

Quantification of Energy Efficiency in the Utilities of the U.S. Affiliate States (Excluding US Virgin Islands)

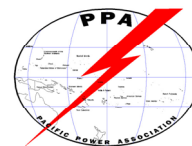
Data Handbook



Pacific Power Association.

Prepared for Palau Public Utilities Corporation (PPUC)

Nov 22, 2010 - Final



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1. Introduction

KEMA Inc has been awarded by the Pacific Power Association (PPA) in Fiji to carry out a project called “Quantification of Energy Efficiency in the Utilities of the U.S. Affiliate States (Excluding US Virgin Islands)”.

As part of the deliverables of this project, an Electrical Data Handbook has been prepared containing all the electrical characteristics of the power system high voltage equipment for each of the utilities. This document represents the Electrical Data Handbook for Palau Public Utilities Corporation (PPUC). All relevant data of the high and medium voltage assets, such as generation data, impedances of lines, cables, transformers, and other equipments are included as far as the relevant data could be gathered. KEMA has incorporated major data of components and equipment in power generation, transmission, distribution and metering. A data template is established to hold comprehensive equipment data, for example for transformer power ratings, primary and secondary voltages, load and no load losses, tap changer data, BIL ratings, cooling class, applicable standards, weight, etc.

2. Power Plant Data

Generators data and power plants' one -line diagram are provided in this section.

2.1 Generator

There are four (4) Pielstick engines in Aimeliik. In Malakal, there are two Mitsubishi units, two Wartsila, and two Caterpillar units and a black start unit. Two Caterpillar units are going to be replaced by two new Niigata units.

Table 1 – Generators

Plant	AIMELIIK			
Unit	P2	P3	P4	P5
Engine Make	PIELSTICK	PIELSTICK	PIELSTICK	PIELSTICK
Engine Model	10PC2MK2	10PC2MK2	10PC2MK2	10PC2MK2
Serial Number	18208	18206	18207	18205
Year Installed	1985	1985	1985	1985
Rated kV	13.8	13.8	13.8	13.8
NamePlate Rate (MW)	3270	3270	3270	3270
De-rated (MW)	3100	3100	2400	2400
Type	IND	IND	IND	IND
Speed (RPM)	450	450	450	450
Power Factor	0.8	0.8	0.8	0.8
X"dv	0.14	0.14	0.14	0.14
X'dv	0.22	0.22	0.22	0.22
X0v	0.02	0.02	0.02	0.02
Xlr	0.14	0.14	0.14	0.14
Fuel Type	DIESEL	DIESEL	DIESEL	DIESEL
Efficiency (k Wh/gal)	12.86	13.27	12.9	12.85
Generator Protection	P1-Lo-A20	P1-Lo-A20	P1-Lo-A20	P1-Lo-A20
Alternator Make	BRUSH	BRUSH	BRUSH	BRUSH
Alternator Type	BRUSHLESS	BRUSHLESS	BRUSHLESS	BRUSHLESS
Alternator Model	34085A 4G	34085A 2G	34085A 1G	34085A 3G
Alternator Serial	A32002117	A32002117	A32002117	A32002117
Alternator Voltage (V)	13800	13800	13800	13800
Remarks				

Table 2 – Generators (cont.)

Plant	MALAKAL				
Unit	MIT12	MIT13	W1	W2	W3
Engine Make	MITSUBISHI	MITSUBISHI	WARTSILA	WARTSILA	WARTSILA
Engine Model	TAKL	TAKL	SR4BGD	SR4BGD	SR4BGD
Serial Number	138220	138221	12007	120075	120076
Year Installed	1998	1998	1997	1997	1997
Rated kV	13.8	13.8	13.8	13.8	13.8
NamePlate Rate (MW)	3400	3400	2000	2000	2000
De-rated (MW)	2800	2800	1200	2000	2000
Type	IND	IND	IND	IND	IND
Speed (RPM)	0	720	2000	0	0
Power Factor	0.8	0.8	0.8	0.8	0.8
X"dv	0.14	0.14	0.14	0.14	0.14
X'dv	0.22	0.22	0.22	0.22	0.22
X0v	0.02	0.02	0.02	0.02	0.02
Xlr	0.14	0.14	0.14	0.14	0.14
Fuel Type	DIESEL	DIESEL	DIESEL	DIESEL	DIESEL
Efficiency (kwh/gal)	0	14.45	12.62	0	0
Generator Protection	IP20	IP20	IP23	IP23	IP23
Alternator Make	TOSHIBA	TOSHIBA	LEROY SUMER	LEROY SUMER	LEROY SUMER
Alternator Type	BRUSHLESS	BRUSHLESS	BRUSHLESS	BRUSHLESS	BRUSHLESS
Alternator Model	JEC-114-1979	JEC-114-1979	LSA 54 VL9-6P	LSA 54 VL9-6P	LSA 54 VL9-6P
Alternator Serial	9.71E+08	9.71E+08	163894-3	163894-1	163894-2
Alternator Voltage (V)	13800	13800	13800	13800	13800
Remarks	non-operational			non-operational	non-operational

Table 3 – Generators (cont.)

