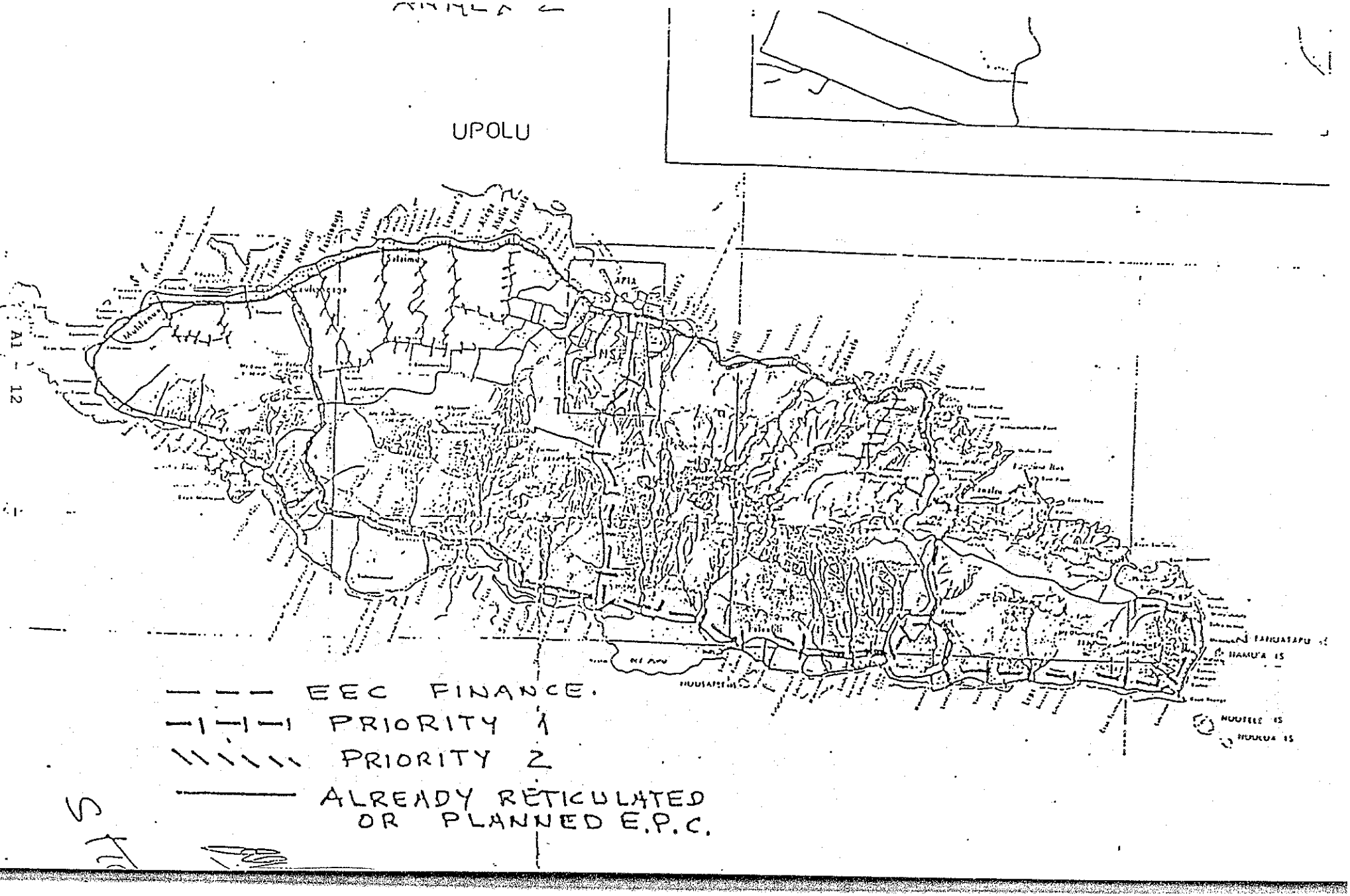
4. To ensure prompt unloading of material provided under Grant Aid.

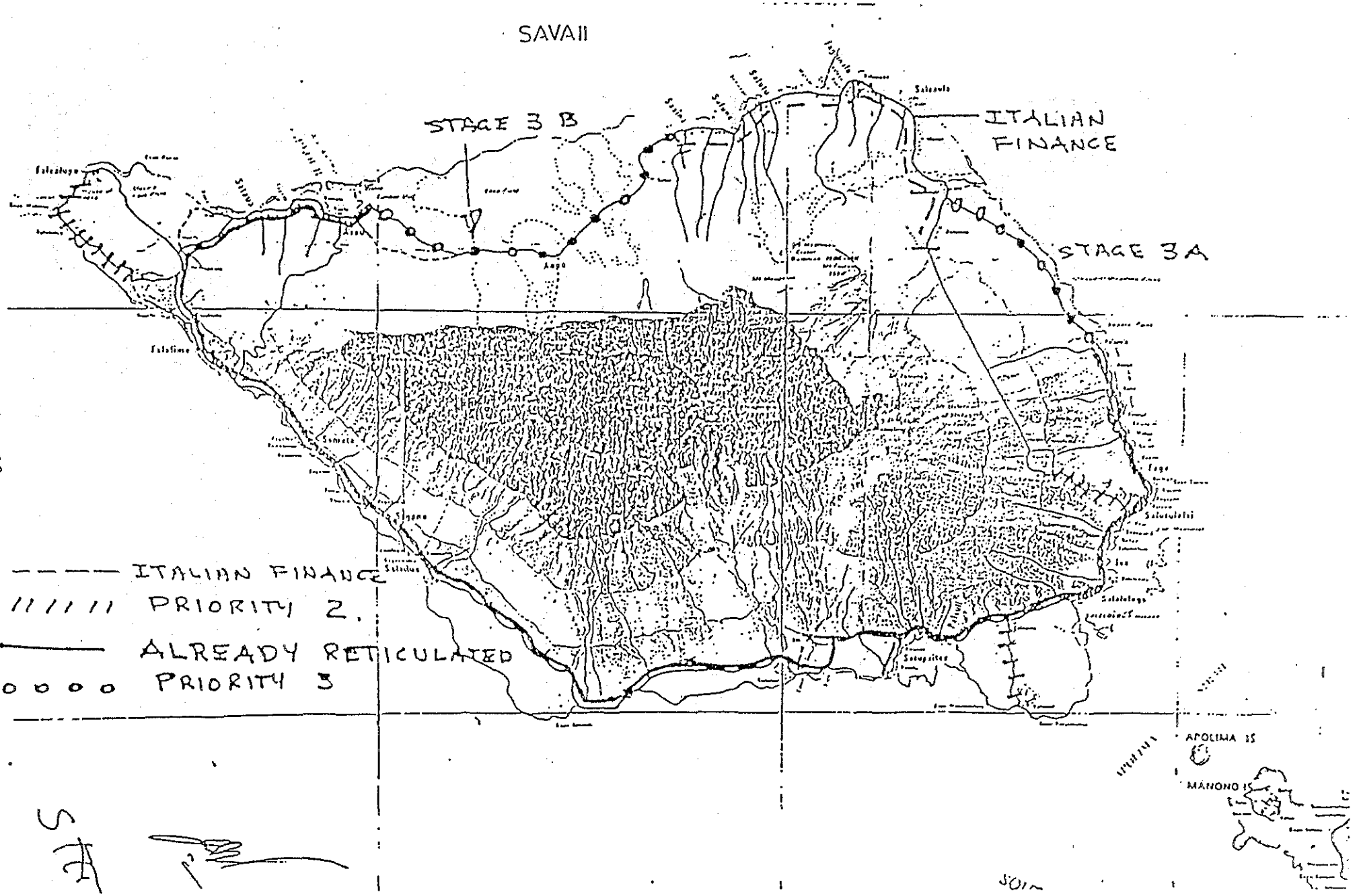
5. To meet customs duties for materials.

