LUMMUS CONSULTANTS
INTERNATIONAL

March 25, 2014

Jeffrey Johnson, Chairman
Guam Public Utilities Commission
Suite 207, GCIC Building
Hagatna, Guam 96932

Docket 13-13: Reliability of the GPA Power System

Dear Chairman Johnson,

Lummus Consultants International, Inc. (Lummus Consultants) is pleased to submit this updated report to the Public Utilities Commission in response to Mr. Fred Horecky's request to evaluate and make recommendations in regard to the reliability of Guam Power Authority's (GPA) power system.

Lummus Consultants hopes that this review has been helpful in assisting the Commission in this matter. The attached document provides the basis for the review, documents the information provided by GPA to support the analysis, and the recommendations offered. If you have any questions or need further assistance, please do not hesitate to contact me.

Very truly yours,

Lummus Consultants International, Inc.

Kathleen A. Kelly

Kathleen A. Kelly
Director and Practice Leader

Docket 13-13: Reliability of the GPA Power System
Draft Report and Recommendations
Lummus Consultants International

Introduction

The impetus for this report stems from a perception that GPA has been experiencing an inordinate frequency and duration of customer outages with virtually no information conveyed with respect to cause, location and expected time to restoration. In this report Lummus Consultants explores several areas relative to reliability, including:

- GPA's reliability statistics and a comparison with peer utilities;
- The cause of outages on the GPA system;
- GPA activities to address reliability on its system;
- GPA's current reliability reporting procedures and protocols; and
- How other utilities report scheduled and unscheduled outages to the public and their commissions.

A key recommendation of this review is that the Commission establishes an outage reporting protocol for GPA.

Sources of Outage that Impact Reliability

The GPA system is comprised of three system components: generation, transmission and distribution. Lummus Consultants has examined the extent to which outages on each of these three system components contribute to the overall reliability of the GPA system.

Generation Reliability Statistics

Generator performance is typically tracked on a standalone basis separate from customer outage statistics in order to better address the causes of generator outages, not all of which result in a customer outage. Separating out the generator outage statistics will also allow for more of an "apples to apples" measure of customer reliability when compared to other utilities, as measured by SAIDI, SAIFI and CAIDI. These IEEE developed measures were specifically developed to track distribution system reliability. The NERC-GADS (Generating Availability Data System) standard for generator reliability is a nationally recognized database for the measurement of generator reliability performance. Although geared toward larger generating units, as of January, 1, 2013 NERC GADS also began collecting outage information for units as small as 20 MW. The database establishes a set of standard measures or "cause codes" that is very useful when comparing the causes of poor performance to other similar units across the country. This unique series of databases is used to collect, record, and retrieve operating information for improving the performance of electric generating equipment. Summary level generator performance measures include:

> **Equivalent Availability Factor (EAF)** - A measure that indicates the percentage of time an electric power generating unit was available for service during a period of time; and
>
> **Equivalent Forced Outage Rate (EFOR)** – Measures the hours of unit failure as a percentage of the total hours the unit was available.

These and other measures are defined and explained in greater detail in IEEE Standard 762, "Definitions for Reporting Electric Generating Unit Reliability, Availability and Productivity".

Distribution Reliability Statistics

Three of the more common reliability reporting statistics used by GPA and in the industry are SAIDI, SAIFI and CAIDI, which are defined below[1].

SAIDI - System Average Duration Index is a measure of the total time that an average customer is without power, usually over a one-year period. SAIDI is defined and calculated as:

Sum of Customer Interruption Durations / Total Number of Customers Served

The mean value for North American utilities is approximately 1.5 hours, or 90 minutes per year.

SAIFI - System Average Interruption Frequency is a measure of the total number of times that an average customer is interrupted, usually in a one-year period. SAIFI is defined and calculated as:

Total Number of Customer Interruptions / Total Number of Customers Served

SAIFI is measured in units of interruptions per customer. The median value for North American utilities is approximately 1.1 interruptions per customer per year.

CAIDI - Customer Average Interruption Duration Index is a measure of the average length of time an interrupted customer is out of service. It is defined and calculated as:

Sum of Customer Interruption Durations / Total Number of Customer Interruptions = SAIDI / SAIFI

CAIDI is the average outage duration in minutes or hours per interruption for customers that are interrupted. The median value for North American utilities is approximately 1.36 hours, or 82 minutes per interruption over the SAIDI and SAIFI measurement period – usually one year.

