2015 ELECTRIC SYSTEM RELIABILITY REPORT

CITY OF ANAHEIM PUBLIC UTILITIES DEPARTMENT

ANAHEIM

Contents

Overview

The City of Anaheim Public Utilities (APU) Department provides high quality electric service to approximately 116,000 residential and business customers. In order to determine the effectiveness of the local grid, performance metrics are utilized to measure outage duration, number and type of outage events, as well as restoration time. Similar statistics are gathered by both private and public utilities and reported to respective regulatory agencies, boards and councils.

The Electric System Reliability Report is intended to parallel industry practice of reporting on reliability metrics and inspection results. Private utilities are required to submit annual reports to the California Public Utilities Commission (CPUC) on (1) reliability metrics, (2) distribution equipment inspections per General Order (GO) 165, and (3) substation equipment inspections per GO 174. This report covers Anaheim's reliability and inspection performance for calendar year 2015.

1.0 Electric System Reliability

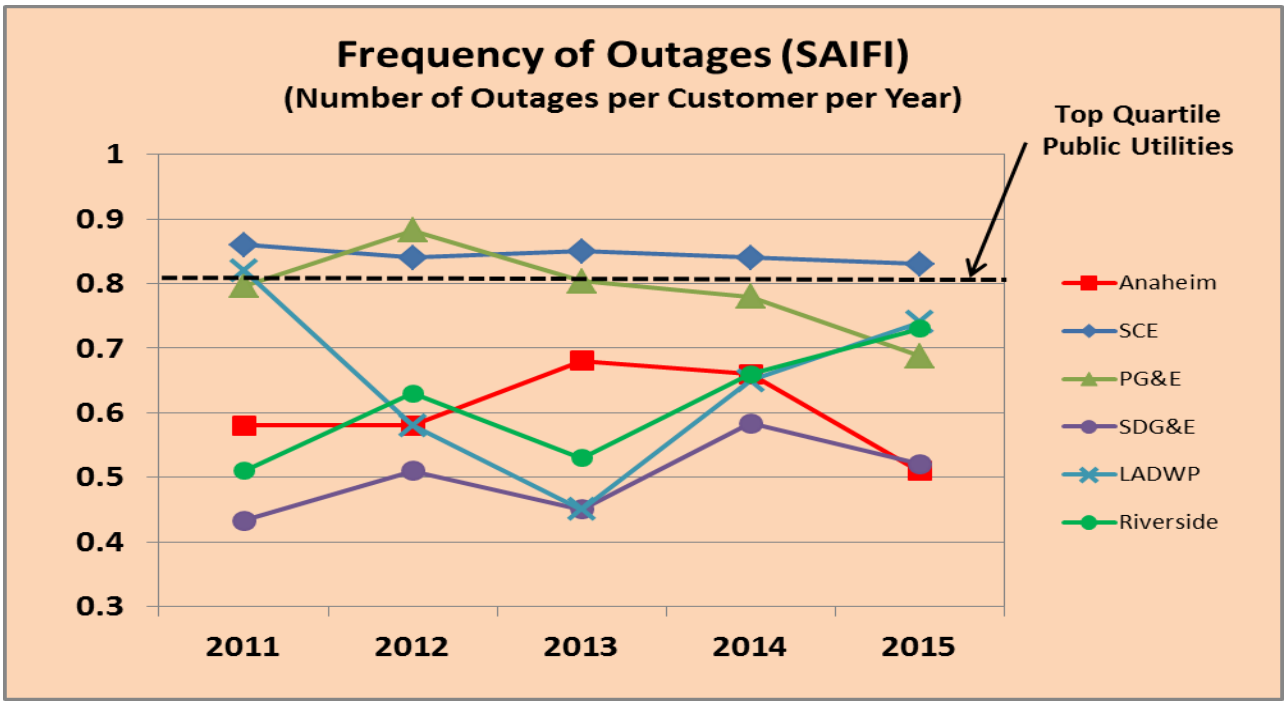
Anaheim Public Utilities is committed to providing reliable electric service to its customers. Reliable electricity is delivered to Anaheim customers by combining a diverse portfolio of power resources with a modern and well maintained distribution network. Anaheim is ranked in the top 25 percent (quartile) of utilities nationwide when it comes to electric system reliability, which means that Anaheim customers have fewer and shorter power outages than the other 75 percent of utilities nationwide.