6. To grant exemption to Japanese nationals who will serve under the Project from local tax and other fiscal levies.

7. To bear the expense for banking services.

8. Others in accordance with principle of Japan's Grant Aid Program


UPOLU
A1 - 12
EEC FINANCE.
PRIORITY 1
PRIORITY 2
ALREADY RETICULATED OR PLANNED E.P.C.


SAVAII
STAGE 3 B
ITALIAN FINANCE
STAGE 3A
ITALIAN FINANCE
PRIORITY 2.
ALREADY RETICULATED
PRIORITY 3
APOLIMA IS
MANONO IS

It is intended to confirm the following results of field survey based on which the basic design will be carried out.

1. FINDINGS IN THE ROUTE SURVEY

(1) Right of Way

Result of site survey for the new line under construction for rural electrification (about 12 km extension from Leulumoega) revealed that habitants who possess land space for the new line route cooperated with EPC in clearing the way in cutting thick trees by themselves to such extent that erection of pole and stringing works were smoothly carried out. The fact is a symbolic outcome which supports urgent need of electrification for habitants and brings about speedy and economical electrification as a result. EPC is confident of this status to be sustained in new line routes which are indicated in the minutes in order of priority.

(2) Private Diesel Power Lines

Three low voltage private diesel power lines, Letui, Manase and Matautu were located along north east coast of Savaii, each of which has a diesel generator (approx 20 kVA), and supply power to each village in the night time.

In the case that rural electrification work proceed to those areas, the existing facilities may be utilized (i.e. poles, conductors, insulators) if they are in good conditions and if villages agree.

(3) Access Routes to Villages

Result of route survey for spur line to Falealupo and Tufutafoe village revealed the following:

1) On route to the villages, no development and very few houses were found.

2) There are two (2) routes to the villages, but south route will be easy in access thereto (i.e. Tufutafoe route).

3) Numbers of people are 1550 and two (2) primary schools are there.

Above factors shall be considered economically at the time of final selection of areas to be electrified at the basic design stage.

(4) Supply to Areas from Saleaula to Sasina

There are two (2) alternatives, that is, one is by an isolated system with a diesel power plant to be newly provided and the other is by supply from Salelologa

through 22 kV line. However the route from Puapua to Saleaula pass through lava4 area where pole erection may require drilling and compressor machine.

The basic design should be carried out in consideration of:

1) Confirmation of applicability of tools above mentioned for pole erection.

2) Economic comparison of two (2) alternatives and others.

(5) Afulilo Hydropower Project

Result of survey revealed:

1) Investigation into the scheme is complete.

2) Tenders has been opened for civil works and machinery.

3) Funding agency approval of the tender yet to be received. Actual work is expected to start in early 1990.

4) Cost for the line from the existing Lalomauga Power Station to the new Ta'elefaga power station; the Fagaloa Bay line and the line from Ta'elefaga to Lotofaga are covered by this project.

2. MATERIAL

(1) Type of Poles

It was found that EPC has used wooden poles because the poles are procurable from neighbouring countries like New Zealand and Australia and easy for erection in mountainous areas in Western Samoa. Wooden poles will be convenient also in this project.

However study is required for comparison with concrete pole taking into account that prestressed concrete poles will be also procurable in neighbouring countries and their life is more than twice the wooden poles.

(2) Other material

It was found that EPC had used other material also from neighbouring countries (so called third countries), thus it is probable that procurement of this project is made from those countries. As a result price estimate in the basic design stage shall be made considering the recent actual prices of those material.

3. SPECIFIC CONDITION IN BASIC DESIGN

(1) Wind Pressure

Wind velocity : 35 m/sec

Safaty factor to the wind pressure applied:

Steel and concrete pole	-	2
Wooden pole (hard)	-	4
Wooden pole (soft)	-	6

(2) Insulator Contamination by Salt

No special insulator for salt contamination required.

(3) Basic Impulse Level of 22kV Line

125 kV.

(4) Lightning Stroke to the Ground

Seldom inspite of high IKL of 60.

(5) Sag and Tension of Conductor

Maximum tension less than 20% of UTS.
(Temperature 25°C and light wind).

APPENDIX 1-3B

MINUTES OF MEETING
BETWEEN
THE GOVERNMENT OF WESTERN SAMOA
AND
BASIC DESIGN STUDY TEAM

MINUTES OF MEETING
ON
RURAL ELECTRIFICATION PROJECT
IN WESTERN SAMOA

In response to the request of the Government of Western Samoa for a grant aid of the rural electrification project (hereinafter referred to as the Project) the Government of Japan has dispatched, through the Japan International Cooperation Agency (JICA), a survey team headed by Mr. Munekazu URANO, Electric Power Technology Div., Agency of Natural Resources and Energy, Ministry of International Trade and Industry from Oct. 9, 1989 to Nov. 11, 1989.

The Team had a series of discussion with the officials concerned of the Government of Western Samoa headed by Mr. Eric J. Hussey and carried out a field survey at the Project areas.

As a results of the survey, discussion and study, both parties agreed to recommend to their respective Government that the results of the survey, discussions and study attached herewith should be examined towards the realization of the Project.