Table 1, below, shows these reliability indices for the GPA system over a recent three-year period. The statistics in Table 1 exclude momentary outages of five minutes or less, but are not otherwise normalized to exclude major storms, planned outages, etc.

Table 1: GPA Reliability Statistics for a Recent Three-Year Period[2]

12-Months Ended	SAIDI (min./custr)	SAIFI (interr./custr)	CAIDI (min./custrs interr'd.)
November 2011	497.66	7.72	64.44
November 2012	216.58	8.05	26.90
November 2013	687.58	10.14	67.78

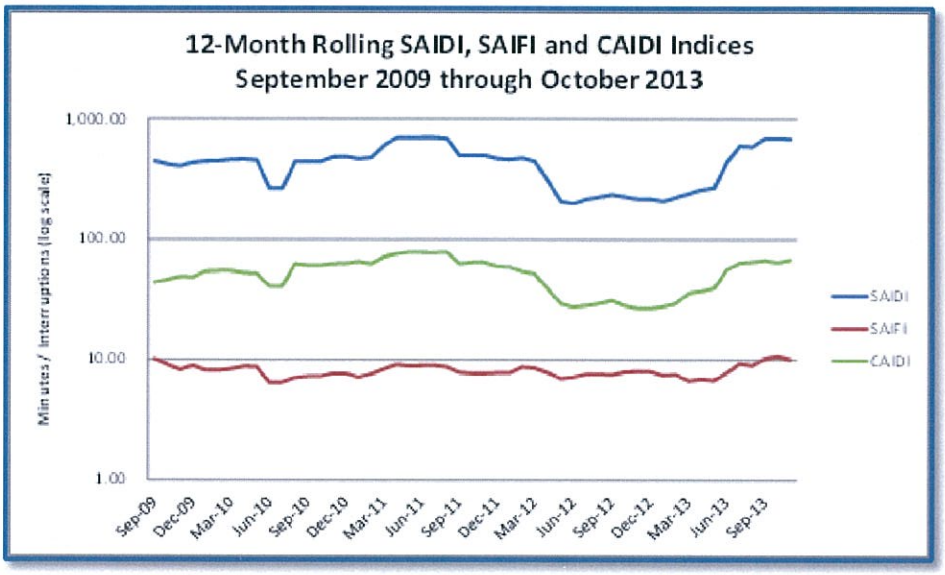
For each of the three years, SAIDI and SAIFI were each above the distribution-only mean for North American utilities of 90 minutes per customer for SAIDI and 1.1 interruptions per customer for SAIFI.

[1] The analytics used to calculate SAIDI, SAIFI and CAIDI are detailed in the IEEE Guide for Electric Power Distribution Reliability Indices, IEEE Std 1366-2012 and intended to be used to assess distribution reliability, i.e., excluding transmission and distribution.

[2] GPA measures SAIDI, SAIFI and CAIDI for its entire system, including generation, transmission and distribution.

Figure 1, below, shows the month-to-month variability of the 12-month rolling reliability indices on the GPA system.

Figure 1: Monthly Variations in 12-Month Rolling Reliability Indices



GPA benchmarks its reliability indices against American Public Power Association reliability indices. Table 2 shows APPA reliability statistics for 2011 broken down into quartile ranges, along with a comparison of GPA reliability statistics.

Table 2: APPA 2011 Reliability Statistics by Quartile Range[3] and Comparison with GPA

Measure	SAIDI (min./custr)	SAIFI (interr./custr)	CAIDI (min./custrs interr'd.)
First Quartile	16.43	0.29	46.31
Second Quartile (Median)	36.35	0.69	65.29
Third Quartile	65.91	1.08	88.39
Fourth Quartile	176.13	4.13	281.84
Average	46.36	0.81	73.86
GPA (September 2011 Filing)	738.27	16.78	43.98
GPA (Jan-Dec 2012)	299.59	9.04	33.14
GPA (February 2013)	294.77	8.68	33.96
GPA (November 2013)	687.58	10.14	67.78
Generation	397.74	6.70	59.38
Transmission	76.09	0.86	88.58
Distribution	213.62	2.58	677.32
Unspecified	0.13	0.00	29.89
Total (Nov. 2013)	687.58	10.14	855.16

[3] American Public Power Association, Evaluation of Data Submitted in APPA's 2011 Distribution System Reliability & Operations Survey, November 2012.

