Kimberly A. Klock
Assistant General Counsel

PPL
Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.5696 Fax 610.774.4102
KKlock@pplweb.com

E-FILE

April 30, 2021

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street
Harrisburg, PA 17120

**Re: PPL Electric Utilities Corporation
Quarterly Reliability Report for the
Period Ended March 31, 2021
Docket No. M-2016-2522508**

Dear Ms. Chiavetta:

Enclosed for filing on behalf of PPL Electric Utilities Corporation ("PPL Electric") is the **NON-CONFIDENTIAL** version of PPL Electric's Quarterly Reliability Report for the Period Ended March 31, 2021 ("Quarterly Reliability Report"). The report is being filed pursuant to 52 Pa. Code § 57.195(d).

Pursuant to 52 Pa. Code § 57.198(l), PPL Electric has included, as an addendum to this Quarterly Reliability Report, redline copies of its Commission-approved 2020-2021 and 2022-2023 Biennial Inspection, Maintenance, Repair and Replacement Plans, which contain proposed revisions to PPL Electric's pole inspection process to include a new drill testing methodology.

Pursuant to 52 Pa. Code § 1.11, the enclosed document is to be deemed filed on April 30, 2021, which is the date it was filed electronically with the Commission's E-Filing System.

PPL Electric has also electronically submitted a proprietary and confidential version of this filing pursuant to the Pennsylvania Public Utility Commission's instructions in the *Emergency Order re Suspension of Regulatory and Statutory Deadlines; Modification to Filing and Service Requirements* at Docket No. M-2020-3019262 (Order entered March 20, 2020).

If you have any questions regarding this document, please call me or

Nikki Jones, PPL Electric's Director of Public Affairs, at (717) 603-4029.

Respectfully submitted,

Kimberly A. Klock

Enclosures

cc via email: Tanya J. McCloskey, Esquire
Steven Gray, Esquire
Mr. Daniel Searfoorce
Mr. John Van Zant

PPL Electric Utilities Corporation

Quarterly Reliability Report

to the

Pennsylvania Public Utility Commission

April 2021

1) ***A description of each major event that occurred during the preceding quarter, including the time and duration of the event, the number of customers affected, the cause of the event and any modified procedures adopted in order to avoid or minimize the impact of similar events in the future.***

No major events occurred during the first quarter of 2021.

2) ***Rolling 12-month reliability index values (SAIFI, CAIDI, SAIDI, and if available, MAIFI) for the EDC's service territory for the preceding quarter. The report shall include the data used in calculating the indices, namely the average number of customers served, the number of sustained customer interruptions, the number of customers affected, and the customer minutes of interruption. If MAIFI values are provided, the report shall also include the number of customer momentary interruptions.***

The following table provides data for the 12 months ending March 31, 2021.

SAIFI	BM 0.98	0.88
	STD 1.18	0.88
CAIDI (Benchmark = 145; Rolling 12-month Std. = 174)	BM 145	147
	STD 174	147
SAIDI (Benchmark = 142; Rolling 12-month Std. = 205)	BM 142	130
	STD 205	130
MAIFI		5.4
Average Number of Customers Served [1]		1,440,246
Number of Sustained Customer Interruptions (Trouble Cases)		21,598
Number of Customers Affected [2]		1,263,710
Customer Minutes of Interruptions (CMI)		186,244,592
Number of Customer Momentary Interruptions		7,825,946

During the first quarter, there were no (0) PUC major events, three (3) PUC reportable events, and three (3) other storms that required the opening of one or more area emergency centers to manage restoration efforts.

[1] PPL Electric calculates the annual indices using customers served at the end of period. This is consistent with the method used to calculate PPL Electric's benchmarks.

[2] The data reflects the number of customers interrupted for each interruption event summed for all events, also known as customer interruptions. If a customer is affected by three separate cases of trouble, that customer represents three customer interruptions, but only one customer interrupted.

PPL Electric's first quarter reliability performance was within the PUC standard and benchmark for all metrics except CAIDI, which was within standard but one percent above benchmark.