Electric reliability is measured by recording how many times service is interrupted (frequency), how long the average customer is interrupted (duration), how long it takes to restore service once a customer is interrupted (restoration time). These three measures of reliability have been standardized and are recognized by the electric industry as best practices for comparing reliability performance among utilities.

1.1 Annual Reliability Data with Utility Comparisons

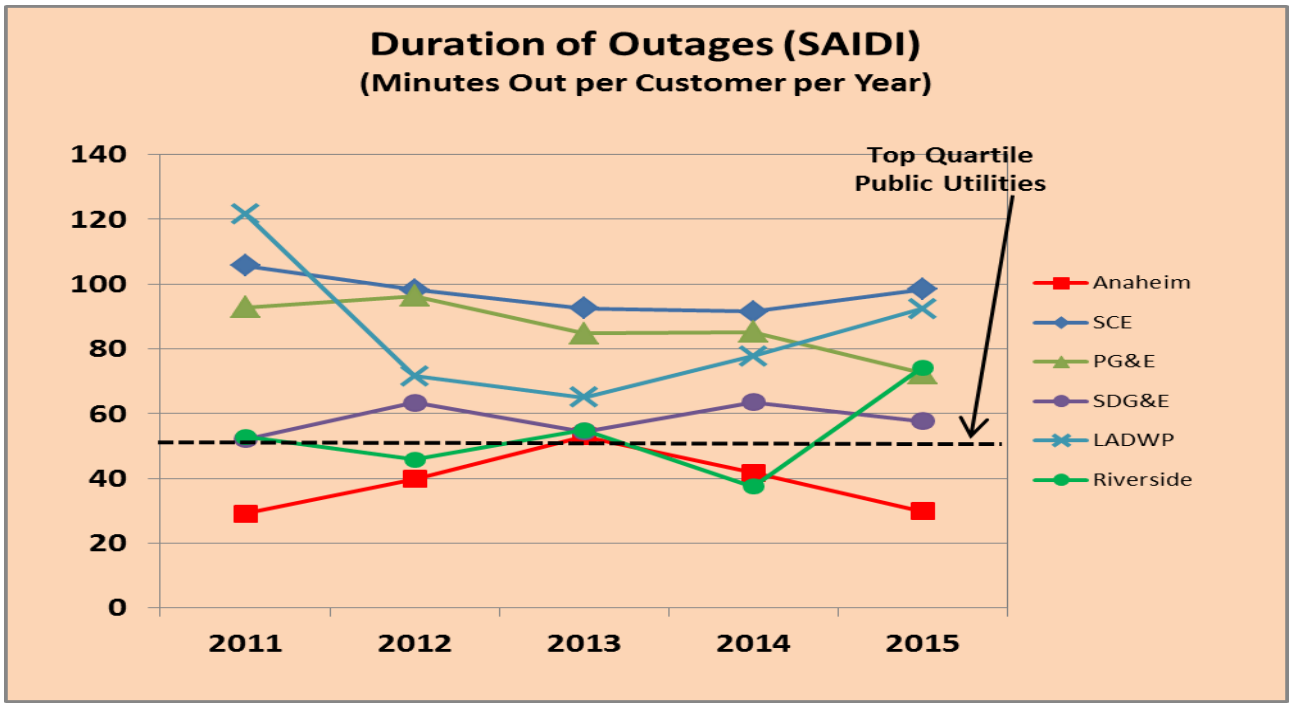
The common indices adopted by utilities include the following:

System Average Interruption Frequency Index (SAIFI): SAIFI is an indication of outage frequency, or how many outages an average customer may experience in a year. It is calculated based on the total number of customers affected by all outages in a given year divided by the number of customers served by the utility. The following graph shows the SAIFI metric for Anaheim as compared to other California utilities. In 2015, an Anaheim customer would have experienced 0.5 power outages, on average, which is about one outage every two years.



This reliability level experienced by Anaheim customers is about 40% better than that of surrounding Orange County communities, and the Department was within the top quartile (25%) of Publicly Owned Utilities (POUs) nationwide. There was one major vehicular accident that damaged a utility pole and several spans of overhead wires in December 2015 that resulting in almost 2,000 customers without power; the majority (50%) of customers were restored within minutes utilizing automated switching technology. For the remaining customers, the Department was able to quickly mobilize field crews to replace damaged pole and wires and restore power within hours. In keeping with the adopted industry standard IEEE 1366-2003, this outage was considered a Major Event Day (MED) and therefore excluded in the SAIFI indices, which will be discussed further in the report.