Plant	MALAKAL				
Unit	CAT1	CAT2	New1	New2	U9
Engine Make	CATERPILLAR	CATERPILLAR	NIIGATA	NIIGATA	ALCO
Engine Model	3516B	3516B	16V28HLX	16V28HLX	
Serial Number	ZAP00290	ZAP00290			
Year Installed	2007	2007	2010	2010	
Rated kV	0.48	0.48	6.6	6.6	4.16
NamePlate Rate (MW)	2000	2000	6.25	6.25	1.25
De-rated (MW)	2000	2000	5	5	0.5
Type	IND	IND	IND	IND	IND
Speed (RPM)	1800	1800	720	720	720
Power Factor					
X"dv					
X'dv					
X0v					
Xlr					
Fuel Type	DIESEL	DIESEL	DO or HFO	DO or HFO	DIESEL
Efficiency (kwh/gal)	14.96	14.45	--	--	0
Generator Protection					
Alternator Make	CAT	CAT			IDEAL ELEC.
Alternator Type	BRUSHLESS	BRUSHLESS			BRUSHLESS
Alternator Model	SR 4B-GD	SR 4B-GD			
Alternator Serial	G5H00167	G5H00165			312814
Alternator Voltage (V)	480	480			4160
Remarks					Black Start; under maintenance

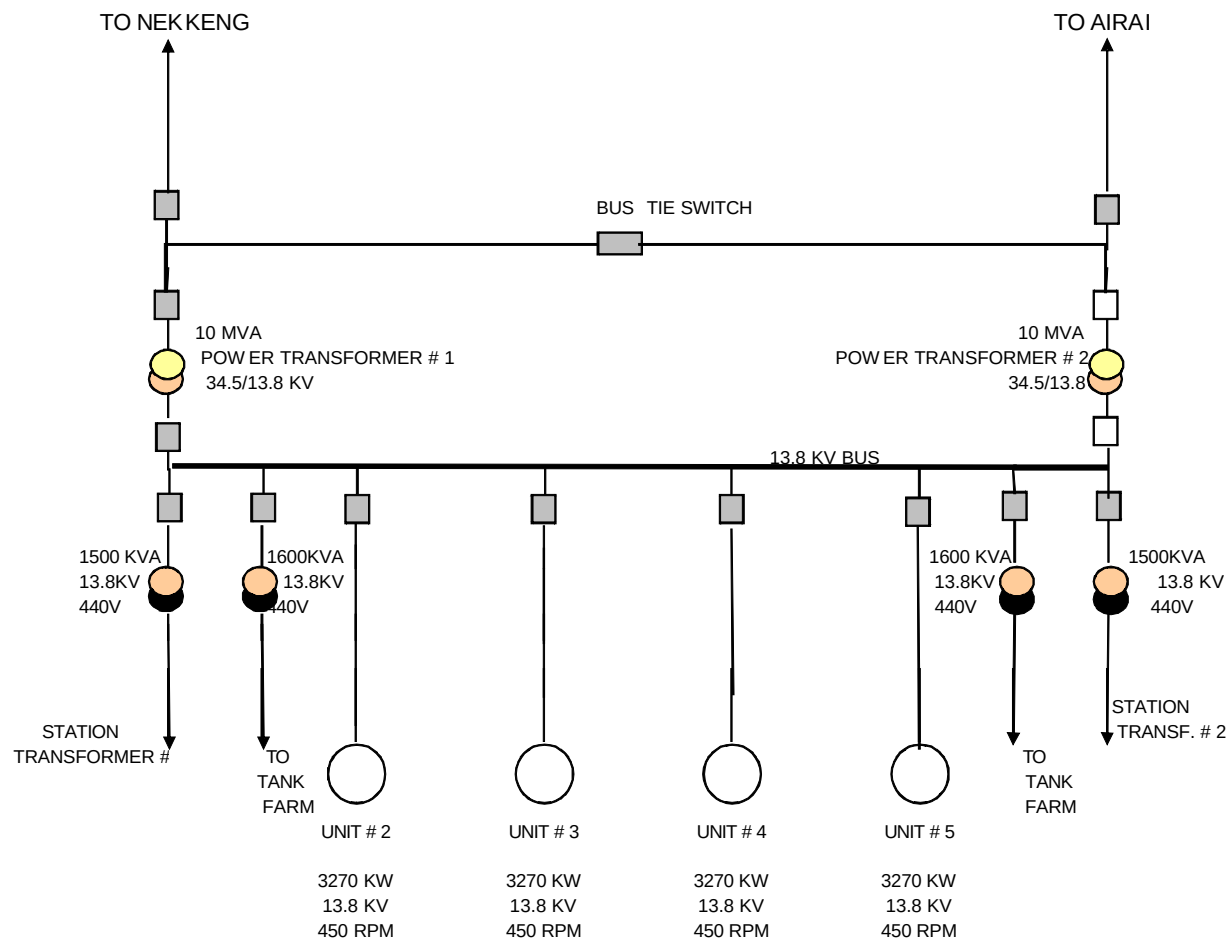
Table 4 – Generators (cont.)