For the rolling four quarters ending in Q1 2021 PUC CAIDI performance was 12% improved over 2018 levels, and 16% improved over 2019 levels, 16% below the PUC standard, but 1% above PUC benchmark. This is partially attributable to the six storm events that occurred in Q1 2021, of which three were PUC reportable.

Because weather has a significant impact to volatility in reliability metrics, PPL Electric's IEEE Metrics are shown below. The IEEE 1366 standard is a widely used methodology that allows for weather normalized performance evaluation that better reflects system performance during non-major storm events. PPL Electric is consistently a first quartile SAIFI performer, a first quartile SAIDI performer, and most recently a first quartile CAIDI performer. The table below lists PPL Electric's IEEE performance metrics compared to the performance quartiles for large utilities nationally, as issued by the IEEE annual reliability survey. This survey comprises some 100 utilities serving 85 million customers across the country. Our more weather normalized IEEE CAIDI was 102 for Q1 2021, among the best ever achieved.

	IEEE CAIDI	IEEE SAIFI	IEEE SAIDI
2018	112	0.74	82.5
2019	113	0.66	74.3
2020	99	0.69	68.6
Rolling 12 Months Ending 3/31/21	102	0.68	69
IEEE First Quartile Ceiling	103	0.85	85
IEEE Second Quartile Ceiling	110	1.01	107

Rolling 12-month reliability index values (SAIFI, CAIDI, SAIDI, CMI, and if available, MAIFI) and other pertinent information such as customers served, number of interruptions, customer minutes interrupted, number of lockouts, and so forth, for the worst performing 5% of the circuits in the system. An explanation of how the EDC defines its worst performing circuits shall be included.

The following table provides reliability index values for the worst performing 5% of the circuits in the system for the 12 months ended at the current quarter. An explanation of how PPL Electric defines its worst performing circuits is included in Appendix A.

WPC Rank	Feeder ID	SAIDI	CAIDI	SAIFI	MAIFI	Customers	Cases of Trouble	Customer Minutes Interrupted (CMI)
1	55001	1066	162	6.58	13.8	1,305	90	1,391,202
2	52401	543	291	1.87	12.7	1,297	67	705,053
3	22602	390	78	5.02	5.5	590	42	230,539
4	20402	687	246	2.79	8.6	1,908	55	1,311,882
5	56501	466	103	4.51	12.2	2,424	45	1,129,730
6	20601	418	199	2.10	24.7	1,475	41	617,594
7	46001	283	142	1.99	4.6	2,368	66	671,113
8	50503	46	25	1.81	9.9	2,109	12	98,121
9	61304	243	259	0.94	2.9	1,704	20	415,547
10	47502	625	234	2.67	3.9	818	24	511,873
11	40602	338	200	1.69	4.5	2,417	87	817,979
12	27301	137	150	0.92	2.3	2,815	16	388,346
13	45302	364	221	1.65	8.9	1,222	52	445,959
14	45902	280	89	3.16	16.6	1,349	54	378,864
15	52402	297	158	1.89	9.2	1,673	87	497,678
16	59401	210	126	1.67	7.3	1,780	70	374,777
17	20403	331	130	2.55	9.2	1,942	99	644,222
18	13606	268	155	1.73	6.4	1,640	32	439,859
19	14501	378	188	2.01	11.7	1,134	22	428,879
20	10107	291	307	0.95	3.6	1,849	11	538,821
21	11303	105	59	1.78	10.0	1,639	35	173,629
22	25801	217	147	1.47	7.0	1,830	57	398,251
23	46702	295	75	3.91	13.5	1,262	62	373,439
24	14403	228	258	0.88	6.2	2,581	77	590,741