Apia, Western Samoa, October 13, 1989

Munekazu URANO

Mr. MUNEKAZU URANO
Leader
Basic Design Study Team
JICA

MR. HON JACK NETZLER
Acting Minister of Work and
Electric Power Corporation

ATTACHMENT

1. The both parties confirm that items from 1 to 10 mentioned on the ATTACHMENT of the Minutes of Meeting signed between the Government of Western Samoa and Preliminary Study Team, JICA dated June 22, 1989 are remained unchanged, and further confirmation are as mentioned hereunder:

   a. The following sections of the lines are excluded in the Japanese Grant Aid and built by EPC;

      Upolu Island: Siumu to Sopoaga (Ref. attached Plate-1)
      Savaii Island: Fusi to Vaiola, Vai'a'ata and Tapu'ele'ele (Ref. attached Plate-2)

   b. The construction methods and completion period of the above lines shall be coordinated with the lines under the Japanese Grant Aid.

2. The following materials, equipment and erection tools (hereinafter referred to as the Plant) for the Project will be provided under the Japanese Grant Aid.

   Distribution line poles
   Conductors
   Insulators
   Distribution transformers
   Switches
   Construction equipment and tools
   Miscellaneous materials and equipment

3. The Consultant will provide the following services for the implementation of the Project;

   Detailed design of the distribution system
   Preparation of the tender document for procurement of the Plant
   Technical assistances for erection works
   Administrative services for the implementation of the Project
   Other assistances

M. URANO

4. The basic design report will be submitted to the Government of Western Samoa by the middle of Mar. 1990.

5. The minutes of meeting signed between the Government of Western Samoa and the Preliminary Study Team is attached herewith for confirmation.

M. UCHIYAMA

UPOLU ISLAND

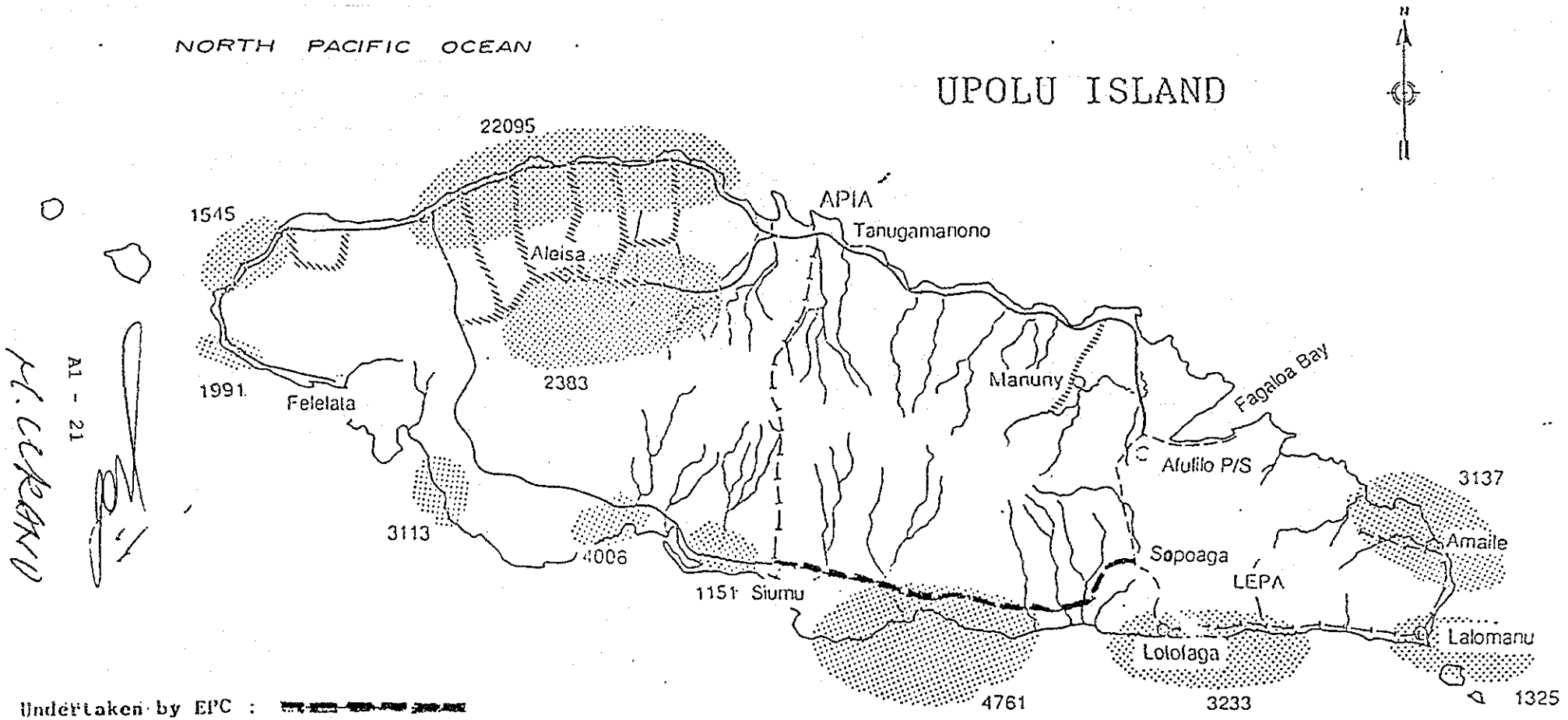
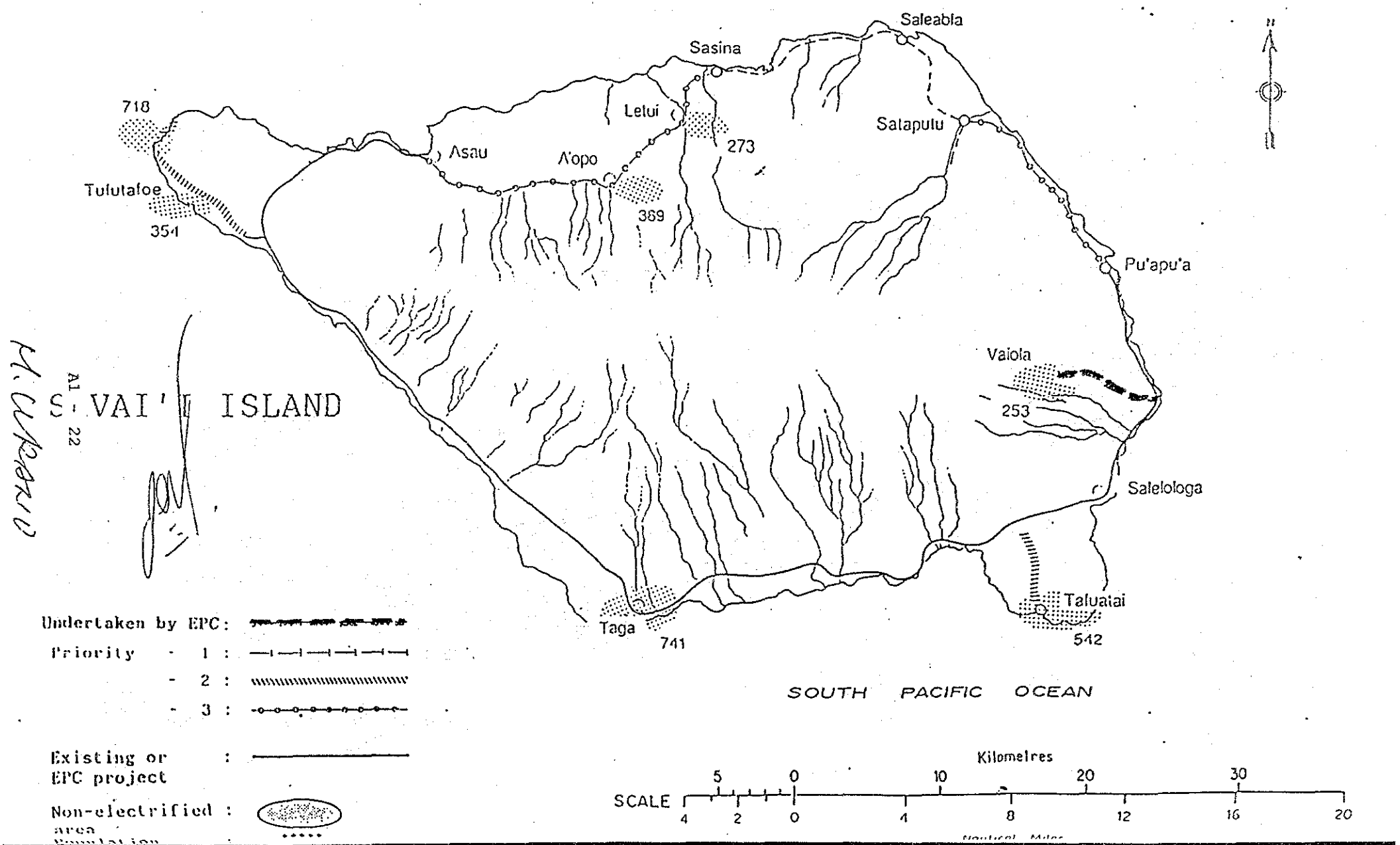