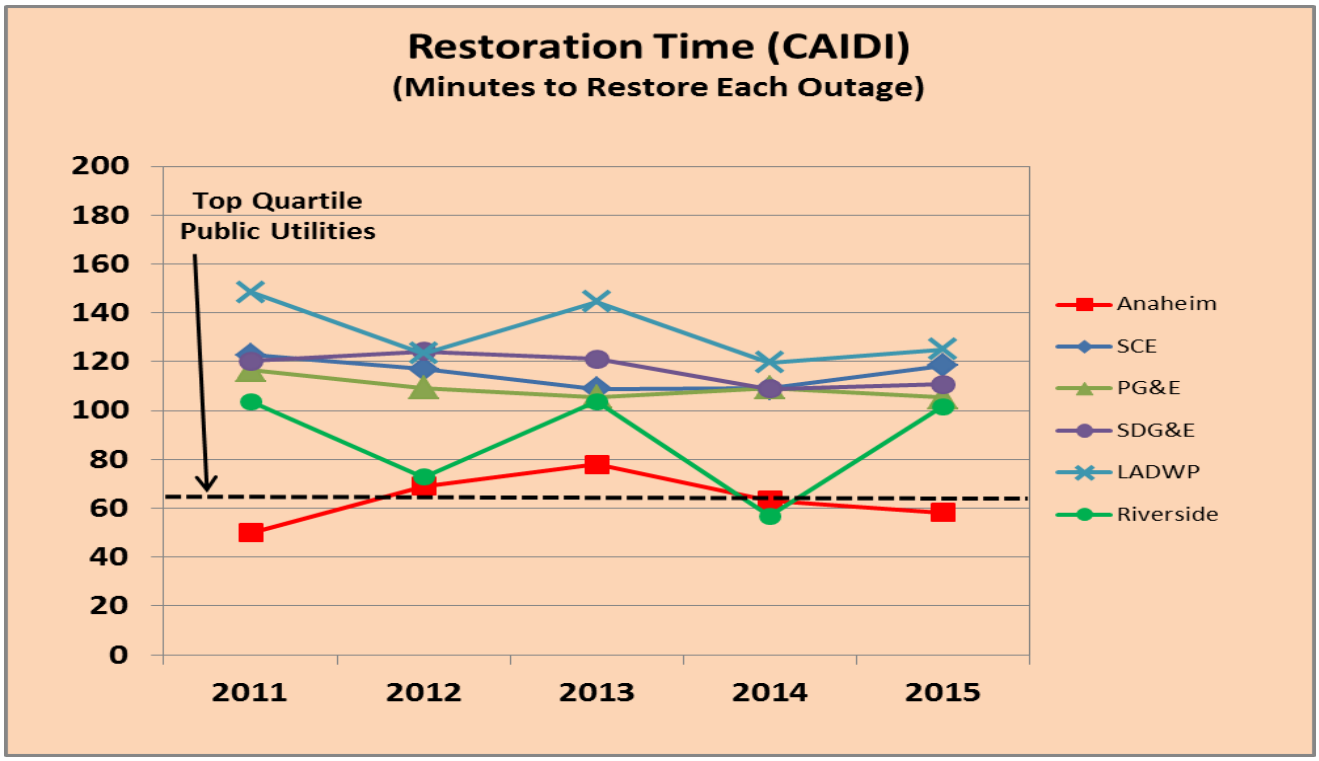
System Average Interruption Duration Index (SAIDI): SAIDI is an indication of outage duration, or how long an average customer will be without service per year. It is calculated based on the total number of minutes that customers are without power in a given year divided by the number of customers served by the utility. The following graph shows the SAIDI metric for Anaheim as compared to other California utilities. In 2015, an Anaheim customer would have gone without power for 30 minutes, on average, which is 70% better than that of surrounding Orange County communities, and the Department was within the top quartile (25%) of Publicly Owned Utilities (POUs) nationwide.