Plant	PELELIU			ANGAUR		
Unit	YANMAR 1	YANMAR 2	DENYO 1	DENYO 1	DENYO 2	CAT 1
Engine Make						
Engine Model						
Serial Number						
Year Installed						2003
Rated kV						
NamePlate Rate (MW)	0.75	0.75	0.5	0.25	0.25	0.15
De-rated (MW)						
Type						
Speed (RPM)						
Power Factor						
X"dv						
X'dv						
X0v						
Xlr						
Fuel Type	DIESEL	DIESEL	DIESEL	DIESEL	DIESEL	DIESEL
Efficiency (kwh/gal)						
Generator Protection						
Alternator Make						
Alternator Type						
Alternator Model						
Alternator Serial						
Alternator Voltage (V)						
Remarks			under maintenance	de-commissioned		under maintenance

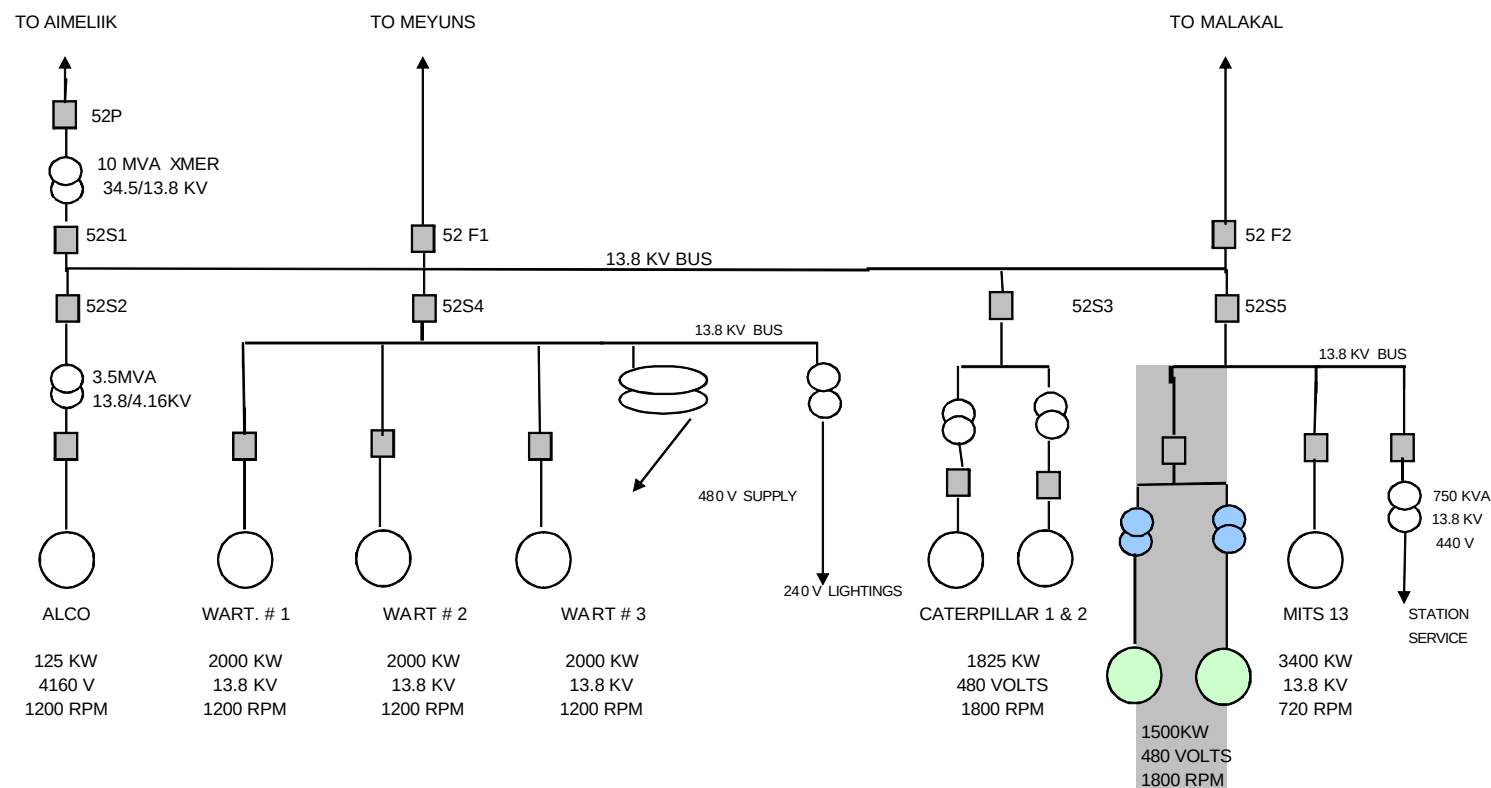
Table 5 – Generators (cont.)

Plant	KAYANGEL		CAPITOL
Unit	DENYO 1	DENYO 2	
Engine Make			
Engine Model			
Serial Number			
Year Installed			2007
Rated kV			
NamePlate Rate (MW)	0.1	0.1	2 kW
De-rated (MW)			
Type			
Speed (RPM)			
Power Factor			
X"dv			
X'dv			
X0v			
Xlr			
Fuel Type	DIESEL	DIESEL	DIESEL
Efficiency (kwh/gal)			
Generator Protection			
Alternator Make			
Alternator Type			
Alternator Model			
Alternator Serial			
Alternator Voltage (V)			
Remarks		under maintenance	OFF-GRID SUPPLY ONLY

2.2 AIMELIIK Power Plant Single Line Diagram



2.3 MALAKAL Power Plant Single Line Diagram



NOTE: PROPOSE D CONNECTION WILL BE AT THE BREAKER OF MITSUBISHI 12.