PLATE-2


NORTH PACIFIC OCEAN
Saleabla
Sasina
Letui
Satapulu
718
273
Asau
A'opo
Tulutafoe
389
354
Pu'apu'a
Vaiola
253
SAVAI'I ISLAND
Salelologa
Taga
741
Taluatai
542
SOUTH PACIFIC OCEAN
Undertaken by EPC:
Priority - 1 :
- 2 :
- 3 :
Existing or EPC project :
Non-electrified area :
Kilometres
SCALE
5 0 10 20 30
4 2 0 4 8 12 16 20

APPENDIX 1-3C

FIELD SURVEY REPORT FOR BASIC DESIGN SURVEY AND EPC's COMMENT FOR THE REPORT

FIELD SURVEY REPORT
ON
RURAL ELECTRIFICATION PROJECT
IN WESTERN SAMOA

It is intended to confirm the following results of the site survey and study made by the Basic Design Study Team of JICA on the Rural Electrification Project.

1. Scope of Project

During site survey of the proposed Project areas with EPC Engineers, it has been found that the following distribution lines in Upolu and Savaii islands will be undertaken by the Japanese Grant Aid, the length of the lines are provisional length which will be finalized referring to the 1/20,000 maps during basic design study:

a. Upolu Island	22 kV Lines	HV/LV Lines	LV Lines	Priority
Tanugamanono - Siumu	16 km	9 km	3 km	1
Lotofaga - Amaile	7 km	15 km	21 km	2
Saluafata - Sauniatu	3 km	4 km	7 km	5
Siusega - Tanumalala	13 km	6 km	9 km	3
Aleisa Road - Saleimoa	4 km	3 km	3 km	6
Nuu - Faleula	0 km	3 km	2 km	4
Lepale - Fasitoouta	4 km	3 km	3 km	7
Satuimalufilufi - Satapuala	5 km	8 km	7 km	8
Total Upolu Island	52 km	51 km	55 km	

b. Savaii Island	22 kV Lines	HV/LV Lines	LV Lines	Priority
Puapua - Samalaeulu	10 km	7 km	1 km	11
Sasina - Matavai	16 km	10 km	1 km	12
Tafutafoe	5 km	2 km	1 km	9
Tafuaufa - Tafuatai	3 km	12 km	4 km	10
Total Savaii	34 km	31 km	7 km	

c. Total Length of Lines	22 kV Lines	HV/LV Lines	LV Lines
	86 km	82 km	62 km
22 kV Lines'	1[illegible] km		
LV lines	14[illegible] km		

The Project may be undertaken into two phases, the selection of the lines in the each phase will be made referring to the priority mentioned above, the lines have prior numbers will be included in the first phase, the remaining lines will be in the second phase.

2. The following materials, equipment and erection tools for the Project will be provided under the Japanese Grant Aid.

Distribution line poles, crossarms and fittings
Conductors, joints, preformed grips and fittings
Insulators, clamps and fittings
Distribution transformers and accessories
Switches lightning arresters and accessories
Construction equipment (Drilling machine)
Pickup trucks
Construction tools
Miscellaneous materials and equipment

It is noted that the Watt-Hour Meters and the step up transformer to be installed at Puapua will be studied during the basic design.

3. The Terms of Reference of the Consultant are as mentioned below:

Home Works

- Detailed design of the distribution system
- Preparation of the bid document for procurement of the Plant
- Administrative works for bidding, evaluation and contract
- Checking of drawings for approval and comment on it
- Pre-shipment inspection and issuing inspection certificates

Field Works

- Pre-shipment inspection and issuing inspection certificates, when required
- Preparation of construction drawings such as route maps, pole and insulator configuration
- Preparation of implementation schedule
- Supervising construction works
- Assist to EPC for the commissioning test of the completed lines

- Providing monthly progress reports
- Provision of foremen for additional working gangs. if required

4. The Government of Western Samoa will provide the followings;
   - To assist provision of site accommodation for the consultant at Apia and Lanomanu in Upolu. Salelologa and Vaisala
   - To secure right of way and clearing of the line routes
   - To provide a personnel of Public Relation to solved trouble with local peoples
   - To provide stock yards for the imported materials for the Project and to secure those materials in stores
   - To unload all materials arrived at Western Samoa and clear it from the custom security
   - To transport the materials from the port of Apia to construction sites via depots including transport to Savaii island
   - To construct all distribution lines
   - To provide all erection forces for the construction works
   - To nominate a person in charge to control construction gangs for implementation of the Project
   - To provide all local fund including custom duties and taxes for the imported materials if required and the banking charges for the banking arrangement required under the Japanese Grant Aid
   - Others not covered by Japanese Grant Aid

5 Technical Confirmation

a. 66 kV design of poles

Taking into account of the future reinforcement of the power system in Upolu island, the poles from Tanugamanono to Lotofaga via Siumu are requested to have sufficient height to add a 66 kV line at the top of the poles. Therefore, the lines from Siumu to Lotofaga and Lotofaga to Afulilo power station, which are scheduled to be undertaken by EPC and EEC respectively, are also designed to have such sufficient pole height.

b Design concept

The design of the distribution lines shall basically be made in accordance with [CORD OF PRACTICE FOR OVERHEAD LINE CONSTRUCTION] established by Electricity Supply Association of Australia: No. C(b) 1, 1974 superseding 1962.