The Department continues to proactively invest in replacement projects to address the historic reliability problems related to direct buried cables. These investments have resulted in fewer cable related outages, lower customer minute interruptions, and improved reliability. There were 35 cable-related outages in 2015 as compared to 51 in the prior year, which is 32% fewer than the 5 year average. The downward trend in the SAIDI indices reflects a 44% decrease in the time customers are without power during an underground cable related outage in 2015,

compared to the 5 year average. As projects are completed and newer systems are installed with conduits allowing for faster restoration, the SAIDI indicator should reflect further improvements in reliability in the future.

Customer Average Interruption Duration Index (CAIDI): CAIDI is an indication of outage duration for those actually interrupted, or how long it takes to restore outages. It is calculated based on the total number minutes that customers are without power in a given year divided by the number of customers actually interrupted by such outages. The following graph shows the CAIDI metric for Anaheim as compared to other California utilities. In 2015, outages experienced by Anaheim customers took approximately 58 minutes to restore, on average, which is 51% better than that of surrounding Orange County communities. Anaheim has incorporated automation with new infrastructure that improves reliability results and maintains restoration time performance within the top 25% of all municipal utilities across the country. Through automation, power is restored within minutes to as many customers as safely possible.



1.2 APU Annual Data

Anaheim collects and reports on all outage data, and in-line with standard utility best practice, separately reports on all outage data and data excluding major events. The reason for this is to determine how the normal grid performs, exclusive of major wind or regional outages to provide a normalized basis for comparison. Anaheim had one major event in 2015.

In a tabular format, Anaheim's data is as follows:

	All Interruptions Included [1]			Major Events Excluded [2]		
YEAR	SAIDI	SAIFI	CAIDI	SAIDI	SAIFI	CAIDI
2011	29.10	0.59	50.00	29.10	0.59	50.00
2012	39.85	0.58	69.00	39.85	0.58	69.00
2013	53.04	0.68	78.03	53.04	0.68	78.03
2014	48.50	0.80	60.87	41.71	0.66	63.23
2015	34.38	0.52	66.04	29.81	0.51	58.19

[1] All calculations include only sustained interruption, which is an interruption resulting in positive customer minute interruption (CMI)

[2] Major Event Exclusions as defined in CPUC D.96-09-045 exclude events such as natural disasters or affects more than 10% of the utility's customers, or as defined by IEEE Std. 1366 exclude events where daily SAIDI exceeds the Major Event Days (MEDs) threshold value. APU applied the IEEE Std. 1366 starting in 2015.

1.3 Major Events

Major Event Exclusions are defined in CPUC D.96-09-045 and adopted utility industry standard IEEE 1366. The CPUC's definition excludes events such as natural disasters or natural causes that affect more than 10% of the utility's customers, or 15% of the utility's system facilities. The IEEE standard uses an additional metric to define when an anomaly has occurred on the system, which recently more utilities are using to reflect a more useful average and standardized measure of reliability to normalize the comparison between utility systems. Below is a summary of major events that have occurred over the past five years in Anaheim.

2011-2013		*None*				
2014	4/29/14	*Wind Storm*	41.71	0.66	63.23	More than 10% of customers affected
2015	12/8/15	*Car Hit Pole*	29.81	0.51	58.19	Outage duration greater than the maximum limit

1.4 Monitoring Individual Circuits

Individual circuits emanating from substations are monitored to determine overall performance. There may be indicators that equipment, geography (in large utility territories), or other factors may be impacting performance. APU reviews circuit performance and develops mitigation measures that include one or more of the following:

- Increased inclusion of automation
- Accelerated equipment replacements
- Capacity upgrades and/or re-distribute load onto adjacent circuits
- Implementation of branch line fuses or underground devices that separate from the backbone in the event of an outage

The following tables show the past five years of circuits that had the highest number of outages:

2011

Rank	Circuit Name	Substation	SAIFI
1	Knott	Clair	0.072
2	La Verne	Sharp	0.067
3	Disney	Katella	0.063
4	Balboa	Southwest	0.037
5	Palm	Anaheim	0.037
6	Spruce	Park	0.026
7	Walnut	Yorba	0.025
8	Ball	Clair	0.024
9	Powers	Hannum	0.021
10	Broadway	Hannum	0.019

2012

Rank	Circuit Name	Substation	SAIFI
1	La Verne	Sharp	0.078
2	Balboa	Southwest	0.037
3	Trident	Hannum	0.034
4	Brenda	Sharp	0.033
5	Jeanne	Sharp	0.026
6	Gilbert	Clair	0.025
7	Ball	Clair	0.025
8	Ranch	Fairmont	0.023
9	Keith	Dowling	0.023
10	Delco	Hannum	0.020

