



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

Data Handbook



Pacific Power Association.
Prepared for Marshall Energy Company.

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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)".

In this report, an Electrical Data Handbook contains all the electrical characteristics of the power system high voltage equipment in Marshalls Energy Company (MEC) is provided. All relevant data of the high and medium voltage assets, such as generation data, impedances of lines, cables, transformers, and other equipments if exists. KEMA has incorporated major data of components and equipment in power generation, transmission, distribution and metering. Data template is established to hold comprehensive equipment data, for example for transformers data collected power ratings, primary and secondary voltages, load and no load losses, tap changer data, BIL ratings, cooling class, applicable standards, weight, etc.

2. Data Content

All data contents are identified based on the information KEMA received.

2.1 Power Station

There are 2 power stations in MEC system, as listed in the table below:

Table 1 – Power Stations

FACILITY	MAJURO POWER STATION 1	MAJURO POWER STATION 1	MAJURO POWER STATION # 2
DATE OF STARTUP	1982	1982	Dec-99
POWER SOURCE	Pielstick 10P.C 2V MK2	Caterpillar 3616	Deutz BV16M640 Engines
NUMBER OF GENERATORS	4 units	1 unit	2 units (with option for 3 rd unit)
SERIAL NUMBERS	Engine # 1 = 18191 Engine # 2 = 18192 Engine # 3 = 18193 Engine # 4 = 18194	Engine # 5 = PD 00048	Engine # 6 = 640-16-010114 Engine # 7 = 640-16-010115
RATED POWER OUTPUT	2.5MW @ 450Rpm each unit	3.3MW @ 720Rpm each unit	6.4MW @ 600Rpm each unit
DISTRIBUTION SYSTEM	13800 Volt, 3 Phase.	13800 Volt, 3 Phase.	13800 Volt, 3 Phase.
FUEL STORAGE CAPACITY	2,000,000 USGals		4,500,000 USGals

2.2 Generator

There are a total of 7 generators in the 2 power stations of MEC. However, 2 out of 7 are damaged and the other 5 are operating with de-rated output.

Table 2 - Generators

MEC	Substation	Station 1	Station 1	Station 1	Station 1	Station 1	Station 2	Station 2
		Engine #	1	2	3	4	5	6
GENERATOR DETAILS	ENGINE MAKE	Pielistick	Pielistick	Pielistick	Pielistick	Caterpillar	Deutz	Deutz
	ENGINE MODEL	10PC2VMK2	10PC2VMK2	10PC2VMK3	10PC2VMK4	3616	BV16M640	BV16M640
	ENGINE SERIAL NUMBER	18191	18192	18193	18194	1P00048	16010114	16010115
	NAME PLATE RATING (KW)	3,275	3,275	3,275	3,275	3,485	6,400	6,400
	DE-RATED (KW)	4,660	4,660	-	-	3,350	6,400	6,400
	SPEED (RPM)	450	450	450	450	720	600	600
	FUEL TYPE	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
	YEAR INSTALLED	1982	1982	1982	1982	1992	1999	1999
ALTERNATOR DETAILS	MAKE	BRUSH	BRUSH	BRUSH	BRUSH	KATO	DEUTZ	DEUTZ
	TYPE	Brushless	Brushless	Brushless	Brushless	Brushless	Brushless	Brushless
	MODEL NO.	31846A4G	31846A4G	31846A4G	31846A4G	A25247	1120LP12	1120LP12
	SERIAL NO.	31846-1G	31846-2G	31846-1G	31846-2G	98350	455-9308	455-9309
	VOLTAGE (V)	13,800	13,800	13,800	13,800	13,800	13,800	13,800
REMARKS		Major repairs needed	Rebuild just completed, was same as # 1	Fire Damaged, total rebuild req'd	Fire Damaged, total rebuild req'd	Under rebuild	Rebuild required	Rebuild required

2.3 Station Transformers

Two substation transformers are operated in the MEC system to transfer power from 13.8 kV feeder to 4.16 kV feeder. Z1, Z0, NO LOAD and FULL LOAD loss, as well as the BIL rating are typical values for transformers in the same class of voltage and kVA capacity¹. MEC shall update the data with specific values provided by the transformer manufacturers.