The main design criterion are as mentioned below;

Maximum ambient temperature			34 deg. C (M/Record)
Average (Every day) temperature of conductor			
Minimum temperature of conductor:			15deg. C (M/Record)
Maximum Conductor Temperature for Max. sag			
Every day stress:		18 % at 15deg. in still air	(Cord C(b) 1)
Recorded Max.Wind velocity:		82 Knot (41 m/sec)	(M/Record)
Wind loads	On conductors	500 Pa	(Cord C(b) 1)
	On Poles	750 Pa	(Cord C(b) 1)
Safety factor	Conductors	18 % at 15deg. in still air	(Cord C(b) 1)
		50 % at 15deg. C with wind	(Cord C(b).1)
	Poles	Wooden poles:	
		Concrete poles:	
		Steel poles:	
		Steel structures	
Ground clearance	a. Over road:	6.7 m	(Cord C(b).1)
	b. Over other road:	6.7 m	(Cord C(b).1)
	c. Over field not negotiable by vehicles:	5.5m	(Cord C(b) 1)
	Clearance for rural area may be 0.6 m less than above c.		
Spacing	Between phase conductor: (Cord C(b).1)		
	$S = 0.0076$ m/kV + $0.37 \times (S)^{1/2}$ where S=dip in m		
	Between phase and neutral:		
	Other structures and building: (Cord C(b).1)		
	Vertical over floor	5.5 m	
	Vertical over roof	4.6 m	
	In any direction from walls	3.0 m	
	In any direction from structure	3.0 m	

Equipment basic insulation level (Spec for Tululbe Project)

22 kV [illegible]

c. Distribution Line Materials

Conductors	High voltage		AAC	FLY
			AAC	WASP
	Line from Tanugamanono to Siumu		AAC	WASP
	Other lines		AAC	FLY
	Low voltage	Phase conductor	PVC Covered AAC	FLY
		Neutral wire	AAC Bare	FLY
	Applied Standard		BS-215	
Insulators	High voltage	22 kV Pin type insulator		
		Strain. Ball socket type suspension discs		
	Low voltage	400V Pin		
	Color of Insulators and Bushing			
	Applied Standard			

Poles: Poles will be specified in acordance with AS 2209 and NSW Overhead Line Construction and Maintenance Regulations 1962 as follows:

Length	Stress Group	Treatment	Top Load
9 m (LV)	A (F=100 MPa)	Full length	6 kN
		Preservative	8 kN
		Treated	
12.5 m (22kV)	A (F=100 MPa)	Full length	6 kN
		Preservative	8 kN
		Treated	12 kN
14 m (66/22kV)	A (F=100 MPa)	Full length	8 kN
		Preservative	12 kN
		Treated	

Applied Standard: AS-061, 0117-1970, 2209-1979

d. Distribution transformers are installed on the basis of the following conditions

i Each village shown on the attached map is provided at least one distribution transformer

ii Single phase transformers 15 kVA and 25 kVA are basically provided in rural area

iii Three phase transformers will be installed at the village where demand is expected to be more than 50 kVA.

iv The demand in each village is estimated on the basis of population and demand per capita (about 30 to 40 W per Capita) obtained from the past record for keeping the same life level as the habitants in electrified area. The list of transformers estimated in accordance with the above conditions is attached for reference.

e The section switches will basically be provided at the following points

i Branch points of the 22 kV lines

ii Every 2 km but it's interval will be decided taking into account location of villages on line routes.

f. Selection of Poles

The wooden poles will basically be used for the Project, however, concrete poles and steel poles are also studied for the economical comparison. If concrete or steel poles is economical, these will be selected for the supports of the Project.

g. Step up transformer 6.6/22 kV at Savaii Island

The voltage of the existing line from Salelologa power station in Savaii island toward Puapua is 6.6 kV, the voltage of the line from Puapua to North coast to be constructed under the Project will be designed with 22 kV. Therefore, a step up transformer from 6.6 kV to 22 kV will be required to be installed at Puapua.

EPC has a plan to up grade the existing 6.6 kV line into 22 kV which has been discussed in the Committee of Rural Electrification Programme and mentioned on the Report issued on May, 1988. The step up transformer will be required till the existing 6.6 kV line is up graded, the capacity of the transformer, therefore, is estimated for covering the demand of villages at North coast up to Aopo, but less than the capacity of the existing step up transformer installed at the Salelologa power station.

h. Feeder from Tanugamanono power station

The existing outgoing feeders at the Tanugamanono power station are four (4) 6.6 kV feeders and three (3) 22 kV feeders, one 6.6 kV feeder named Alaoa feeder out of four will be up graded to 22 kV feeder when the line from Tanugamanono to Siumu is completed

EPC intends to provide a new outdoor switchyard out side the power station at his own cost taking into account of the expansion of 22 kV feeders and 66 kV feeders for the 66 kV transmission system in future The out door switchyard shall have to be completed by the commencement of the 22 kV line for Siumu under the Project

No equipment and materials for the 22 kV feeder for the outdoor switchyard at the power station, therefore, is required to be provided under the Japanese Grant Aid Project.

i. Provisional Pole Arrangement

The provisional pole arrangement for the 22/LV distribution lines to be constructed under the Project are attached herewith for reference.

6 Capability of EPC erection gangs

a. Work progress undertaken by EPC erection gang

The erection gangs (two gangs) of EPC have completed the line from Leulumoega to Siumu about 35 km in length for five months with two gangs, the work progress is, therefore, calculated to be 3.5 km/month/gang.

The stringing work for low voltage single phase line is being carried out at the South coast, the progress is calculated to be 3.5 km/day (stringing work is being carried out in night time, since no traffic on the road).