2013

Rank	Circuit Name	Substation	SAIFI
1	La Verne	Sharp	0.034
2	Powers	Hannum	0.032
3	Citron	Anaheim	0.029
4	Ball	Clair	0.025
5	Balboa	Southwest	0.022
6	Jewel	Anaheim	0.019
7	Broadway	Hannum	0.018
8	Oliver	Anaheim	0.017
9	Armand	Hannum	0.017
10	Fry	Yorba	0.017

2014

Rank	Circuit Name	Substation	SAIFI
1	Moody	Hannum	0.131
2	La Verne	Sharp	0.060
3	Disney	Katella	0.055
4	Sycamore	Anaheim	0.041
5	Keith	Dowling	0.038
6	Christine	Sharp	0.038
7	Knott	Clair	0.036
8	Beach	Clair	0.031
9	Powers	Hannum	0.031
10	Debbie	Sharp	0.026

2015

Rank	Circuit Name	Substation	SAIFI
1	Keith	Dowling	0.040
2	Beach	Clair	0.031
3	Newport	Southwest	0.031
4	Disney	Katella	0.030
5	Powers	Hannum	0.029
6	Jeanne	Sharp	0.027
7	Brenda	Sharp	0.025
8	Dale	Clair	0.023
9	Armand	Hannum	0.018
10	Walnut	Yorba	0.018

The Keith circuit out of Dowling Substation experienced a total of 4 sustained outages in 2015. One significant outage was due to vehicle hitting a utility pole causing an outage affecting 2,200 customers in April. Damage to a utility pole and overhead transformer and wires down on the ground were reported. Through automated field switching, more than 50% of the customers were restored within 8 minutes and the majority of remaining customers within one and one half hours through manual field switching. Field crews made repairs to restore the remaining customers.

As criteria for prioritizing circuits to escalate performance improvement, the top five (5) Worst Performing Circuits (WPC) are monitored using circuit performances over the past five years based on average SAIFI and SAIDI excluding MEDs.

Top 5 SAIFI WPC (Excluding MED)

RANK	Circuit	Substation	SAIFI
1	La Verne	Sharp	0.0112
2	Jewel	Anaheim	0.0102
3	Palm	Anaheim	0.0091
4	Disney	Katella	0.0089
5	Moody	Hannum	0.0080

Note: Only circuits whose outages that also occurred in the last two years of the five year period are shown.

Top 5 SAIDI WPC (Excluding MED)

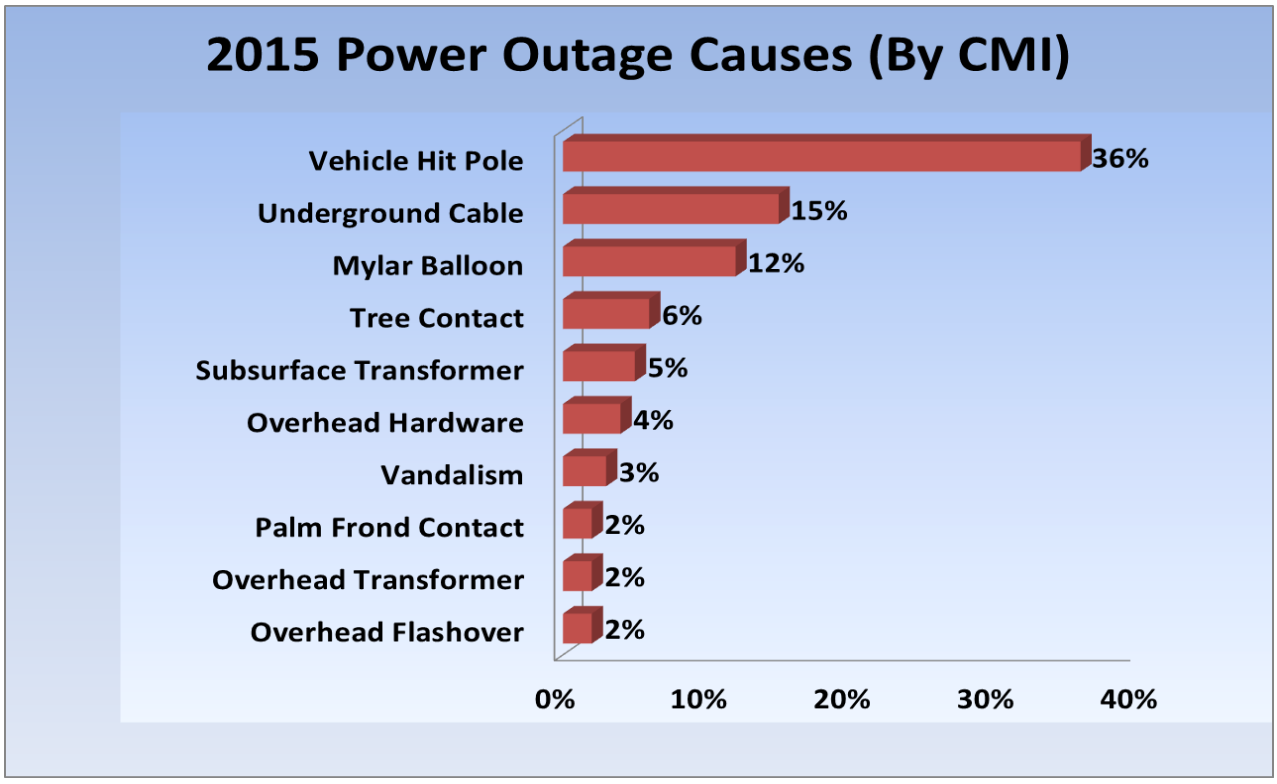
RANK	Circuit	Substation	SAIDI
1	Addie	Lewis	0.766
2	Gilbert	Clair	0.709
3	Freda	Lewis	0.679
4	Debbie	Sharp	0.554
5	Walnut	Yorba	0.550