3. Transmission System Data

Transmission system equipments data are listed in this section, including data for power transformers and transmission lines.

3.1 Power Transformers

Table 6 – Power Transformers

Substation Name	Serial No.	Year of Manufacture	MVA Rating	Phase	Frequency (Hz)
MALAKAL S/S	9420999	1994	10	3P	60
AIMELIHK S/S NO. 1 (PP)		1986	10	3P	60
AIMELIHK S/S NO. 2 (PP)		1986	10	3P	60
AIRAI S/S	8522639	1986	10	3P	60
MALAKAL STN USE	9420998	1994	3.5	3P	60
ABB NO.1	1LVN2060924	2007	2.5	3P	60
ABB NO. 2	1LVN2060923	2007	2.5	3P	60
WART1			0.1	3P	60
WART2			0.1	3P	60
WART3			0.1	3P	60
MITSUBISHI	9820430		0.7	3P	60
KOKUSAI S/S			5	3P	60
IBOBANG S/S			0.075	3P	60
ASAHI S/S			0.3	3P	60
NGARDMAU S/S			0.225	3P	60
NGAARD S/S NO. 1		1999	0.075	3P	60
NGAARD S/S NO. 2			0.75	3P	60
NEKKING S/S			0.3	3P	60
AIMELIHK STATE S/S NO. 1			0.3	3P	60
AIMELIHK STATE S/S NO. 2			0.075	3P	60
KAYANGEL S/S			0.3	3P	60
PELILIU NO. S/S NO.1	99V4886-1		1.0	3P	60

PELILIU NO. S/S NO.2	99V4886-2		1.0	3P	60
ANGUAR S/S	ON0168801	1999	1.0	3P	60

Table 7 – Power Transformers (cont.)

Substation Name	RATED VOLTAGE		RATED CURRENT		Impedance %
	PRI	SEC	PRI(A)	SEC (A)	
MALAKAL S/S	13.8 kV	34.5kV	167	418	5.62
AIMELIHK S/S NO. 1 (PP)	13.8 kV	34.5kV			
AIMELIHK S/S NO. 2 (PP)	13.8 kV	34.5kV			
AIRAI S/S	34.5 kV	13.8 kV			
MALAKAL STN USE	0.4160 kV	13.8 kV	146	486	6.05
ABB NO.1	0.480kV	13.8 kV			5.52
ABB NO. 2	0.480kV	13.8 kV			5.46
WART1	0.400 kV	13.8kV			
WART2	0.400 kV	13.8kV			
WART3	0.400 kV	13.8kV			
MITSUBISHI	.208Y /120	13.8 kV		1943	4.75
KOKUSAI S/S	34.5 kV	13.8 kV			
IBOBANG S/S	34.5 kV	13.8 kV			
ASAHI S/S	34.5 kV	13.8 kV			
NGARDMAU S/S	34.5 kV	13.8 kV			
NGAARD S/S NO. 1	34.5 kV	13.8/7.96 kV	3.14		
NGAARD S/S NO. 2	34.5 kV	13.8/7.96 kV			
NEKKING S/S	34.5 kV	13.8/7.96 kV			
AIMELIHK STATE S/S NO. 1	34.5 kV	13.8/7.96 kV			
AIMELIIF STATE S/S NO. 2	34.5 kV	13.8/7.96 kV			
KAYANGEL S/S		13.8 kV			
PELILIU NO. S/S NO.1	440 Del ta	13.8/7.96kV			5.75
PELILIU NO. S/S NO.2	440 Del ta	13.8/7.96kV			5.75
ANGUAR S/S	208	13.8/7.96kV	2776	418	6.3

Table 8 – Power Transformers (cont.)

Substation Name	Losses		TANK, CORE & OIL DETAILS			
	NL (W)	FL (W)	OIL		Weight	
			Vol(Lil)	Weight(Lbs)	Net	Core, Oil & TC
MALAKAL S/S			6600 KG	600	27000	11500
AIMELIHK S/S NO. 1 (PP)	50800	10400	7300		27000	
AIMELIHK S/S NO. 2 (PP)						
AIRAI S/S						
MALAKAL STN USE						
ABB NO.1				1220	5000	
ABB NO. 2				1220	5000	
WART1						
WART2						
WART3						
MITSUBISHI				450	2350	
KOKUSAI S/S						
IBOBANG S/S						
ASAHI S/S	2120	4000	1110			
NGARDMAU S/S						
NGAARD S/S NO. 1			320		655	
NGAARD S/S NO. 2						
NEKKING S/S						
AIMELIHK STATE S/S NO. 1						
AIMELIIF STATE S/S NO. 2						
KAYANGEL S/S						
PELILIU NO. S/S NO.1						
PELILIU NO. S/S NO.2						
ANGUAR S/S				640	2420	

Table 9 – Power Transformers (cont.)