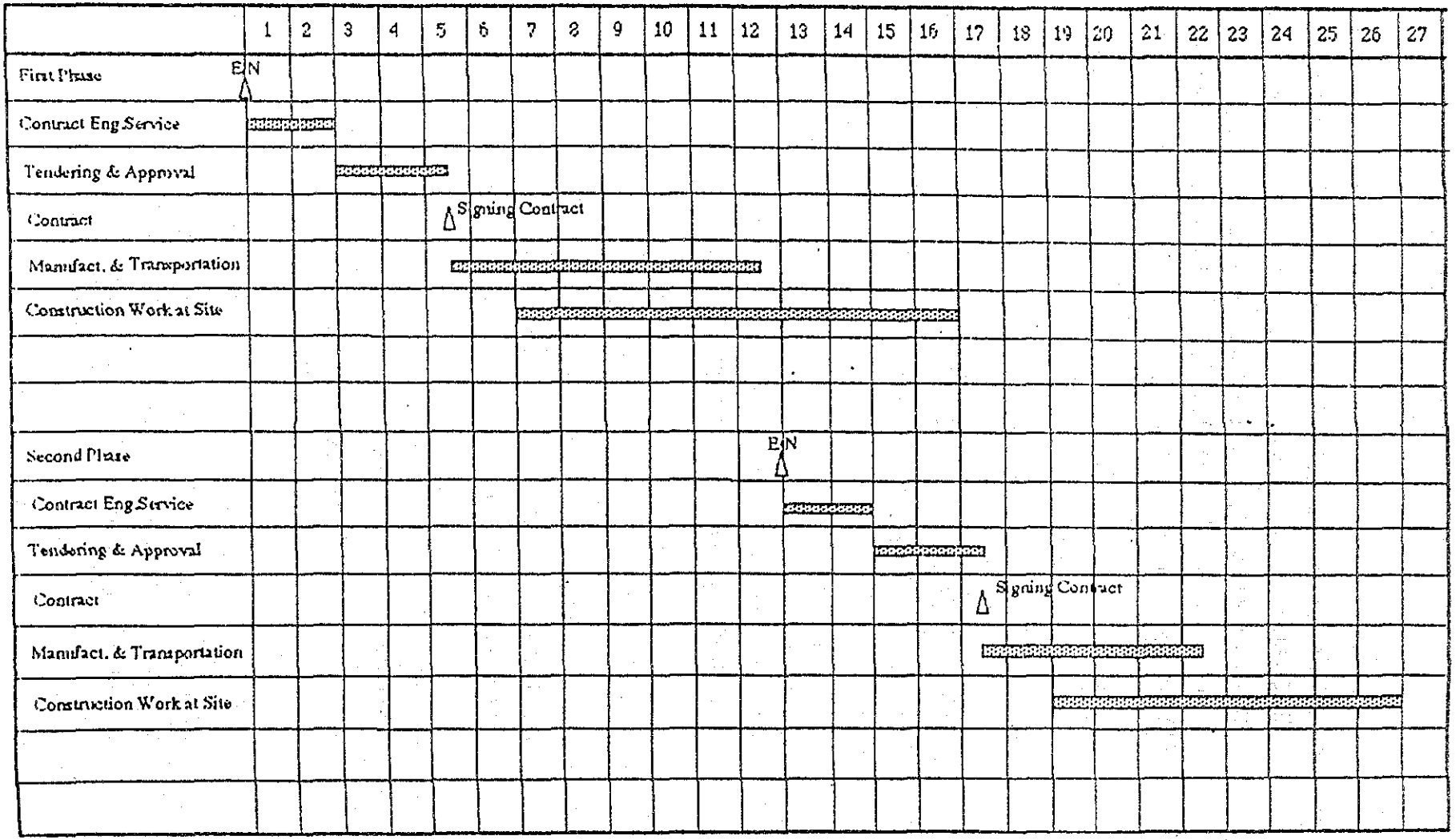
b. EPC organization for the Project

All construction works of the distribution lines under Japanese Grant Aid will be undertaken by EPC's own construction gangs. A person in charge to control the construction gangs is required to be nominated by EPC for the proper implementation of the Project.

7. Tentative Implementation Schedule

Referring to the Item 17 Reference in page 14 in [Japan's Grant Aid Program] the Tentative Implementation Schedule for the Project is estimated to be as shown on the attached Schedule provided that all construction gangs under EPC are placed for the Project.

TENTATIVE IMPLEMENTATION SCHEDULE ON RURAL ELECTRIFICATION IN PROJECT IN WESTERN SAMOA



Population and Transformer Capacity for Villages to be Electrified

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
UPOLUISLAND											
VAIMAUGA WEST	**Moataa**	1,363	1,447	43	58	72		0	0	0	0
	Vaivase-Tai	1,344	1,426	43	57	71		0	0	0	0
	Vaivase-Uta	542	575	17	23	29		0	0	0	0
	Magiagi-Tai	1,419	1,506	45	60	75		0	0	0	0
	Magiagi-Uta	56	59	2	2	3		0	0	0	0
	Toomatagi	286	304	9	12	15		0	0	0	0
	Tanoalei'a	719	763	23	31	38		0	0	0	0
	Faatoialemanu	965	1,024	31	41	51		0	0	0	0
	Vaiala-Tai	481	511	15	20	26		0	0	0	0
	Vaiala-Uta	236	250	8	10	13		0	0	0	0
	Vinifou	131	139	4	6	7		0	0	0	0
	Vaipuna	391	415	12	17	21		0	0	0	0
	Levili	203	215	6	9	11		0	0	0	0
	Matautu-Uta	511	542	16	22	27		0	0	0	0
	Matautu-Tai	872	926	28	37	46		0	0	0	0
	Leone	581	617	18	25	31		0	0	0	0
	Vaisigano	432	459	14	18	23		0	0	0	0
	Niue	233	247	7	10	12		0	0	0	0
	Maluafou	120	127	4	5	6		0	0	0	0
	Malifa	258	274	8	11	14		0	0	0	0
	Lelata	196	208	6	8	10		0	0	0	0
	Leifiifi	239	254	8	10	13		0	0	0	0
	Motootua	1,131	1,200	36	48	60		0	0	0	0
	Leufisas	255	271	8	11	14		0	0	0	0
	Tanugamanon	654	694	21	28	35		0	0	0	0
	Papauta	504	535	16	21	27		0	0	0	0
	Vailima	790	838	25	34	42		0	0	0	0
	Avele	371	394	12	16	20		0	0	0	0