As shown in Table 2, for the 12-months ended November 2013, the greatest number of interruptions on the GPA system is generation-related. Comparing distribution only, GPA has a SAIDI index of 213.62 minutes per customer, which is higher than the fourth quartile of APPA utilities (176.13) and a SAIFI index of 2.58 interruptions per customer, which is between the third and fourth quartile of APPA utilities. Distribution CAIDI for GPA (677.32 minutes to restoration per interrupted customer) is significantly higher than the fourth quartile of APPA utilities.

Reliability statistics are, by nature, variable and although some improvement is noted, it is difficult to discern a clear trend on GPA's system. Similarly, there is not a clear trend in APPA's reliability statistics, which are shown in Table 3, based on its biennially published historical statistics from 2005 through 2011.

Table 3: APPA Reliability Statistics (2005, 2007, 2009, 2011)

Year	SAIDI (min./custr)	SAIFI (interr./custr)	CAIDI (min./custrs interr'd.)
2005	54.03	1.60	65.91
2007	69.80	4.18	90.06
2009	68.98	0.88	86.75
2011	46.36	0.81	73.86

Overall, the APPA statistics are generally consistent with those of North American utilities.

Reliability statistics for the GPA system was also compared with other Pacific island utilities in a 2012 Benchmarking Report of Pacific Power Utilities[4] (PPA report). The results are shown in Table 4.

[4] Pacific Power Benchmarking Report 2012, prepared by the Pacific Power Association.

Table 4: Reliability Indices from 2012 PPA Benchmarking Report[5,6,7]

	Utility	SAIDI	SAIFI
ASPA	American Samoa Power Authority	183	6
CUC	Saipan Commonwealth Utilities Corp.	1148	15
EDT	Electricite de Tahiti	90	1
EPC	Samoa Electric Power Corp.	1732	13
FEA	Fiji Electricity Authority	1518	22
GPA	Guam Power Authority	1206	8
KAJUR	Kwajalein Joint Utility Resources	127	6
SIEA	Solomon Islands Electricity Authority	1075	9
TAU	Te Aponga Uira O Tumu -Te-Varovaro (Cook Islands)	155	2
TEC	Tuvalu Electricity Corporation	5	0.1
TPL	Tonga Power Limited	1704	16
UNELCO	UNELCO Vanuatu Limited	583	4
YSPSC	Yap State Public Service Corp.		3
Average		794	8
Mean		829	6.3
Number		12	13

The PPA Report notes that reported SAIDI and SAIFI customer supply interruption indicators are roughly 25 per cent higher for PPA members than CARILEC[8] members, although PPA reporting accuracy remains questionable.

The PPA report recommends that the extension of reliability performance reporting to make the distinction between generation, transmission and distribution outage contributions to SAIDI and SAIFI should be considered for the next period. Few PPA utilities report separately in this way at present, but the report notes that it is a logical extension of reliability performance reporting.

Lummus Consultants also compared system SAIDI and SAIFI reliability indices for the four Hawaiian electric utilities in Table 5, below, with GPA (Table 2; November 2013), the distribution system of APPA utilities (Table 2) and with PPA systems (Table 4). The results show that reliability for the Hawaiian electric systems are, on average, significantly better than GPA and the aggregate of PPA member utilities, but not quite as good as the APPA member utilities, which reporting is only for distribution.

[5] Indicators of interruptions to supply (SAIDI and SAIFI) for the PPA utilities were mostly estimated not measured, although many utilities are implementing improvements to systems for subsequent period data capture.

[6] Of the 21 PPA utilities that provided information for the 2012 Pacific Power Benchmarking Report, 13 provided reliability statistics.

[7] As published, the 2012 Pacific Power Benchmark Report had a SAIFI value of 34 for GPA. GPA indicated that there was a computational error and that the correct 2012 value should have been 8.05.

[8] The Caribbean Electric Utility Service Corporation (CARILEC) is an association of electric utilities, suppliers, manufacturers and other stakeholders operating in the electricity industry in the Caribbean and includes 32 electric utilities.

Table 5: Reliability Indices for Hawaiian Electric Utilities[9]

	Utility	SAIDI	SAIFI	CAIDI
HECO	Hawaiian Electric Co.	211	1.4	153.5
HELCO	Hawaii Electric Light Co.	173	2.9	59.1
MECO	Maui Electric Co., Ltd.	129	1.5	86.3
KIUC	Kauai Island Utility Cooperative	125	5.8	21.5
Average (Hawaii GTD)		159	2.9	55.1
Average (GPA GTD)		688	10.1	855.2
Average (APPA Distrib. Only)		46	0.8	73.9
Average (PPA GTD)		794	8.1	98.3

Lower reliability indices could be expected for island systems that do not have the benefit of mainland systems in terms of being interconnected with neighboring systems.