Table 3 Station Transformers

MEC	SUBSTATION NAME		JENROK SUB	LAURA SUB	
	TRANSFORMER NO.		X6000	X4000	
	SERIAL NO.		S04C200910	90687A2144	
	YEAR OF MANUFACTURE		1998	1998	
ELECTRICAL CHARACTERISTICS	RATING (MVA)		3150	1725	
	NO. OF PHASES		3	3	
	VECTOR GROUP				
	VOLTAGE (V)	HIGH		13800	13800
		LOW		4160/2400	4160/2400
	IMPEDANCE (%)	Z1		5.5	5.56
		Z0			
	LOSSES (WATTS)	NO LOAD		6775	3455
		FULL LOAD		33100	15716
	MAX. CURRENT (A)	HV			
LV			2400	2400	
TANK, CORE & OIL DETAILS	OIL	VOL (GALS)	785	372	
		WEIGHT (LBS)	25812	9555	
	WEIGHT (LBS)	NET			
		CORE, COIL & TC		1330	
TAPS & TC DETAILS	NO. OF	TAPS		5	
	TAPCHANGER	TYPE		D-EO	
COOLING METHOD					
REMARKS					

¹ Reference: Electric Power Distribution System Engineering, Turan Gonen

2.4 Distribution Feeders

2.4.1 Feeders

There are 3 main distribution feeders in the MEC system. Majority of the feeders are 13.8 kV, with the exception of 2 sections of feeders at 4.16 kV. A summary of feeder information can be found in the table below. The conductor type for feeder section 1c is updated from #2 into 2/0 as informed by MEC.

Table 4 Feeders

MARSHALLS ENERGY COMPANY - MAJURO POWER GRID INFORMATION

AS AT March 4th 2010.

			Voltage	power	Size	Distance (Feet)	Customers	Padmount Transformers	Total kVA	Polemount transformers	Total kVA	Primary Poles	Secondary Poles	Street Lights
Feeder 1	1a	Main	13800	O/H	2/0	19477	784	17	4237.5	57	2305	67	99	61
	1b	Main	13800	O/H	2/0	8520	308	7	1025	25	940	28	66	45
	1c	Main	13800	U/G	2/0	98657	435	39	3062.5	0	0	0	0	172
	1d	Main	4160	O/H	#2	8366	430	29	3445	26	975	30	46	166
					Total	135020	1957	92	11770	108	4220	125	211	444
Feeder 2	2a	Main	13800	O/H	2/0	9295	726	18	4020	65	3155	61	143	48
	2b	Main	13800	O/H	2/0	3736	295	4	262.5	29	1450	20	57	19
	2c	Branch	13800	U/G	2/0	3916	229	17	3762.5	10	415	0	63	22
	2d	Main	13800	U/G	#2	3175	151	12	3382.5	0	0	0	20	8
	2e	Main	4160	O/H	#2	3369	314	4	405	39	987.5	17	58	25
	2f	Main	4160	O/H	#2	3954	690	4	397.5	49	2227.5	40	160	84
	2g	Main	4160	U/G	#2	4471								
					Total	34914	2405	64	12755	192	8235	138	501	206
Feeder 3	F3	Main	13800	U/G	2/0	7122	220	13	4350	0	0	0	0	26
		Branch line	13800	O/H	2/0	1492				5	262.5	5	32	
					Total	7122	220	13	4350	5	262.5	5	32	26
					Totals	177056	4582	169	28875	305	12717.5	268	744	676

- NOTE:
- 1 Distance in Feet is for a single run of wire along the line of the primary poles.
 - 2 Customer numbers includes those with Zero usage and disconnected
 - 3 Transformer numbers are total qty of individual transformers. A trio of pole mounted Xfms is counted as three.
 - 4 The branch lines on 2f & F3 are primary dead end branches off the main feeder line
 - 5 Feeder 2c comes off a three way switch and travels about 200 feet before splitting into two separate lines in opposite directions.

A summary of feeders and secondary conductors is listed in the table below.