WPC Rank	Feeder ID	SAIDI	CAIDI	SAIFI	MAIFI	Customers	Cases of Trouble	Customer Minutes Interrupted (CMI)
25	58401	328	262	1.25	5.6	1,518	46	498,338
26	13601	217	80	2.73	7.2	1,136	36	246,900
27	60801	257	67	3.86	13.8	796	25	205,027
28	56504	171	97	1.77	21.8	1,992	116	341,560
29	41602	457	65	6.98	11.5	838	68	383,421
30	22003	175	60	2.90	7.5	1,403	54	246,811
31	13704	425	291	1.46	19.1	1,576	34	671,013
32	40201	301	103	2.91	11.0	1,665	121	501,353
33	47704	668	264	2.53	3.8	1,390	69	929,084
34	52403	445	180	2.47	7.8	1,269	78	565,031
35	45402	1281	592	2.16	18.5	1,640	93	2,102,279
36	54701	205	58	3.54	32.9	1,114	45	229,122
37	24003	197	77	2.57	4.8	1,141	6	225,888
38	12705	493	145	3.40	3.1	597	6	294,530
39	15704	344	247	1.39	7.8	1,292	52	444,872
40	26602	492	83	5.93	7.5	664	18	327,024
41	40502	163	86	1.90	7.6	1,946	71	317,562
42	56803	288	92	3.13	8.4	1,265	65	364,823
43	27101	161	74	2.16	6.7	1,833	42	295,255
44	43401	463	121	3.82	34.5	988	45	457,670
45	45702	80	46	1.73	19.4	1,650	73	132,516
46	41901	432	129	3.35	14.5	712	34	307,756
47	12301	196	60	3.29	7.9	1,469	43	288,961
48	11402	116	89	1.31	7.3	2,488	24	290,354
49	26001	333	68	4.86	8.2	1,448	71	483,390
50	11506	292	112	2.60	9.8	1,310	54	382,819
51	46302	303	138	2.19	3.1	1,097	72	333,111
52	12802	442	137	3.22	1.0	737	12	325,831
53	26401	184	103	1.78	23.2	2,209	83	406,922
54	24901	583	262	2.22	17.0	2,292	56	1,338,286
55	44903	155	87	1.78	11.2	1,749	7	271,312
56	15601	376	151	2.49	40.3	1,121	48	422,533
57	57403	174	118	1.47	31.2	1,473	34	256,651
58	56802	473	99	4.79	13.3	1,539	74	729,000
59	23902	149	73	2.05	7.3	1,476	39	220,178
60	25602	173	44	3.93	3.2	1,310	20	227,359
61	46701	735	281	2.61	2.5	682	34	501,488
62	17001	211	104	2.04	3.3	1,536	61	324,574
63	52002	178	170	1.05	3.1	1,937	9	345,035

3) ***Specific remedial efforts taken and planned for the worst performing 5% of the circuits identified in paragraph (3).***

01 Circuit 55001 -- NEWPORT 50-01

Performance Analysis

The NEWPORT 50-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On June 4, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 394 customers for up to 1,706 minutes resulting in 666,941 CMI.

In total, the NEWPORT 50-01 circuit had 68 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (44); equipment failure (11); animal contacts (7); vehicles (3); Improper Design (1); nothing found (1); other (1).

Remedial Actions

- In 2019, a new Smart Grid device was installed.
- In 2019, a battery demonstration energy storage system was installed to study reliability benefits and voltage control. Since that time, it has operated once, saving 2,724 customer minutes.
- In 2019, three single-phase reclosers were installed, along with related fusing.
- In 2019, a substation conversion was performed.
- In 2019, additional single-phase sectionalizing was installed.
- In 2020, three single-phase reclosers were installed.
- In 2020, three fuses were installed.
- In 2020, full circuit trimming was performed.
- In 2020, a section of single-phase was resourced.
- In 2020, a Proactive Circuit Analysis was performed with several minor remediations implemented.
- In 2021, an additional single-phase recloser was installed.
- In 2021, six additional fuses will be installed.
- In 2022, a section of three-phase conductor in a heavily wooded area will be relocated.
- In 2022, a section of single-phase will be reconductored.