Cause of GPA System Outages

In order to better understand the cause of outages on the GPA system, Lummus Consultants analyzed 914 outage occurrences over the period December 3, 2012 to November 29, 2013 based on data provided by GPA. Table 6, below, summarizes the cause of outages by category.

Table 6: Reliability Indices by Cause 12-Months Ended November 2013

	Occurences		SAIDI		SAIFI		
Root Category Name	No.	%	Index	%	Index	%	CAIDI
Equipment	621	67.9%	512.59	72.1%	13.07	70.7%	39.22
Unknown	86	9.4%	34.76	4.9%	1.57	8.5%	22.12
Animals	61	6.7%	26.74	3.8%	1.29	7.0%	20.69
Human Error	46	5.0%	7.91	1.1%	1.12	6.0%	7.09
Vegetation	43	4.7%	63.07	8.9%	0.59	3.2%	107.25
Construction	20	2.2%	35.92	5.1%	0.13	0.7%	282.20
External Interference	17	1.9%	5.59	0.8%	0.39	2.1%	14.37
Repair (scheduled)	7	0.8%	18.24	2.6%	0.15	0.8%	120.88
Preventative Maintenance	5	0.5%	4.22	0.6%	0.03	0.2%	142.77
Weather / Environment	5	0.5%	0.09	0.0%	0.06	0.3%	1.62
Other	3	0.3%	-	0.2%	-	0.5%	
Total	914	100.0%	709.11	100.0%	18.39	100.0%	38.56

The results show that equipment failures, by far the most frequent cause of outages, account for approximately 68 percent of the outages during this period and contribute to more than 70 percent of the SAIDI and SAIFI values. Outages specifically identified as caused by animals (predominately snakes) and vegetation together account for 11.4 percent of the outages and 20.8 percent when combined with the second highest category,

[9] 2011 Indices per Annual Report of the State of Hawaii Fiscal Year 2011-12.

Unknown, which GPA categorizes as a combination of animals and vegetation. Human error, predominately using incorrect equipment, is 5 percent. Construction, scheduled repair and preventative maintenance are 3.5 percent. External interference (predominately vandalism) accounts for 1.9 percent.

Although equipment failures account for the highest portion of outage minutes per customer and number of interruptions per customer (SAIDI and SAIFI), CAIDI, which is a measure of the average duration of each outage for customers that are interrupted is approximately the average of the system (39.22 minutes per outage versus 38.56 minutes per outage for all occurrences). Construction, repair and scheduled maintenance have the highest CAIDI indices, averaging approximately 182 minutes to restoration for each interruption per interrupted customer.

Appendix 1 to this report provides a breakdown of each outage cause in Table 6 by generation, transmission and distribution functions on pages 1 and 2. Page 5 of Appendix 1 contains a drill-down of generation, transmission, and distribution equipment failures showing the outage cause by category.

Under-frequency load shedding is a frequent occurrence on the GPA system. This occurs when a sudden loss of a generating unit results in an imbalance where there is more load than generating capacity causing in a drop in frequency below 60 Hertz. In order to avoid total collapse of the system, load is shed a block at a time until the system stabilizes. Over the period 12/3/2012 to 11/29/2013 there have been 467 occurrences of load shedding. This can be seen on pages 3 and4 of Appendix 1.

GPA's Efforts to improve System reliability

GPA considers improvements in the reliability of its system to be one of its prime concerns but stated in its filing that due to its FY 2014 base rate increase and attendant austerity measures there could be a temporary deferment of important resource investments for reliability. GPA noted that:

- Reliability could suffer because austerity measures being taken by GPA will result in not all O&M needs being addressed in FY 2014, and
- EPA regulations will require considerable capital expenditures that are higher priority and will reduce valuable funding needed for system reliability and efficiency improvements.

Not being able to invest in baseload units at appropriate levels, combined with improvements needed for peaking and emergency generators that may need to be deferred, will directly impact GPA's ability to reduce customer outage duration and frequency.

An overview of GPA's maintenance and capital projects activities directed at improving system reliability and its Smart Grid and the Energy Storage Feasibility study initiatives are described below.

Maintenance

Notwithstanding budgetary constraints, GPA is continuing to do vegetation management, albeit on a somewhat lesser scale. The company prioritizes its worst feeders and trouble spots in order to decide where its investments are most needed. Main lines and laterals are a higher priority and GPA tries to impact as many of its customers as possible with repairs and upgrades, but not all of the secondary lines can be addressed within the current budgets. When workmen are extending lines to customers or responding to short-term outages, they also make note of other repairs or upgrades that are needed in the area for future work.