Table 5 – Feeders and Secondary Conductors

Description	Quantity
Total # 2/0 AWG Bare Copper Conductor (includes overhead phase Conductors and overhead and direct buried neutral)	409,739 LF
Total # 2/0 AWG XLP Shielded Insulated Conductor (direct buried XLP Insulation rated at 15KV)	447,792 LF
#2 AWG Triplex Cable (two 600V insulated and one bare neutral)	163,707 LF
#4 AWG Triplex Cable (two 600V insulated and one bare neutral)	209,486 LF
#6 AWG Triplex Cable (two 600V insulated and one bare neutral)	150,890 LF
#2 Insulated, Single Conductor (insulation rated at 600V)	55,216 LF
#4 Insulated, Single Conductor (insulation rated at 600V)	74,174 LF
#6 Insulated, Single Conductor (insulation rated at 600V)	53,100 LF
#6 Bare copper (pole grounding conductor and oil)	14,500 LF

Summary of PVC conduits listed in the table below.

Table 6 – PVC Conduits

Size	Quantity
1 ¼"	14,600 LF
1 ½"	4,400 LF
2"	38,000 LF
3"	3,800 LF
4"	15,700 LF
5"	100 LF
6"	200 LF

Summary of PVC Elbows of 90 degree is listed below.

Table 7 – PVC Elbows

Size	Quantity
1 ¼"	198
1 ½"	60
2"	516
3"	92
4"	106
5"	4
6"	14

Summary of PVC Couplings is listed below.

Table 8 – PVC Couplings

Size	Quantity
1 ¼"	730
1 ½"	220
2"	1900
3"	190
4"	785
5"	5
6"	10

Summary of PVC Molded End Bells is listed below.

Table 9 – PVC Molded End Bells

Size	Quantity
1 ¼"	198
1 ½"	60
2"	516
3"	92
4"	106
5"	4
6"	14

2.4.2 Pole

A summary of primary poles are listed in the table below.

Table 10 – Primary Poles

Item Description	Quantity
Primary poles	269
Single Cross Arms	359
Double Cross Arms	165
HV Ball Pin Insulators	914
HV Dead End Insulators	517
Single LV Insulators	685
3 Rack Mounted LV Insulators	83
4 Rack Mounted LV Insulators	283
HV Cutouts	602
Surge Arrestors (separate from arrestors included on transformers)	125
Down Guys	99
Stub Guys	7
Sidewalk Guys	3
Pole Braces	6
3" HV Weather heads	26
4" HV Weather heads	43
5" HV Weather heads	2
6" HV Weather heads	4
1 ¼" LV Weather heads	21
1 ¼" LV Weather heads	10
2" LV Weather heads	88
3" LV Weather heads	17
4" LV Weather heads	10
HV Shrink Terminators	160

A summary of secondary poles are listed in the table below.

Table 11 – Secondary Poles

Item Description	Quantity
Secondary poles	762
Single LV insulators	1183
3 Rack Mounted LV insulators	153
4 Rack Mounted LV insulators	5
Down Guys	17
Stub Guys	0
Sidewalk Guys	1
Pole Braces	0
1 ¼" LV Weatherheads	87
1 ½" LV Weatherheads	25
2" LV Weatherheads	184
3" LV Weatherheads	7
4" LV Weatherheads	1

2.4.3 Distribution Transformer

Distribution transformers are listed in the tables below, identified in 4 categories:

- 13.8 kV Pole Mounted Transformer (Single Phase)
- 4.16 kV Pole Mounted Transformer (Single Phase)
- 13.8 kV Pad-Mount Transformer (Three Phase)
- 4.16 kV Pad-Mount Transformer (Three Phase)

Z%, R%, X%, No Load and Full Load Losses are typical values for transformers in the same class of voltage and kVA capacity. MEC shall update the data with specific values provided by the transformer manufacturers.²

Table 12 - 13.8kV Pole Mounted Transformers (Single Phase)

MEC	Impedance			Losses		Number of Transformers			Total kVA Installed
	kVA Rating	Z%	R%	X%	No Load	Full Load	Feeder 1	Feeder 2	
15	1.6	1.3	1	84	305	2	3	5	75
25	1.7	1.1	1.1	118	437	20	3	23	575
37.5	1.6	1	1.3	166	585	33	33	66	2475
50	1.7	0.9	1.5	185	735	16	51	67	3350
75	1.5	0.8	1.2	285	1050	8	11	19	1425
Total						79	101	180	7830

Table 13 - 4160V Pole Mounted Transformers (Single Phase)