02 Circuit 52401 -- GREEN PARK 24-01

Performance Analysis

The GREEN PARK 24-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 5, 2020, an equipment failure occurred on a substation component causing a circuit breaker to trip to lockout. This outage affected 5,050 customers for up to 156 minutes resulting in 662,293 CMI.

In total, the GREEN PARK 24-01 circuit had 57 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (33); equipment failure (16); animal contacts (3); nothing found (2); vehicles (2); contact or dig in (1).

Remedial Actions

- In 2019, two fuses were installed.
- In 2019, two single-phase reclosers were installed.
- In 2020, multiple hazard trees were removed.
- In 2020, three single-phase reclosers were installed.
- In 2020, a transmission upgrade was completed.
- In 2021, five additional fuses will be installed.
- In 2021, protective device coordination will be reviewed.
- In 2021, a single-phase relocation will be evaluated.
- In 2022, full circuit trimming will be performed.
- In 2022, three sections of single-phase will be relocated.
- In 2022, a section of single-phase will be reconductored.
- In 2022, additional sectionalizing devices will be installed.
- In 2022, an additional Smart Grid device will be installed.

03 Circuit 22602 -- KIMBLES 26-02

Performance Analysis

The KIMBLES 26-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On November 17, 2020, an equipment failure occurred on an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 4,168 customers for up to 239 minutes resulting in 560,955 CMI.

In total, the KIMBLES 26-02 circuit had 33 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (14); animal contacts (10); equipment failure (6); nothing found (2); other (1).

Remedial Actions

- In 2021, four dissimilar metal connections were remediated.
- In 2021, additional fusing was installed.
- In 2021, additional animal guarding was installed with more to be done.
- In 2021, a new tie line will be constructed.
- In 2021, full circuit trimming will be performed.
- In 2021, numerous porcelain cutouts will be replaced.
- In 2021, an additional Smart Grid device will be evaluated.
- In 2021 and 2022, five additional single-phase reclosers will be installed.

04 Circuit 20402 -- ASHFIELD 04-02

Performance Analysis

The ASHFIELD 04-02 circuit experienced three outages of over 100,000 CMI between April 2020 and March 2021.

On April 26, 2020, during a period of strong wind, a tree contacted a pole or pole arm causing a sectionalizing device to be interrupted. This outage affected 660 customers for up to 199 minutes resulting in 108,193 CMI.

On November 1, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 275 customers for up to 1,056 minutes resulting in 290,356 CMI.

On June 19, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 1,213 customers for up to 667 minutes resulting in 649,398 CMI.

In total, the ASHFIELD 04-02 circuit had 45 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (22); animal contacts (12); equipment failure (8); contact or dig in (1); nothing found (1); vehicles (1).

Remedial Actions

- In 2019, a single-phase recloser was installed.
- In 2020, a new Smart Grid device was installed.
- In 2021, 200 hazard trees were removed.
- In 2021, two additional single-phase reclosers were installed.
- In 2021, additional fusing was installed at five locations.
- In 2021, three sections of single-phase will be relocated and another will be evaluated.
- In 2021, a four-mile section of single-phase will be upgraded to three-phase and relocated to a more accessible location.
- In 2021, an additional Smart Grid device will be installed.
- In 2021, a section of underground will be evaluated for extension.
- In 2021, a three-phase tie will be evaluated.

- In 2021, additional line relocations and single-phase reclosers will be evaluated for this circuit.

05 Circuit 56501 -- ROCKVILLE 65-01

Performance Analysis

The ROCKVILLE 65-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On October 17, 2020, an equipment failure occurred on an overhead conductor causing an interruption. This outage affected 5,002 customers for up to 316 minutes resulting in 1,254,262 CMI.

In total, the ROCKVILLE 65-01 circuit had 26 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (14); animal contacts (6); equipment failure (5); vehicles (1).