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
	Letava	264	280	8	11	14	15	1	0	0	0
	Vaoala	503	534	16	21	27	50	0	0	1	0
	Tiapapata	112	119	4	5	6	15	1	0	0	0
	Afiamalu East	74	79	2	3	4	15	1	0	0	0
	Afiamalu West	40	42	1	2	2	15	1	0	0	0
	Apia	358	380	11	15	19		0	0	0	0
	Tauese	236	250	8	10	13		0	0	0	0
	Tufuiopa	370	393	12	16	20		0	0	0	0
	Lalovaea	815	865	26	35	43		0	0	0	0
	Palisi	671	712	21	28	36	50	0	0	1	0
	Matafele	53	56	2	2	3	15	1	0	0	0
	Mulivai	66	70	2	3	4	15	1	0	0	0
	Tuloto	541	574	17	23	29		0	0	0	0
	Togafuafua	389	413	12	17	21		0	0	0	0
	Taufusi	716	760	23	30	38		0	0	0	0
	Alamagoto	611	648	19	26	32		0	0	0	0
	Vaimea	426	452	14	18	23		0	0	0	0
	Fugalei	868	921	28	37	46		0	0	0	0
	Salcufi	516	548	16	22	27		0	0	0	0
	Savalalo	396	420	13	17	21	25	0	1	0	0
	Gogi	314	333	10	13	17	25	0	1	0	0
	Mulinuu	194	206	6	8	10	15	1	0	0	0
	Aai-o-Fiti	282	299	9	12	15	15	1	0	0	0
	Sub-Total	24,098	25,577					8	2	2	0

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
SIUMU	Maninoa	320	340	10	14	17	25	0	1	0	0
	Siumu	561	595	18	24	30	50	0	0	1	0
	Siumu-Uta	590	626	19	25	31	50	0	0	1	0
	Saaga	407	432	13	17	22	25	0	1	0	0
	Sub-Total	1,878	1,993					0	2		
FALEALILI	Togitogiga	45	48	1	2	2	15	1	0	0	0
	Iliili	77	82	2	3	4	15	1	0	0	0
	Saleilua	549	583	17	23	29	50	0	0	1	0
	Poutasi	462	490	15	20	25	25	0	1	0	0
	Vaovai	638	677	20	27	34	50	0	0	1	0
	Hatautu	296	314	9	13	16	25	0	1	0	0
	Tafatafa	275	292	9	12	15	15	1	0	0	0
	Malaemalu	239	254	8	10	13	15	1	0	0	0
	Satalo	302	321	10	13	16	25	0	1	0	0
	Piu	74	79	2	3	4	15	1	0	0	0
	Sapunaoa	387	411	12	16	21	25	0	1	0	0
	Salwsatele	368	391	12	16	20	25	0	1	0	0
	Siuniu	116	123	4	5	6	15	1	0	0	0
	Salani	631	670	20	27	33	50	0	0	1	0
	Utulaelae	171	181	5	7	9	15	1	0	0	0
	Sapee	131	139	4	6	7	15	1	0	0	0
	Sub-Total	4,761	5,053					8	5	3	0
LOTOFAGA	Matatufu	475	504	15	20	25	25	0	1	0	0
	Lotofaga	916	972	29	39	49	50	0	0	1	0
	Vavau	387	411	12	16	21	25	0	1	0	0
	Sub-Total	1,778	1,887					0	2	1	0

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr. Capa (kVA)	25 kVA	35 kVA	50 kVA	100 kVA
LEPA	Aufaga	511	542	16	22	27	50	0	0	1	0
	Vaigalu	124	132	4	5	7	15	1	0	0	0
	Lepa	318	338	10	14	17	25	0	1	0	0
	Siupapa	198	210	6	8	11	15	1	0	0	0
	Saleapaga	304	323	10	13	16	25	0	1	0	0
	Sub-Total	1,455	1,544					2	2	1	0
ALEIPATA	Satitea	481	511	15	20	26	50	0	0	1	0
	Malaela	123	131	4	5	7	15	1	0	0	0
	Lepue	258	274	8	11	14	15	1	0	0	0
	Mutiatele	252	267	8	11	13	15	1	0	0	0
	Saleaaumua	572	607	18	24	30	50	0	0	1	0
	Utufaalalafa	90	96	3	4	5	15	1	0	0	0
	Samusu	517	549	16	22	27	50	0	0	1	0
	Amaile	260	276	8	11	14	15	1	0	0	0
	Tiavea	584	620	19	25	31	50	0	0	1	0
	Lalomanu	748	794	24	32	40	50	0	0	1	0
	Vailoa	376	399	12	16	20	25	0	1	0	0
	Ulutogia	201	213	6	9	11	15	1	0	0	0
	Sub-Total	4,462						6	1	5	0
ANOAMAA EAST	**Saletele**	198	210	6	8	11		0	0	0	0
	Sauano	221	235	7	9	12	15	1	0	0	0
	Falevao	423	449	13	18	22	25	0	1	0	0
	Lalemauga	327	347	10	14	17		0	0	0	0
	Manunu	177	188	6	8	9	15	1	0	0	0
	Sauniatu	133	141	4	6	7	15	1	0	0	0
	Lufilufi	896	951	29	38	48		0	0	0	0
	Falefa	1,356	1,439	43	58	72		0	0	0	0
	Sub-Total	3,731	3,960					3	1	0	0

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
FALEATA EAST	**Sinamoga**	1,119	1,188	36	48	59		0	0	0	0
	Moamoa	1,007	1,069	32	43	53		0	0	0	0
	Vaimoso	1,290	1,369	41	55	68		0	0	0	0
	Pesaga	254	270	8	11	13		0	0	0	0
	Lotopa	1,802	1,913	57	77	96		0	0	0	0
	Alafua	884	938	28	38	47		0	0	0	0
	Tuaefu	54	57	2	2	3	15	1	0	0	0
	Tuanaimato East	325	345	10	14	17	25	0	1	0	0
	Seesee	234	248	7	10	12	25	0	1	0	0
	Lepea	670	711	21	28	36	50	0	0	1	0
	Vaitoloa	459	487	15	19	24		0	0	0	0
	Sub-Total	8,098	8,595					1	2	1	0
FALEATA WEST	Tulaele	292	310	9	12	15	15	1	0	0	0
	Talimatau	781	829	25	33	41		0	0	0	0
	Vailoa	1,153	1,224	37	49	61		0	0	0	0
	Vaiusu	1,371	1,455	44	58	73		0	0	0	0
	Vigaga	724	768	23	31	38		0	0	0	0
	Elisefou	217	230	7	9	12		0	0	0	0
	Vaitele	391	415	12	17	21		0	0	0	0
	Saina	198	210	6	8	11		0	0	0	0
	Toamua	582	618	19	25	31		0	0	0	0
	Safune	221	235	7	9	12		0	0	0	0
	Puipaa	623	661	20	26	33		0	0	0	0
	Falelauniu	53	56	2	2	3	15	1	0	0	0
	Leaupuni	169	179	5	7	9	15	1	0	0	0
	Tapatapae	117	124	4	5	6	15	1	0	0	0
	Tanumapua	374	397	12	16	20	25	0	1	0	0
	Tafaigata	278	295	9	12	15	15	1	0	0	0
	Siusega	729	774	23	31	39		0	0	0	0
	Tuanaimato West	248	263	8	11	13	15	1	0	0	0
	Sub-Total	8,521	9,044					6	1	0	0