Note: Only circuits whose outages that also occurred in the last two years of the five year period are shown.

When a circuit for two consecutive years appears on both the Top 5 SAIFI and SAIDI WPC, the circuit will be prioritized for an improvement plan and the anticipated timeline for completing the mitigation measures. The most common causes for outages for the above WPC were underground cable failures and/or metallic balloon contacts.

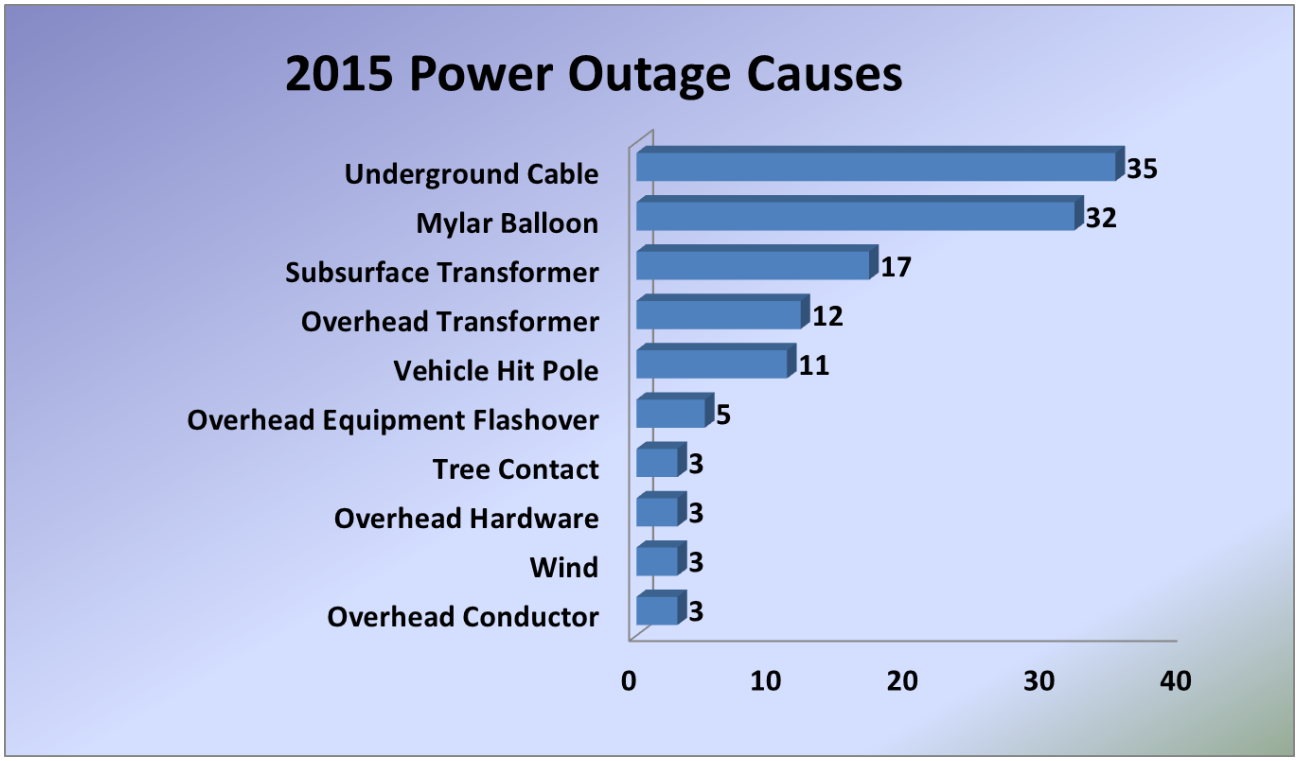
1.5 Outage Causes

Outage causes are evaluated periodically to determine how to structure operational and capital programs. The causes are tracked by frequency and by customer minute interruption (CMI). The most common cause of 2015 outages by CMI was from vehicles hitting electric poles. The second most common cause by CMI is attributed to direct buried cable installed by developers as the industry practice in 1970s and 80s. Without protective conduit, the cable is more prone to environmental factors causing damage to the cable and resulting in power outages. APU has been steadily addressing cable replacements through a $5 Million per year capital program which is approximately 70% complete. Locations are identified by utilizing outage data and recommendations by field staff as to the conditions of the cable to prioritize replacement projects.



The frequency of events is also monitored closely, and underground cable failures followed by metallic balloons caused the most number of outages in 2015. Educational campaigns and outreach efforts have been ongoing for balloon safety, including developing a public service announcement warning customers to properly dispose of metallic balloons. The third common cause of 2015 outages by frequency was from subsurface transformers, which are aging transformers installed in underground vaults serving both residential and commercial customers. APU will continue with the replacement strategy of these overhead transformers and continue to monitor and prioritize the subsurface transformers through the program which are aging transformers installed in underground vaults serving both residential and commercial customers. In previous years, a significant number of outages were occurring due to an older