Remedial Actions

- In 2019, full circuit tree trimming was performed.
- In 2019, voltage support devices were installed.
- In 2019, an existing recloser was upgraded to a Smart Grid device.
- In 2020, 18 locations received animal guarding.
- In 2020, nine new fuses were installed.
- In 2020, ten new single-phase reclosers were installed and will have protection settings optimized in 2021.
- In 2020, three new Smart Grid devices were evaluated and will be installed in 2023.
- In 2021, an additional Smart Grid device was installed.
- In 2021, an additional tie line was installed.
- In 2021, a new substation and three-phase reconductoring will be evaluated.
- In 2021, a section of line was re-sourced.
- In 2021, sections of single-phase and three-phase will be reconductored.

06 Circuit 20601 -- GREENWOOD 06-01

Performance Analysis

The GREENWOOD 06-01 circuit experienced two outages of over 100,000 CMI between April 2020 and March 2021.

On November 1, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 924 customers for up to 575 minutes resulting in 308,063 CMI.

On February 16, 2021, during a period of heavy rain, an equipment failure occurred on a pole or pole arm causing a recloser to trip to lockout. This outage affected 307 customers for up to 478 minutes resulting in 146,742 CMI.

In total, the GREENWOOD 06-01 circuit had 49 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (22); equipment failure (14); animal contacts (8); nothing found (4); vehicles (1).

Remedial Actions

- In 2020, seven additional fuses were installed.
- In 2020, an adjacent circuit was reconductored to improve transfer capability.
- In 2020, two additional single-phase reclosers were installed.
- In 2020, an existing recloser was replaced with a Smart Grid device.
- In 2020, a section of two-phase conductor was upgraded to three-phase.
- In 2021, an additional single-phase recloser was installed.
- In 2021, additional fusing was installed at six locations.
- In 2021, additional single-phase ties will be evaluated.
- In 2021, full circuit trimming will be performed.

07 Circuit 46001 -- BERWICK 60-01

Performance Analysis

The BERWICK 60-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On October 26, 2020, an equipment failure occurred on an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 2,362 customers for up to 1,854 minutes resulting in 2,020,159 CMI.

In total, the BERWICK 60-01 circuit had 39 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (22); equipment failure (10); animal contacts (3); nothing found (2); other (1); vehicles (1).

Remedial Actions

- In 2021, a section of difficult-to-access to conductor will be relocated and customers transferred to another circuit.
- In 2021, the section of conductor that experienced the large failure in 2020 will be reconductored.
- In 2021, an alternate feed will be evaluated for the customers who experienced the large outage in 2020.
- In 2022, full circuit trimming be performed.
- In 2022, an additional single-phase recloser will be installed.

08 Circuit 50503 -- MECHANICSBURG 05-03

Performance Analysis

The MECHANICSBURG 05-03 circuit experienced three outages of over 100,000 CMI between April 2020 and March 2021.

On August 23, 2020, a vehicle contacted a pole causing an interruption. This outage affected 1,888 customers for up to 517 minutes resulting in 320,003 CMI.

On June 11, 2020, an equipment failure occurred on an overhead conductor causing an interruption. This outage affected 1,353 customers for up to 235 minutes resulting in 122,459 CMI.

On August 24, 2020, an equipment failure occurred on an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 2,089 customers for up to 206 minutes resulting in 214,695 CMI.

In total, the MECHANICSBURG 05-03 circuit had 14 outages between April 2020 and March 2021, with the causes breaking down as follows: animal contacts (5); equipment failure (3); tree related (3); contact or dig in (1); other (1); vehicles (1).

Remedial Actions

- In 2020, a new three-phase sectionalizing device was installed.
- In 2020, additional animal guarding was installed.
- In 2021, full circuit trimming was performed.
- In 2021, additional animal guarding was installed with more to be performed.
- In 2021, reconductoring will be evaluated.

09 Circuit 61304 -- EARL 13-04

Performance Analysis

The EARL 13-04 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 17, 2020, during a period of extreme temperatures, an equipment failure occurred on a substation component causing a circuit breaker to trip to lockout. This outage affected 1,662 customers for up to 286 minutes resulting in 337,601 CMI.