Substation Name	TAPS & T C DETAILS		Cooling Method	BRAND
	No. of Taps	Tap Changer Type		
MALAKAL S/S		OLTC	ONAN	
AIMELIHK S/S NO. 1 (PP)		NLTP	ONAN	
AIMELIHK S/S NO. 2 (PP)		NLTP	ONAN	
AIRAI S/S		OLTC	ONAN	
MALAKAL STN USE		NLTP	ONAN	
ABB NO.1			ONAN	
ABB NO. 2			ONAN	
WART1			ONAN	
WART2			ONAN	
WART3			ONAN	
MITSUBISHI				
KOKUSAI S/S				
IBOBANG S/S				
ASAHI S/S				
NGARDMAU S/S				
NGAARD S/S NO. 1				
NGAARD S/S NO. 2				
NEKKING S/S				
AIMELIHK STATE S/S NO. 1				
AIMELIIF STATE S/S NO. 2				
KAYANGEL S/S				
PELILIU NO. S/S NO.1		NLTP	ONAN	VANTRAN
PELILIU NO. S/S NO.2		NLTP	ONAN	VANTRAN
ANGUAR S/S		NLTP	ONAN	

3.2 Transmission Lines

34.5kV transmission line data are listed in Table 10 and Table 11. 34.5kV Pole dimension and conductor spacing information is shown in Table 12.

Table 10 – Transmission Lines 34.5 kV

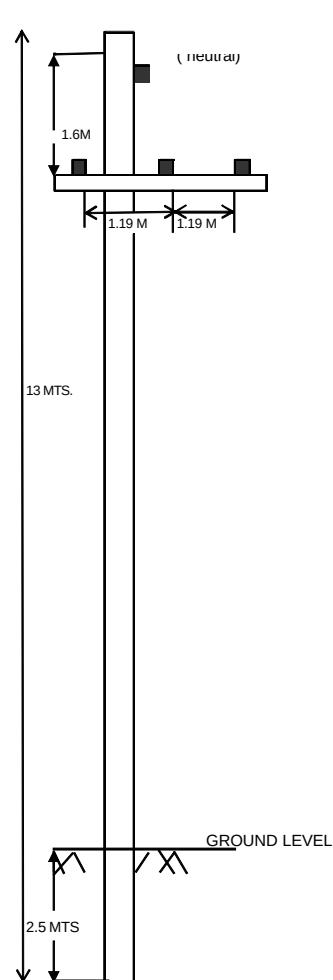
No.	NAME	Linear Length		Total Length of Wires (Multiplier Taken)			CONDUCTOR	SIZE OF WIRE
		Meter	(Miles)	Multiplier *	Meters	Miles		
1	Aimeliik Power Plant to Nekken	4,287.5	2.68	6	25,725.0	16.08	ACSR	336 MCM
2	Nekken to Kokusai	8,849.7	5.53	3	26,549.1	16.59	ACSR	336 MCM
3	Kokusai to Ngaraard	38,778.4	24.24	3	116,335.2	72.71	ACSR	336 MCM
4	Nekken to Airai Substation	14,266.7	8.92	3	42,800.1	26.75	ACSR	336 MCM
5	Malakal to Airai Substation	9,184.9	5.74	3	27,554.7	17.22	ACSR	336 MCM
		75,367.2	47.10		238,964.1	149.35	ACSR	336 MCM

Table 11 – Transmission Lines 34.5 kV (cont.)

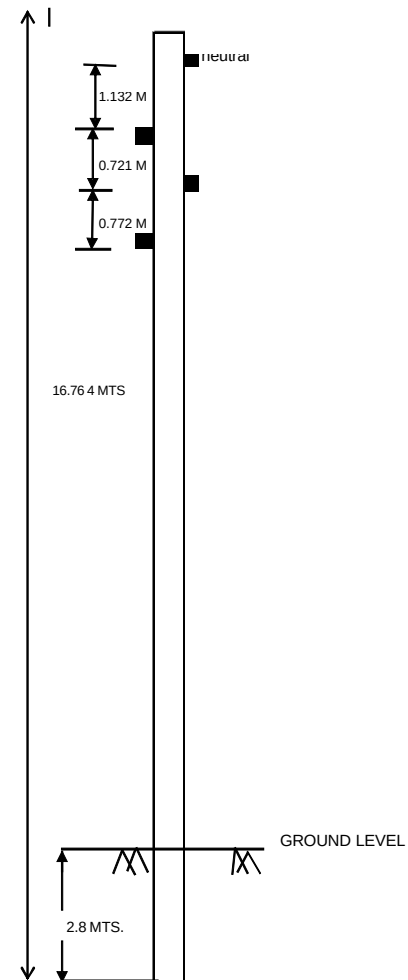
No.	NAME	FEEDER	REMARKS
1	Aimeliik Power Plant to Nekken	34.5 kV NE KING FEEDER and AIMELIIK KOROR FEEDER	DOUBLE CIRCUIT
2	Nekken to Kokusai	34.5 kV NE KING FEEDER	
3	Kokusai to Ngaraard	34.5 kV NE KING FEEDER	
4	Nekken to Airai Substation	34.5 kV AIMELIIK KOROR FEEDER	
5	Malakal to Airai Substation	34.5 kV AIMELIIK KOROR FEEDER	

Note :1. - * in Multiplier is the No. of phase wire (neutral excluded) in each pole
 2. - No survey yet for Angaur and Kayangel.(Underground System)

Table 12 – Pole Dimensions and Conductor Spacing (34.5 kV)



TYPICAL 34.5 KV LINE (80% OF 34.5 KV POLES)



TYPICAL 34.5 KV LINE (20% OF 34.5 KV POLES)

4. Distribution System Data

Distribution system equipments data are listed in this section, including data for 13.8kV distribution feeders, power poles , distribution transformers and switchgears .