In 2011 GPA developed the T&D Maintenance Action Plan to replace old and deteriorated overhead line hardware which includes rotted wood poles. The main focus of the work, which was completed in February 2012, was to address failing splices, rusty line hardware, and improve vegetation management to minimize outages associated with line equipment failure. Additional work under the plan is currently in progress.

Additionally, GPA extended its Distribution Medium Range Plan to include proper fuse coordination and additional lateral and sub-lateral protection to isolate faults in the system to minimize the number of customers affected.

Projects specific to certain feeders include: reconfiguration of P-261 and P-262 to reduce the number of customers interrupted by snake and vegetation; reconfiguration of P-087, P-046, and P-330 for voltage and loading issues as well as back-feeding capability; installation of switches on P-322, P-321, P-221, P-223, and P-005 to provide quick restoration of affected feeders as well as surrounding feeders.

GPA has also installed reclosers at all the distribution breakers and is in the process of developing the procedures for their use. This will reduce outage times associated with temporary line faults associated with vegetation and snakes.

Capital Projects

GPA has a long-range master plan to invest in their T&D system and based on funding, tries to adjust to the plan as much as possible. In conversations with GPA, it noted that generation outages always have priority over peaking if there are choices that need to be made. After generation, substations and transmission are the next priority for funding. Factors that come into play regarding where to spend the dollars include reliability on one side and, e.g., safety, legal on the other side. GPA maintains a prioritized tracking list for its CIP.

A review of GPA's current capital improvement program shows that it has budgeted $16.2M in FY 2014 for T&D reliability-related projects, $13.5M of which has already received PUC approval. In FY 2015 the company has budgeted $9.8M in bond-funded T&D reliability work.

Smart Grid

GPA's Smart Grid project consists of several initiatives, including:

- Smart Meter installations: Over 40,000 customer meters replaced with Smart Meters. Completion of installation is projected by 1st Quarter 2014.
- Systems Implementation: Several systems already in place for GPA's use, as follows:
    - Command Center – for tracking and monitoring Advanced Metering Infrastructure (AMI).
    - Meter Data Management System (MDMS) – for smart meter data management
    - ePortal – website for customer access to KWH consumption
- Other ongoing initiatives targeting completion by 1st Quarter 2014:
    - Substation Automation
    - Outage Management System
- Communications for various programs underway

GPA's Smart Grid Initiatives have been implemented and rolled-out in a staggered approach since 2012. GPA is already utilizing programs that are in place, such as the AMI system, MDMS and ePortal. Target implementation of all initiatives is by 1st or 2nd Quarter of 2014.

In terms of reliability, the Smart Grid project will allow outage areas to be identified more quickly for crews to respond. Also, customer reliability indices are calculated automatically by the AMI Command Center and MDMS applications as will the OMS. Currently, GPA receives outage reports from the AMI Command Center staff.

Energy Storage Feasibility Contract

In August 2013 GPA authorized TG Engineers to proceed with a study to determine the feasibility of adding energy storage systems to GPA's grid, as well as other recommendations, to achieve the following:

- Resolve power quality and system reliability issues resulting from the integration of existing and planned renewable energy generation, such as wind and solar, produced by GPA and its customers.
- Optimize the penetration level of prospective renewable energy generation.
- Reduce the number of under-frequency load shedding outages.
- Resolve system reliability issues resulting from low-inertia systems.
- Improve reactive power management.
- Increase system stability.
- Improve power quality.
- Improve the economics of power generation and energy consumption (e.g., reduce total system fuel-related production costs).
- Plan grid operations for different sets of generation mix due to the transition to LNG and generation unit retirements.
- Optimize system protection and operations strategies to reduce costs, decrease customer outages, and improve grid operational capabilities.
- Determine optimum siting for new generation additions.
- Determine optimum siting for new energy storage system.

These sets of studies will provide GPA with recommendations for Capital Improvement Projects.

Outage Reporting

Lummus Consultants queried GPA regarding their outage communications and reporting to the public and the PUC.

When a scheduled outage occurs, GPA issues notices to the various mayors' offices and reaches out to media outlets before the scheduled outage will occur. When an unscheduled outage occurs, e.g., a generator trips and there's an under-frequency load shedding event, GPA dispatchers try to correct the situation and immediately contact GPA's information officer, who then tries to get the message out to the media, radio, television and newspapers regarding what happened.