In total, the EARL 13-04 circuit had 15 outages between April 2020 and March 2021, with the causes breaking down as follows: animal contacts (6); equipment failure (5); tree related (2); nothing found (1); vehicles (1).

Remedial Actions

- In 2020, a section of difficult-to-access single-phase was relocated.
- In 2020, an additional single-phase fuse was installed.
- In 2021, an existing recloser will be replaced with a Smart Grid device.
- In 2021, an additional single-phase recloser will be installed.
- In 2021, a new line and terminal will be constructed on an adjacent circuit, increasing tie capabilities.
- In 2021, an additional tie line will be evaluated.
- In 2022, a complete substation rebuild will occur.
- In 2022, an additional three-phase recloser will be upgraded to a telemetered device.
- In 2022, five single-phase reclosers will be installed.
- In 2023, two additional single-phase reclosers will be installed.

10 Circuit 47502 -- NEW COLUMBIA 75-02

Performance Analysis

The NEW COLUMBIA 75-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On June 19, 2020, an equipment failure occurred on an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 804 customers for up to 360 minutes resulting in 143,800 CMI.

In total, the NEW COLUMBIA 75-02 circuit had 25 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (11); tree related (9); animal contacts (2); nothing found (2); vehicles (1).

Remedial Actions

- In 2020, multiple porcelain cutouts were replaced.
- In 2021, two substation transformers will be replaced.
- In 2022, a three-phase recloser will be installed.
- In 2022, two single-phase reclosers will be installed and a section of the circuit will be reconfigured.
- In 2022, additional fusing will be installed.
- In 2022, two reclosers will be relocated to protect more customers.

11 Circuit 40602 -- PINE GROVE 06-02

Performance Analysis

The PINE GROVE 06-02 circuit experienced two outages of over 100,000 CMI between April 2020 and March 2021.

On May 29, 2020, during a period of strong wind, a tree contacted an overhead conductor causing an interruption. This outage affected 436 customers for up to 258 minutes resulting in 111,547 CMI.

On March 9, 2021, an equipment failure occurred on an overhead conductor causing a motor operated switch to be interrupted. This outage affected 735 customers for up to 303 minutes resulting in 222,094 CMI.

In total, the PINE GROVE 06-02 circuit had 71 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (40); equipment failure (15); animal contacts (7); nothing found (5); other (2); vehicles (2).

Remedial Actions

- In 2019, an additional Smart Grid device was installed.
- In 2019, an additional single-phase recloser was installed.
- In 2019, two poles were replaced.
- In 2019, ten additional locations received fusing.
- In 2019, a drone patrol was performed. As a result, several cross-arms, several splices, and a pole were replaced.
- In 2020, an additional single-phase recloser was installed.
- In 2020, a section of single-phase line was reconductored to three-phase, and the protection scheme upgraded.
- In 2021, full circuit trimming will be performed.
- In 2021, an additional Smart Grid device will be installed.
- In 2021, five additional fuses will be installed.
- In 2022, a section of difficult-to-access single-phase will be relocated.
- In 2022, an additional single-phase recloser will be installed.

12 Circuit 27301 -- PARRISH 73-01

Performance Analysis

The PARRISH 73-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On August 24, 2020, during a period of strong wind, an unidentified issue occurred with an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 3,200 customers for up to 1,495 minutes resulting in 891,708 CMI.

In total, the PARRISH 73-01 circuit had 17 outages between April 2020 and March 2021, with the causes breaking down as follows: animal contacts (9); equipment failure (6); other (1); tree related (1).

Remedial Actions

- In 2019, a three-phase tie was constructed to the PARRISH 73-03.
- In 2020, a drone patrol was conducted with several minor remediations identified for 2021.
- In 2021, an additional Smart Grid device will be evaluated for this circuit.

13 Circuit 45302 -- WEST BERWICK 53-02

Performance Analysis

The WEST BERWICK 53-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On October 10, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 466 customers for up to 463 minutes resulting in 161,729 CMI.