technology of Current-Protecting (CP) overhead transformers that are equipped with internal protective devices used in residential areas had the highest frequency and duration of outages than any other type of transformer in the system. Through the capital replacement program, these smaller transformers were prioritized for replacement due to factors including age, reduced capacity and visible condition, and are being replaced with a newer style of transformer with separate external protection. Approximately 15% of these type CP transformers are replaced annually as part of the capital improvement program.



2.0 Distribution Equipment Inspection Program

2.1 Overview

APU conducts routine inspections of distribution equipment to assess their condition for prioritization of any needed maintenance or replacement. The prioritization method follows industry practice, which aligns with CPUC guidelines as delineated in GO 165.

There are three condition levels. They are prioritized based on probable impact on safety or reliability, taking into account several factors. These factors include facility or equipment type and condition, loading, location, accessibility, and direct or potential impact on safety or reliability. The three conditions and their priority levels are:

Condition level "1": Maintenance required. Repair or replace within 90 days. If there is an imminent safety or reliability problem, inspector should contact Electric Operations for confirmation with field personnel and to identify and schedule mitigation procedures.

Condition level "2": Maintenance needed but deferrable, no immediate safety or reliability concern.

Condition level "3": Minor aging, fully serviceable, no safety or reliability concern. Okay for next scheduled inspection.

Accordingly, those maintenance items that pose the greatest public safety or system reliability risks will either: (a) be repaired immediately, or (b) if the repair proves too complex to complete immediately or requires materials that are unavailable, a temporary repair will be made to address the risks, and the item will be reprioritized for repairs to be completed at a later date.