4.1 Distribution Lines

Table 13 – Distribution Lines : Koror and Babeldaob

No.	NAME	Linear Length		Total Length of Wires (Multiplier Taken)		
		Meter	(Miles)	Multiplier *	Meters	Miles
1	Airai Substation to Ngerikiil Pumping Station	9,714.8	6.1	3	29,144.3	18.2
2	Airai Substation to Pole ID AA195	5,339.3	3.3	3	16,017.8	10.0
3	Ngermid	2,737.6	1.7	3	8,212.8	5.1
4	Ngesaol	1,258.4	0.8	3	3,775.2	2.4
5	Iyebukel and Ngerchemai	2,787.1	1.7	3	8,361.3	5.2
6	Ngerkeseuaol	1,340.3	0.8	3	4,020.9	2.5
7	T-Dock	830.5	0.5	3	2,491.4	1.6
8	Dngeronger	595.2	0.4	3	1,785.5	1.1
9	Idid- Ikelau	2,048.4	1.3	3	6,145.3	3.8
10	Ngerbeched	4,248.4	2.7	3	12,745.1	8.0
11	Medalaii	2,100.6	1.3	3	6,301.7	3.9
12	Meyuns	5,111.2	3.2	3	15,333.5	9.6
13	Malakal	1,763.0	1.1	3	5,289.0	3.3
14	Aimeliik	8,588.3	5.4	3	25,764.9	16.1
15	Ngatpang	8,168.7	5.1	3	24,506.0	15.3
16	Ibobang	2,913.6	1.8	3	8,740.7	5.5
17	Ngardmau	3,038.2	1.9	3	9,114.5	5.7
18	Capitol to Ngiwal	10,839.5	6.8	3	32,518.4	20.3

19	Kokusai to Capitol	21,152.1	13.2	3	63,456.4	39.7
20	Malakal to Airai (Main Road)	9,184.9	5.7	3	27,554.7	17.2
21	Ngchesar	21,411.0	13.4	3	64,232.9	40.1
22	Ngaraard	26,150.6	16.3	3	78,451.9	49.0
23	Ngerchelong	10,357.4	6.5	3	31,072.1	19.4
24	Ngaremlengui - 3 Phase Line	17,783.6	11.1	3	53,350.9	33.3
25	Ngaremlengui - 1 Phase Line	2,250.2	1.4	1	2,250.2	1.4
		181,712.6	113.6		540,637.4	337.9

Table 14 – Distribution Lines : Koror and Babeldaob (cont.)

No.	NAME	CONDUCTOR	SIZE OF WIRE	FEEDER	REMARKS
1	Airai Substation to Ngerikiil Pump ing Station	ACSR	336 MCM	13.8 kV AIRA I - AIRPORT	
2	Airai Substation to Pole ID AA195	ACSR	2	13.8 kV AIRA I - AIRPORT	
3	Ngermid	ACSR	2	13.8 kV AIRA I - KOROR	
4	Ngesaol	CU.	2	13.8 kV AIRA I - KOROR	
5	Iyebukel and Ngerchemai	ACSR	336 MCM	13.8 kV AIRA I - KOROR	
6	Ngerkeseuaol	CU.	4	13.8 kV AIRA I - KOROR	
7	T-Dock	ACSR	336 MCM	13.8 kV AIRA I - KOROR	
8	Dngeronger	ACSR	336 MCM	13.8 kV AIRA I - KOROR	
9	Idid - Ikela	ACSR	336 MCM	13.8 kV MALAKAL FEEDER	
10	Ngerbeched	ACSR	336 MCM	13.8 kV MALAKAL FEEDER	
11	Medalaii	ACSR	336 MCM	13.8 kV MALAKAL FEEDER	
12	Meyuns	ACSR	336 MCM	13.8 kV MALAKAL FEEDER	
13	Malakal	ACSR	336 MCM	13.8 kV MMD C FEEDER	
14	Aimeliik	ACSR	2	13.8 kV AIMELI I K FEEDER	
15	Ngatpang	ACSR	2	13.8 kV FEEDER	
16	Ibobang	CU.	2	13.8 kV FEEDER	
17	Ngardmau	ACSR	336 MCM	13.8 kV FEEDER	

18	Capitol to Ngiwal	CU.	2	13.8 kV FEEDER	
19	Kokusai to Capitol	ACSR	336 MCM	13/8 kV FEEDER	
20	Malakal to Airai (Main Road)	ACSR	336 MCM	13.8 kV FEEDER	UNDERBUILD
21	Ngchesar	CU.	2	13.8 kV FEEDER	
22	Ngaraard	CU.	2	13.8 kV FEEDER	
23	Ngerchelong	CU.	2	13.8 kV FEEDER	
24	Ngaremlengui- 3 Phase Line	ACSR	2	13.8 kV FEEDER	
25	Ngaremlengui- 1 Phase Line	CU.	2	13.8 kV FEEDER	

Table 15 – Distribution Lines : Peleliu

No.	NAME	Linear Length		Total Length of Wires (Multiplier Taken)			CONDUCTOR	SIZE OF WIRE
		Meter	(Miles)	Multiplier *	Meters	Miles		
1	Kambek to Ochelochel - 3 Phase Line	11,145.4	7.0	3	33,436.2	20.9	ACSR	
2	Single Phase Line	2,247.3	1.4	1	2,247.3	1.4	ACSR	
		13,392.7	8.4		35,683.6	22.3	ACSR	