In total, the WEST BERWICK 53-02 circuit had 44 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (25); animal contacts (8); equipment failure (7); nothing found (3); vehicles (1).

Remedial Actions

- In 2021, a section of difficult-to-access conductor will be relocated.
- In 2022, a section of conductor will be relocated and refed.
- In 2022, full circuit trimming will be performed.
- In 2023, a section of difficult-to-access conductor will be relocated.

14 Circuit 45902 -- AUBURN 59-02

Performance Analysis

The AUBURN 59-02 circuit experienced two outages of over 100,000 CMI between April 2020 and March 2021.

On August 2, 2020, during a period of heavy rain, a tree contacted an overhead conductor causing an interruption. This outage affected 455 customers for up to 353 minutes resulting in 103,070 CMI.

On July 3, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 188 customers for up to 665 minutes resulting in 125,097 CMI.

In total, the AUBURN 59-02 circuit had 65 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (45); equipment failure (8); animal contacts (6); nothing found (4); vehicles (2).

Remedial Actions

- In 2019, a section of three-phase was reconductored.
- In 2019, several hazard trees were removed.
- In 2020, additional fusing was installed at several locations.
- In 2020, a dissimilar metal connection was remediated.
- In 2020, multiple cross arms were replaced.
- In 2020, multiple porcelain cutouts were replaced.
- In 2021, hazard tree removal was performed.
- In 2021, additional fusing will be installed.
- In 2022, nine single-phase reclosers will be installed.
- In 2023, the AUBURN substation will be configured to be remotely transferrable.
- In 2023, a section of this circuit will be transferred to a new line.

15 Circuit 52402 -- GREEN PARK 24-02

Performance Analysis

The GREEN PARK 24-02 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the GREEN PARK 24-02 circuit had 61 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (31); equipment failure (13); animal contacts (12); nothing found (2); vehicles (2); contact or dig in (1).

Remedial Actions

- In 2019, a single-phase sectionalizing device was installed.
- In 2019, additional animal guarding was installed.
- In 2019, a section of difficult-to-access single-phase was relocated.
- In 2019, 80 additional fuses were installed.
- In 2020, five sections of conductor were relocated.
- In 2020, a second transmission source to the distribution substation was constructed.
- In 2020, six single-phase sectionalizing devices were installed.
- In 2020, a Proactive Circuit Analysis was performed, several future remediations were identified as a result.
- In 2020, additional animal guarding was installed.
- In 2020, additional fusing was installed.
- In 2021, an additional section of single-phase will be relocated overhead.
- In 2021, full circuit trimming will be performed.
- In 2021, one section of single-phase will be relocated to underground.
- In 2021, additional animal guarding will be installed.
- In 2021, one section of single-phase will be reconductored.
- In 2021, expanded trimming right-of-way will be sought for this circuit.

- In 2022, an additional section of single-phase will be reconductored.
- In 2022, two sections of single phase will be relocated.
- In 2022, two sections of single-phase will be re-sourced to reduce exposure.

16 Circuit 59401 -- RICHFIELD 94-01

Performance Analysis

The RICHFIELD 94-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the RICHFIELD 94-01 circuit had 62 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (26); equipment failure (21); animal contacts (10); nothing found (3); other (1); vehicles (1).

Remedial Actions

- In 2019, a single-phase sectionalizing device was installed.
- In 2020, one animal guard was installed, with several others to be installed in 2021.
- In 2021, a section of three-phase conductor will be evaluated for cross-arm replacement.
- In 2021, full circuit trimming will be performed.
- In 2021, three additional fuses will be installed.
- In 2021, additional fusing will be evaluated.
- In 2021, an additional Smart Grid device will be installed.
- In 2022, two additional single-phase reclosers will be installed.

17 Circuit 20403 -- ASHFIELD 04-03

Performance Analysis

The ASHFIELD 04-03 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the ASHFIELD 04-03 circuit had 88 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (49); equipment failure (14); animal contacts (12); vehicles (8); nothing found (3); other (2).