GPA has a mobile app for use by customers that allows access to GPA contact information, outage information, news releases, PayGPA and a link to the GPA website. However, outage information currently on the mobile app includes only scheduled outages at this time and is not updated regularly. GPA envisions building in real-time outage information to the mobile app, including anticipated time to restoration, sometime in the future. GPA does not have a direct connection to Facebook regarding outages and outage information. In the future, GPA envisions real-time outage information on both Facebook and Twitter. For local outages there is capability for an automatic trouble call recording telling customers that call from a particular area that GPA knows there is an outage and will state the estimated duration of the outage. In discussing this capability with GPA, they were unsure if it was currently operative.

There is currently no formal reporting relative to outages and reliability to the Commission. An outage notice usually originates from the dispatchers and flows to the general manager and other key GPA personnel who then notify the PUC via a phone call or an email message.

Reliability reports are provided once a month for the CCU meetings and include one year rolling statistics relative to SAIDI and SAIFI for the reporting month as well as the previous month, graphs depicting the monthly cumulative SAIDI and SAIFI, and the total yearly cause breakdown by frequency and duration. Additionally, a quarterly report is provided to include SAIDI, SAIFI, CAIDI, Storm CAIDI, and CEMI[10].

Discussion and Recommendations

GPA System Reliability

In comparison with most North American integrated systems where distribution reliability is typically the focus of attention, generation on GPA's system, notwithstanding its large amount of reserve capacity, is, by far, the leading cause of outages. When the GPA system is compared against APPA, GPA lags considerably in terms of SAIDI and SAIFI, even recognizing that APPA data is based on reliability indices of member systems that are predominately distribution. GPA distribution, however, is comparable with APPA in terms of the SAIFI measure, but lags in terms of SAIDI and CAIDI (Table 2).

GPA reliability is comparable to responding Pacific Power Association member systems, with the caveat that the reliability of PPA reporting utilities is in question. Reliability statistics of the four Hawaiian electric systems, which do have generation, are significantly better than those of GPA.

There is no doubt that reliability improvements are needed for GPA's generation resources. Over the past few years there has not been a discernable trend in system overall reliability improvement. Lummus Consultants believes that GPA should strive towards achieving comparable reliability of the four Hawaiian electric utilities, but recognizes that GPA should first focus on demonstrating continuing improvement relative to its own history. The energy storage study performed by TG Engineers may provide some important insight towards achieving this goal.

Outage Reporting

GPA has procedures in place to disseminate scheduled and unscheduled outage information to mayors' offices and to radio and television stations. However, this same type of information is not readily at hand on a real-time basis when a customer experiencing an outage needs it most, especially when that customer does not have power for the radio or television. We recommend that one of GPA's goals should be to incorporate real-time information on its mobile app to communicate those areas and number of customers affected along with estimated time to restoration, as well as to provide such information to media and the GPUC regularly during the outage.

Although there is some formal reporting to the CCU, there is no formal period for specific reporting to the Commission. Lummus Consultants reviewed reporting requirements of other utilities to their Commission relative to reliability. We recommend that GPA provide regular and periodic reporting to the Commission as described in the following sections.

[10] CEMI is Customers Experiencing Multiple Interruptions. CEMI-X is a measure of the percentage of customers who experienced *X* interruptions.

Monthly Reporting

Monthly reporting should contain the same metrics reported to the CCU and to include, if not already in the CCU report:

- One year number of outage occurrences, SAIDI, SAIFI, CAIDI and ASAI[11] for the reporting month as well as the previous month
    - Breakdown among generation, transmission and distribution;
    - Number of occurrences, SAIDI, SAIFI and CAIDI that resulted in under frequency load shedding;
    - Information linking the outages to distribution circuits to track potential problem circuits;
- Graphs depicting the monthly cumulative SAIDI, SAIFI, CAIDI and ASAI;
- Reporting of all generator related offline trip events, their causes and duration (whether or not customers lost service);
- Unit specific outage reporting related to Equivalent Availability Factors (EAF)and Equivalent Forced Outage Rate EFOR) consistent with GADS reporting;
- Graphic representation of historic EAF and EFOR for multiple years; and
- The total yearly outage cause breakdown by frequency and duration.

Quarterly Reporting

For each third month, corresponding with GPA's quarterly reporting to the CCU, the same information contained in the monthly reporting, above, and with the addition of storm CAIDI, CEMI and other metrics contained in GPA's quarterly report.