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
SAGAGA USOGA	**Malic**	1,572	1,668	50	67	83		0	0	0	0
	Afega	1,708	1,813	54	73	91		0	0	0	0
	Tuanai	1,102	1,170	35	47	58		0	0	0	0
	Sub-Total	4,382	4,651					0	0	0	0
GAGAEMAUGA I	**Leauvaa**	2,244	2,382	71	95	119		0	0	0	0
SAGAGA FALEFA	**Falcula**	1,631	1,731	52	69	87		0	0	0	0
	Alamutu	224	238	7	10	12		0	0	0	0
	Levi	885	939	28	38	47		0	0	0	0
	Lotosoa	572	607	18	24	30		0	0	0	0
	Salepeua'e	624	662	20	26	33		0	0	0	0
	Nonoa	434	461	14	18	23		0	0	0	0
	Malua	297	315	9	13	16		0	0	0	0
	Utualii	478	507	15	20	25		0	0	0	0
	Tufulele	703	746	22	30	37		0	0	0	0
	Aleisa East	344	365	11	15	18	25	0	1	0	0
	Aleisa West	610	647	19	26	32	50	0	0	1	0
	Aele	326	346	10	14	17	25	0	1	0	0
	Nuu	257	273	8	11	14	15	1	0	0	0
	Sub-Total	7,385	7,838					1	2	1	0
ALOFI I	**Falcasiu**	2,894	3,072	92	123	154		0	0	0	0
	Fasitoo-Uta	1,837	1,950	58	78	97		0	0	0	0
	Lepale	43	46	1	2	2	15	1	0	0	0
	Sub-Total	4,774	5,067					1	0	0	0
ALOFI II	Nofoalii	1,716	1,821	55	73	91	50	0	0	2	0
	Leulumoega	1,200	1,274	38	51	64	50	0	0	2	0
	Sub-Total	3,095	93					0	0	4	0

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
ALOFI III	**Fasitootai**	1,254	1,331	40	53	67		0	0	0	0
	Vailuutai	738	783	23	31	39		0	0	0	0
	Falcatiu	474	503	15	20	25		0	0	0	0
	Faleele	26	28	1	1	1	15	1	0	0	0
	Satapuala	1,296	1,376	41	55	69		0	0	0	0
	Afia	163	173	5	7	9	15	1	0	0	0
	Vaipapa	126	134	4	5	7	15	1	0	0	0
	Satuimaluifilu	543	576	17	23	29		0	0	0	0
	Afolau	65	69	2	3	3	15	1	0	0	0
	Sina	150	159	5	6	8	15	1	0	0	0
	Sub-Total	4,835	5,132					5	0	0	0

Districts	Villages	Population in 1986	Population in 1990	30W/Cap	Demand (kW) 40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
TOTAL TRANSFORMERS IN UPOLU ISLAND								41	20	15	0

Population and Transformer Capacity for Villages to be Electrified in Savaii Island

Districts	Villages	Population in 1986	Population in 1990	Demand (kW) 30W/Cap	40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
SAVAII ISLAND											
FAASDALELEAGA IV	**Lane**	695	738	22	30	37		0	0	0	0
	Asaga	243	258	8	10	13		0	0	0	0
	Puapua	519	551	17	22	28		0	0	0	0
	Sub-Total	1,457	1,546					0	0	0	0
GAGAEMAUGA I	Patamea	605	642	19	26	32	50	0	0	1	0
	Samalaeulu	828	879	26	35	44	50	0	0	1	0
	Mauga	157	167	5	7	8	15	1	0	0	0
	Sub-Total	1,590	1,688					1	0	2	
GAGAIFOMAUGA III	Fagaee	248	263	8	11	13	15	1	0	0	0
	Sasina	614	652	20	26	33	50	0	0	1	0
	Letui	273	290	9	12	14	15	1	0	0	0
	Aopo	389	413	12	17	21	25	0	1	0	0
	Sub-Total	1,524	1,618					2	1	1	0
VAISIGANO EAST	**Utulea**	41	44	1	2	2		0	0	0	0
	Matavai	1,571	1,667	50	67	83		0	0	0	0
	Auala	679	721	22	29	36		0	0	0	0
	Vaisala	652	692	21	28	35		0	0	0	0
	Sub-Total	2,943	3,124					0	0	0	0
FALEALUPO	Falealupo-Uta	718	762	23	30	38	50	0	0	1	0
	Vaetupua	386	410	12	16	20	25	0	1	0	0
	Avata	170	180	5	7	9	15	1	0	0	0
	Sub-Total	1,274	1,352					1	1	1	0

Districts	Villages	Population in 1986	Population in 1990	30W/Cap	Demand (kW) 40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
ALATAUA WEST	Tufutafoe	354	376	11	15	19	25	0	1	0	0
	Neiafu-Tai	506	537	16	21	27	50	0	0	1	0
	Neiafu-Uta	603	640	19	26	32	50	0	0	1	0
	Falelima	555	589	18	24	29	50	0	0	1	0
	Sub-Total	2,018						0	1	3	0
PALAULI FALEFA	**Gataivai**	1,006	1,068	32	43	53		0	0	0	0
	Gautavai	285	302	9	12	15		0	0	0	0
	Vaiala	291	309	9	12	15		0	0	0	
	Sili	870	923	28	37	46		0	0	0	0
	Pulcia	281	298	9	12	15		0	0	0	0
	Papa	235	249	7	10	12		0	0	0	0
	Tafua-Tai	357	379	11	15	19	25	0	1	0	0
	Tafua-Uta	185	196	6	8	10		0	0	0	0
	Sub-Total	3,510	3,725					0	1	0	0

Districts	Villages	Population in 1986	Population in 1990	30W/Cap	Demand (kW) 40W/Cap	50W/Cap	Tr. Capa (kVA)	15 kVA	25 kVA	50 kVA	100 kVA
TOTAL TRANSFORMERS IN ~~UPOLU~~ SAVAII ISLAND								4	4	5	0
TOTAL TRANSFORMERS IN UPOLU ISLAND								41	20	18	0
GROUND TOTAL								45	24	23	0

2.425 kVA