Note: 1. - * in Multiplier is the No. of phase wire (neutral excluded) in each pole

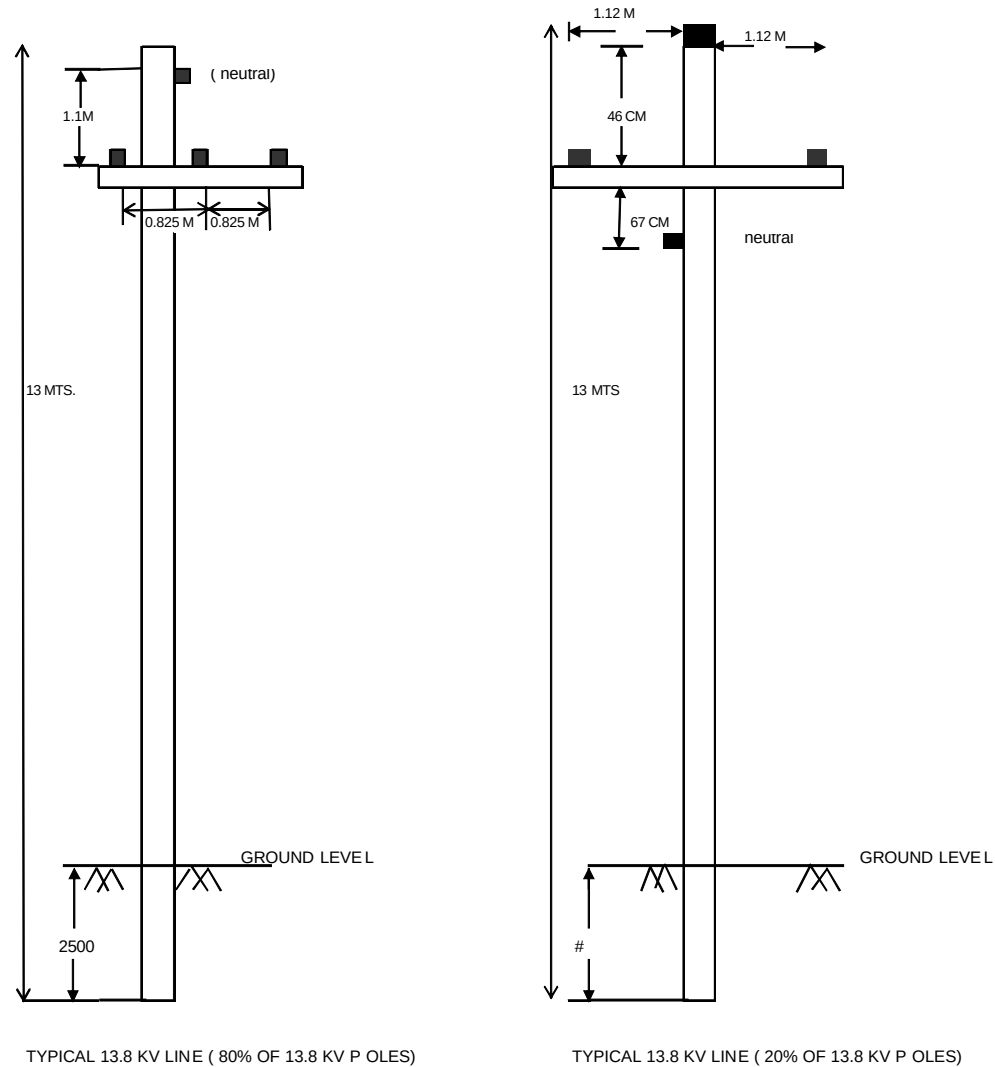
2. - No survey yet for Angaur and Kayangel.(Underground System)

4.2 Power Poles

Table 16 – Power Poles

		Concrete	Wooden	Total
1	Koror and Babeldaob -in No. of poles			6652
2	Peleliu	292	38	330

Table 17 – Pole Dimensions and Conductor Spacing (13.8 kV)



4.3 Distribution Transformers

Table 18 – Distribution Transformers

Type	kVA	State or Area										
		Aimeliik	Airai	Dngeronger	Ikelaui	Malakal	Medalai	Meketii	Melekeok	Meyungs	Ngaraard	Ngardmau
Single Phase	n/a	2	2						4	3		1
	5	4						1	2	1	6	1
	10	11	6	2		3			6	5	10	2
	15	10	12	1		8			7	12	20	6
	20	18							1			
	25	6	19	2	1	12	1	5	13	14	4	6
	30											
	37.5	2	15	1	4	9	1	5		15		1
	50		3	6	3	6	1			24		
	67						1					
	75		2	4	1	5	2			14	1	
	100		2	2		2	3	1		7		
	150									1		
	167				1			2		1		
	Total	53	61	18	10	45	9	14	33	97	41	17

Table 19 – Distribution Transformers (cont.)

Type	kVA	State or Area							
		Ngatpant	Ngchesar	Ngerbeched	Ngerchelongs	Ngerchemai	Ngeremlengui	Ngerkesouaol	Ngiwal
Single Phase	n/a						1		
	5	3	4	1	3	2	3		1
	10	5	12	5	7	4	6		2
	15	4	13	9	3	7	12	6	14
	20	7		1		1			
	25	7	7	12	13	16	13	9	2
	30			1					
	37.5	2		23		16	2	6	
	50			7		4		4	
	67								
	75			4		5		3	
	100			5		2		2	
	150								
	167					1			
	Total	28	36	68	26	58	37	30	19

Table 20 – Distribution Transformers (cont.)