Annual Reporting

A more comprehensive and detailed report to include the quarterly information in order to facilitate reporting and eliminate duplication of information and be provided at the end of the calendar year in order to facilitate comparison with other utilities. Additional information should include:

- Monthly reliability statistics for each, SAIDI, SAIFI, CAIDI and ASAI, in tabular and graphical form over the most recent five-year period, normalized and not normalized, with Identification of any normalization adjustments, including storms, momentary outages, etc., that have been made to the current year data;
- Benchmarking of GPA reliability statistics against its own historical performance and discussion of such trends;
- Benchmarking of GPA reliability statistics against other systems such as those included in APPA, PPA, and Hawaiian systems;
- Discussion and analysis of significant events during the year that assist in providing insight into the reliability indices of each, generation, transmission and distribution;
- Discussion and rationale relative to trends in increased, decreased or same level of reliability;

[11] ASAI, the Average Service Availability Index, calculated as 1-SAIDI/8760, is a measure of total customer hours actually served as a percentage of the total customer hours possible during the year.

- Discussion relative to reliability-related maintenance and capital spending during the year; Smart Grid; special studies; or other initiatives undertaken during the year have influenced or are expected to influence reliability;
- Discussion relative to actions needed and progress towards mitigating the particularly frequent generation outages;
- Discussion of proposed maintenance and capital improvements projects, including budgets, for the next fiscal year and beyond and the anticipated effect on reliability;
- Discussion relative to reporting of scheduled and unscheduled outages to customers and the Commission, including status of real-time reporting of outage information on GPA's mobile app and/or other means.

Lummus Consultants understands and recommends that the reporting protocols may need to be revised from time to time.

GPA All-Causes, Outages by Cause - 12-Months Ended November 2013

	All-Cause Outages						
	Occurrences		SAIDI		SAIFI		
Cause Category	No.	%	Index	%	Index	%	CAIDI
Equipment							
Generation	500	54.7%	401.72	56.7%	10.65	57.9%	37.71
Transmission	17	1.9%	18.24	2.6%	0.31	1.7%	59.55
Distribution	104	11.4%	92.63	13.1%	2.11	11.5%	43.89
Total Equipment	621	67.9%	512.59	72.3%	13.07	71.1%	39.22
Unknown							
Generation	17	1.9%	6.78	1.0%	0.38	2.1%	17.79
Transmission	18	2.0%	2.49	0.4%	0.14	0.8%	17.63
Distribution	51	5.6%	25.48	3.6%	1.05	5.7%	24.30
Total Unknown	86	9.4%	34.76	4.9%	1.57	8.5%	22.12
Animals							
Generation	-	0.0%	-	0.0%	-	0.0%	
Transmission	12	1.3%	3.28	0.5%	0.24	1.3%	13.43
Distribution	49	5.4%	23.46	3.3%	1.05	5.7%	22.39
Total Animals	61	6.7%	26.74	3.8%	1.29	7.0%	20.69
Human Error							
Generation	32	3.5%	5.81	0.8%	0.77	4.2%	7.50
Transmission	3	0.3%	1.05	0.1%	0.16	0.9%	6.34
Distribution	11	1.2%	1.06	0.1%	0.18	1.0%	5.99
Total Human Error	46	5.0%	7.91	1.1%	1.12	6.1%	7.09
Vegetation							
Generation	-	0.0%	-	0.0%	-	0.0%	
Transmission	11	1.2%	43.84	6.2%	0.08	0.4%	557.94
Distribution	32	3.5%	19.23	2.7%	0.51	2.8%	37.75
Total Vegetation	43	4.7%	63.07	8.9%	0.59	3.2%	107.25

GPA All-Causes, Outages by Cause - 12-Months Ended November 2013 (cont'd)