Each year, equipment is prioritized for replacement, pursuant to an ongoing systematic infrastructure replacement program targeted for reliability improvement. In 2015, the following infrastructure was upgraded:

Equipment	Quantity Upgraded	Unit	2015 Total Expenditure
Distribution transformers	40	Each	$144,000
Utility poles	26	Each	$280,000
Overhead wires	12,600	Circuit Feet	$430,000
Direct buried cable	34,000	Circuit Feet	$4,010,000
Overhead and underground switches	17	Each	$1,050,000
Branch line fuses Installed	8	Each	$5,000
Underground vaults	4	Each	$1,180,000
			Total $7,099,000

2.2 Equipment Inspection

Underground distribution equipment is on a 3-year inspection cycle. Surface-mounted and overhead equipment is inspected on a 5-year inspection cycle, consistent with GO 165 guidelines. System patrols occur on a routine basis to ensure that immediate issues are addressed as quickly as possible. Detailed inspections are performed for more of a diagnostic and proactive evaluation of equipment conditions.

Section A. Patrols

A patrol is a visual inspection of applicable utility equipment and structures that is designed to identify obvious structural problems and hazards.

A.1 Distribution System Patrols

Annual patrols of applicable utility equipment and structures in urban areas are conducted by troubleshooters. Typical issues found during patrols include problems with wood poles or cross arms, equipment in need of repair or replacement, and equipment or lines in need of clearance from vegetation.

A.2 Streetlight Patrols

The electric utility has approximately 20,000 street lights in the entire system. Annual patrols are conducted on all major thoroughfares. Repairs are conducted when detected on patrols or reported by residents and businesses. Street lights in need of repair can be reported through the Anaheim Anytime web portal, 311 phone service, an

online street light repair request form, and the MyAnaheim smart phone app. In 2015, Department staff repaired 1,996 streetlights within 2.7 days of being notified, on average.

Section B. Intrusive and Detailed Inspections

APU initiated system inspections of the distribution system beginning in August 2015. In keeping with the GO 165 recommended inspection cycle, the underground electric system inspection will begin first. A visual inspection of over 8,700 underground substructures and above surface equipment is expected to be complete by early 2017. Subsequent inspections will include the overhead system, which includes over 17,000 poles and associated overhead conductors and equipment is expected to be complete by mid-2018.

3.0 Substation Equipment Inspection and Replacement Program

3.1 Overview

APU substations are designed, constructed, operated and maintained in accordance with accepted good industry standards, practices and equipment specifications for their intended use, in addition to promoting the safety of substation personnel and the public and to enable reliable electrical service. APU's substation inspection practices follow utility industry best practice using guidelines that meet or exceed the State adopted GO 174 requirements for inspections.

Qualified substation personnel inspect each of the Department's 13 substations monthly for anomalies that may include rusting, leakage, or visible signs that maintenance or replacement is warranted. Findings are prioritized based on probable impact on safety or reliability, taking into account several factors. These factors include facility or equipment type and condition, loading, location, accessibility, and direct or potential impact on safety or reliability. The three conditions and their priority levels are:

Priority level "1": Maintenance required there is an imminent safety or reliability problem that substation field personnel will identify and schedule mitigation procedures.

Priority level "2": Maintenance needed but deferrable, no immediate safety or reliability concern.

Priority level "3": Minor aging, fully serviceable, no safety or reliability concern. Monitor during next scheduled inspection.

In 2015, the total capital expenditure for substation upgrades and repairs was $3.4 million. The following substation infrastructures were upgraded and/or repaired:

Major Substation Equipment	Upgraded	Repaired	2015 Total Expenditure
56MVA Power Transformers	1	0	$2,800,000
12kV Power Circuit Breakers	6	1	$236,000
69kV Power Circuit Breakers	0	2	$6,000
12kV Capacitor Banks	0	2	$21,000
69kV Capacitor Banks	0	0	0
Battery Systems	2	0	$258,000
Switched Disconnects	1	1	$96,500
			Total $3,417,500

3.2 Substation Inspection

During the 2015 calendar year 156 Substation inspections were completed. As an enhancement to the substation inspection program, 26 infra-red inspections were conducted (each substation twice a year) on all energized components. Infra-red testing will identify where energized equipment has elevated temperatures called a "hot spot" which may lead to premature aging or reduced available capacity of equipment with increased risk to reliability. As an example, an infra-red inspection conducted at Dowling Substation in December 2015 indicated there was a hot spot on a 69kV line disconnect switch. Substation crews scheduled the repair under a planned outage minimizing impact on customers.

As a result of several catastrophic substation equipment failures with the State over the past few years, emphasis has been placed on adopting a set of guidelines for utility inspection best practices which will be incorporated into the GO 174 standards. Currently, APU substation inspection best practices meet or exceed the developing guidelines.