Type	kVA	State or Area										
		Aimeliik	Airai	Dngeronger	Ikelaui	Malakal	Medalai	Meketii	Melekeok	Meyungs	Ngaraard	Ngardmau
Three Phase	n/a	3										
	5								3			
	10	1						1	4			
	15	1							3		3	1
	25	1							1			
	37.5							3				
	50					1			1			
	167					1						
	200					1						
	250					1						
	500					2						
	Total	6				6		4	12		3	1

Table 21 – Distribution Transformers (cont.)

Type	kVA	State or Area							
		Ngatpant	Ngchesar	Ngerbeched	Ngerchelongs	Ngerchemai	Ngeremlengui	Ngerkesouaol	Ngiwal
Three Phase	n/a								
	5								
	10	1							
	15		1				2		2
	25		1		3	1	2		
	37.5			5		2	1		
	50	1							
	167								
	200								
	250								
	500								
	Total	2	2	5	3	3	5		2

Table 22 – Typical Losses for Distribution Transformers

Type	kVA	Primary Voltage (kV)	Secondary Voltage (V)	NO Load Loss (W)	Full Load Loss (W)	% Z	% R	% X	Remark
Single Phase	5	7.97	120	42	154	2.4	2.3	0.9	
	10	7.97	120	73	215	1.9	1.4	1.3	
	15	7.97	120	84	305	1.8	1.5	1.0	
	20	7.97	120	101	371				extrapolation
	25	7.97	120	118	437	1.8	1.3	1.3	
	30	7.97	120	137	496				extrapolation
	37.5	7.97	120	166	585	1.8	1.1	1.4	
	50	7.97	120	185	735	1.9	1.1	1.4	
	67	7.97	120	235	893				extrapolation
	75	7.97	120	285	1050	1.8	1.0	1.5	
	100	7.97	120	355	1300	2.0	0.9	1.8	
	150	7.97	120	463	1942				extrapolation
	167	7.97	120	500	2160	2.2	1.0	2.0	
Three Phase	5	13.8	208	360	1350	2.1	1.3	1.6	
	10	13.8	208	360	1350	2.1	1.3	1.6	
	15	13.8	208	360	1350	2.1	1.3	1.6	
	25	13.8	208	360	1350	2.1	1.3	1.6	
	37.5	13.8	208	360	1350	2.1	1.3	1.6	
	50	13.8	208	360	1350	2.1	1.3	1.6	
	167	13.8	208	633	2488				extrapolation
	200	13.8	208	773	2950				extrapolation
	250	13.8	208	880	3300				extrapolation
	500	13.8	208	1600	6800	2.3	1.0	2.1	

Note: No Load and Full Load Losses are typical value for transformer in the same class of voltage and kVA capacity.

PPUC shall update the data with specific values provided by the transformer manufacture.

4.4 Switchgear Data

Table 23 – Switchgear Data

Components	Parameters	Switchgear - 1
Busbar Data	Material	Copper
	Dimension	6 x 75 cm
	Ampacity	160 Am peres
Vacuum Circuit Breaker	Rated Voltage	24 kV
	Rated Nominal Current	630 Am peres
	Rated Short Ckt Breaking Current	12.5 kA
	Rated Lightning Impulse Withstand Voltage	125 kV
	Rated Closing Operation Voltage	DC 100 V
	Rated Closing Control Voltage	DC 100 V
	Rated Operating Sequence	0-3M-10-3M-CO
	Rated Tripping Control Voltage	DC 100 V
	Mass	135 kg
PT/CT Data	PT	13800 / 110 V
	CT	200 / 100 : 5 A
Surge Arrester for 13.8kV	Type	GLS-30S
	Rated kV	30 kV
	Nominal Discharge Current	10 kA
	Rated Frequency	60 Hz
	Max. Continuous Operating Voltage	24.4 kV rms
	Reference Voltage	45.0 kV
	Lightning Impulse Residual Voltage for Discharge Current	
	•5,000 A discharge current	93.4 kV peak (max)
	•10,000 A discharge current	99.0 kV peak (max)
	•20,000 A discharge current	108.0 kV peak (m ax)

Table 24 – Switchgear Data (cont.)

Components	Parameters	Switchgear – 1
Impulse Withstand Current	High Current	100 kA peak
	Long Duration Current	150 A peak
Voltage Withstand Test of Arrester Insulation	Impulse (Wave shape; 1.2/50 micro second)	150 kV peak
	Wet Power Frequency (10 sec)	60 kV rms
	Dry Power Frequency (1 min)	70 kV rms
Applicable Service Conditions		(a) Ambient temperature not exceeding 40 °C nor below -40 °C
		(b) Altitude not exceeding 1,800 meters
Construction	Insulator	Insulator used for the arrester housing shall be of high strength wet process porcelain and colored light gray.
	Connection Terminal - Line and each terminal	
	•Material	Stainless
	•Type	Clamp type
	•Size	Suitable for 2.6 mm dia. to 38 mm ² wire conductor.



Appendices

No Appendix for this document.