	All-Cause Outages						
	Occurrences		SAIDI		SAIFI		
Cause Category	No.	%	Index	%	Index	%	CAIDI
Construction							
Generation	-	0.0%		0.0%		0.0%	
Transmission	-	0.0%		0.0%		0.0%	
Distribution	20	2.2%	35.92	5.1%	0.13	0.7%	282.20
Total Construction	20	2.2%	35.92	5.1%	0.13	0.7%	282.20
External Interference							
Generation		0.0%		0.0%		0.0%	
Transmission	13	1.4%	2.32	0.3%	0.31	1.7%	7.53
Distribution	4	0.4%	3.27	0.5%	0.08	0.4%	40.55
Total External Interference	17	1.9%	5.59	0.8%	0.39	2.1%	14.37
Repair (scheduled)							
Generation		0.0%		0.0%		0.0%	
Transmission	1	0.1%	1.35	0.2%	0.05	0.3%	26.00
Distribution	6	0.7%	16.89	2.4%	0.10	0.5%	170.69
Total Repair	7	0.8%	18.24	2.6%	0.15	0.8%	120.88
Preventative Maintenance							
Generation	-	0.0%	-	0.0%	-	0.0%	
Transmission	1	0.1%	3.25	0.5%	0.01	0.1%	348.06
Distribution	4	0.4%	0.97	0.1%	0.02	0.1%	47.95
Total Preventative Maint.	5	0.5%	4.22	0.6%	0.03	0.2%	142.77
Weather / Environment							
Generation	-	0.0%		0.0%		0.0%	
Transmission	-	0.0%		0.0%		0.0%	
Distribution	5	0.5%	0.09	0.0%	0.06	0.3%	1.62
Total Weather/Environment	5	0.5%	0.09	0.0%	0.06	0.3%	1.62
Other	3	0.3%	-	0.0%	-	0.0%	
Total	914	100.0%	709	100.0%	18	100.0%	38.56

GPA Under-Frequency Load Shedding - 12-Months Ended November 2013

	Under-Frequency Load Shedding						
	Occurrences		SAIDI		SAIFI		
Cause Category	No.	%	Index	%	Index	%	CAIDI
Equipment							
Generation	393	84.2%	255.46	94.2%	9.40	90.3%	27.18
Transmission	-	0.0%		0.0%		0.0%	
Distribution	-	0.0%		0.0%		0.0%	
Total Equipment	393	84.2%	255.46	94.2%	9.40	90.3%	27.18
Unknown							
Generation	15	3.2%	6.68	2.5%	0.38	3.6%	17.69
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Unknown	15	3.2%	6.68	2.5%	0.38	3.6%	17.69
Animals							
Generation		0.0%		0.0%		0.0%	
Transmission	3	0.6%	0.13	0.0%	0.07	0.7%	1.71
Distribution	12	2.6%	0.88	0.3%	0.25	2.4%	3.49
Total Animals	15	3.2%	1.01	0.4%	0.33	3.1%	3.09
Human Error							
Generation	31	6.6%	5.79	2.1%		0.0%	
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Human Error	31	6.6%	5.79	2.1%	-	0.0%	
Vegetation							
Generation		0.0%		0.0%		0.0%	
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Vegetation	-	0.0%	-	0.0%	-	0.0%	

GPA Under-Frequency Load Shedding - 12-Months Ended November 2013 (cont'd)

	Under-Frequency Load Shedding						
	Occurrences		SAIDI		SAIFI		
Cause Category	No.	%	Index	%	Index	%	CAIDI
Construction							
Generation		0.0%		0.0%		0.0%	
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Construction	-	0.0%	-	0.0%	-	0.0%	
External Interference							
Generation		0.0%		0.0%		0.0%	
Transmission	13.00	2.8%	2.32	0.9%	0.31	3.0%	7.53
Distribution		0.0%		0.0%		0.0%	
Total External Interference	13	2.8%	2.32	0.9%	0.31	3.0%	7.53
Repair (scheduled)							
Generation		0.0%		0.0%		0.0%	
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Repair	-	0.0%	-	0.0%	-	0.0%	
Preventative Maintenance							
Generation		0.0%		0.0%		0.0%	
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Preventative Maint.	-	0.0%	-	0.0%	-	0.0%	
Weather / Environment							
Generation		0.0%		0.0%		0.0%	
Transmission		0.0%		0.0%		0.0%	
Distribution		0.0%		0.0%		0.0%	
Total Weather/Environment	-	0.0%	-	0.0%	-	0.0%	
Other		0.0%		0.0%		0.0%	
Total	467	100.0%	271	100.0%	10	100.0%	26.06

GPA – Detail of Equipment Failures - 12-Months Ended November 2013

Equipment	Occurences	SAIDI	SAIFI
Generation			
Generator	137	168.13	2.63
Mechanical System Fuel Leaks	41	3.47	0.92
Auxiliary Systems	322	230.12	7.10
Total Generation	500	401.72	10.65
Transmission			
Substation Transformers	4	6.60	0.11
Overhead	11	9.40	0.14
Underground	2	2.24	0.06
Total Transmission	17	18.24	0.31
Distribution			
Substation	10	1.34	0.04
Overhead	87	89.50	2.06
Underground	7	1.79	0.02
Total Distribution	104	92.63	2.11
Total Equipment	621	512.59	13.07