MEC	Impedance			Losses		Number of Transformers			Total kVA Installed
	kVA Rating	Z%	R%	X%	No Load	Full Load	TF1	Laura	
15	1.8	1.5	1	84	305	1	0	1	15
25	1.8	1.3	1.3	118	437	6	12	18	450
37.5	1.8	1.1	1.4	166	585	22	11	33	1237.5
50	1.9	1.1	1.4	185	735	30	4	34	1700
75	1.8	1	1.5	285	1050	9	3	12	900
Total						68	30	98	4302.5

Table 14 - 13.8 kV Pad Mount Transformers (Three Phase)

² Reference: Electric Power Distribution System Engineering, Turan Gonen

MEC	Impedance			Losses		Number of Transformer s					Total kVA Installed	
	kVA Rating	Z%	R%	X%	No Load	Full Load	Fdr 1	Fdr 2	Fdr 3	TF2 U/G		Total transformers
15											0	15
25							0	1			1	25
30								1			1	30
37.5							1				1	37.5
45							0	3			3	135
50							30	1	1	1	33	1650
75	1.7	1.3	1.1	360	1350	11	2	2	9		24	2550
112.5	1.5	1.1	1	530	1800	3	2				5	562.5
125							0				0	125
150	1.9	1.1	1.6	560	2250	2	3	1	2		8	1200
200							1				1	200
225	1.8	1.1	1.4	880	3300	4	1		1		6	1350
300	1.6	1.1	1.2	1050	4300	5	9	3	0		17	5100
500	1.7	1	1.4	1600	6800	3	5	1	1		10	5000
750	5.7	1.1	5.6	1800	10200	1	0	2	0		3	2250
1000	5.7	1	5.6	2100	12500	2	1	1			4	4000

Table 15 – 4160 V Pad Mount Transformers (Three Phase)

MEC	Impedance			Losses		Number of Transformers					Total kVA Installed	
	kVA Rating	Z%	R%	X%	No Load	Full Load	Ejit	TF1	TF2	Laura		Total transformers
15										8	8	120
25										1	1	25
30								2			2	60
37.5												37.5
45												45
50							4	2		12	18	900
75	2.1	1.3	1.6	360	1350	2	1			4	7	525
112.5	1.7	1.1	1.3	530	1800		2				2	225
125												125
150	1.9	1.1	1.6	560	2250		1			1	2	300
225	1.9	1.1	1.6	880	3300		3			1	4	900
300	2	1.1	1.7	1050	4300	1				1	2	600
500	2.3	1	2.1	1600	6800						1	500
750	5.7	1.1	5.6	1800	10200						1	750
1000	5.7	1	5.6	2100	12500							1000
Total							7	11	0	28	48	6112.5

2.5 Circuit Breaker and Switches

Table 16 - HV Circuit Breakers (VCBS and OCBS)

Location	Type	Voltage Rating	Quantity
Laura	VCB	4160 V	1
Airport Substation	VCB	13.8 kV	1
Kessai Switching Station	VCB	13.8 kV	1
Momotoro Switching Station	VCB	13.8 kV	1
Ulīga Substation	VCB	13.8 kV	1
Jenrok Substation	VCB	4160 V	1
MIHS Switching Station	VCB	4160 V	1
Total			7

Table 17 – Pad Mount Switches

Location	Voltage Rating	Quantity
Feeder 1	13.8 kV	35
Feeder 2	13.8 kV	8
Feeder 3	13.8 kV	7
Ejit	4160 V	1
Town Feeder 1	4160 V	1
Town Feeder 2 UG	13.8 kV	5
Total		57

2.6 Street Lights

There are 675 street lights in MAJU RO, among them, 275 or about 41% , are on private property. Power consumed by street light is neither metered nor billed. Based on 175 watts per light, annual consumption is 519.3 MW h for 12 hour daily usage.

2.7 Reactor and Capacitor

There is no reactor or capacitor in MEC system.

The table below is provided as a template for future capacitor data.

Table 18 – Future Capacitor Data

Location	Voltage Rating	MVAR	Quantity
Total			

The table below is provided as a template for future reactor data.

Table 19 – Future Reactor Data

Location	Voltage Rating	IMPEDANCE	Quantity
Total			



Appendices



No Appendix for this document.