Remedial Actions

- In 2019, full circuit trimming was performed.
- In 2020, additional hot spot trimming was performed.
- In 2020, two and one-half miles of three-phase conductor was rebuilt.
- In 2020, a section of difficult-to-access single-phase was relocated.
- In 2021, single-phase ties will be evaluated for this circuit.
- In 2021, three additional single-phase reclosers will be installed on this circuit.
- In 2021, an existing recloser will be upgraded to a Smart Grid device.
- In 2022, four additional single-phase reclosers will be installed.
- In 2023, a section of single-phase will be extended.

18 Circuit 13606 -- RICHLAND 36-06

Performance Analysis

The RICHLAND 36-06 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On August 5, 2020, an equipment failure occurred on an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 2,539 customers for up to 103 minutes resulting in 207,672 CMI.

In total, the RICHLAND 36-06 circuit had 16 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (10); equipment failure (4); animal contacts (1); vehicles (1).

Remedial Actions

- In 2020, a section of this circuit was reconductored.
- In 2021, a section of aerial cable was replaced.
- In 2021, additional fusing will be installed.
- In 2021, additional animal guarding will be installed.
- In 2021, two single-phase reclosers will be replaced.
- In 2021, hot spot trimming will be performed.
- In 2022, as additional single-phase recloser will be installed.

19 Circuit 10107 -- ALLENTOWN 01-07

Performance Analysis

The ALLENTOWN 01-07 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On August 24, 2020, during a period of heavy rain, an unidentified issue occurred with an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 675 customers for up to 3 minutes resulting in 128,234 CMI.

In total, the ALLENTOWN 01-07 circuit had 19 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (11); tree related (3); nothing found (2); other (2); animal contacts (1).

Remedial Actions

- In 2020, full circuit trimming was performed.
- In 2021, seven poles will be replaced on this circuit.
- In 2021, several cutouts, cross arms, poles, and insulators will be replaced.
- In 2021, additional fusing will be installed.
- In 2021, several spans of open conductor will be replaced with covered conductor.

20 Circuit 14501 -- SCHOENECK 45-01

Performance Analysis

The SCHOENECK 45-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the SCHOENECK 45-01 circuit had 20 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (9); equipment failure (4); animal contacts (3); nothing found (2); contact or dig in (1); vehicles (1).

Remedial Actions

- In 2020, additional fusing was installed at two locations.
- In 2020, the protection scheme for this circuit was optimized.
- In 2020, hot spot trimming was performed.
- In 2021, two additional single-phase reclosers were installed with three more to be completed on this circuit.
- In 2021, full circuit trimming will be performed.
- In 2021, additional animal guarding will be installed.

21 Circuit 11303 -- EMMAUS 13-03

Performance Analysis

The EMMAUS 13-03 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On November 1, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 594 customers for up to 227 minutes resulting in 134,600 CMI.

In total, the EMMAUS 13-03 circuit had 37 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (12); tree related (10); animal contacts (9); vehicles (3); other (2); contact or dig in (1).

Remedial Actions

- In 2020, six additional locations received fusing.
- In 2021, a single-phase recloser was installed.
- In 2021, a section of difficult-to-access conductor will be relocated.
- In 2021, full circuit trimming will be performed.
- In 2022, nine additional single-phase reclosers will be installed.

22 Circuit 25801 -- SULLIVAN TRAIL 58-01

Performance Analysis

The SULLIVAN TRAIL 58-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the SULLIVAN TRAIL 58-01 circuit had 57 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (22); equipment failure (15); animal contacts (11); nothing found (5); other (3); vehicles (1).

Remedial Actions

- In 2020, an off-cycle drone inspection was performed with several minor remediations performed as a result.
- In 2021, two additional single-phase reclosers were installed on this circuit with another scheduled.
- In 2021, a section of three-phase will be reconductored.
- In 2021, a section of three-phase conductor will be extended.
- In 2021, full circuit trimming will be performed.

23 Circuit 14403 -- SO SLATINGTON 44-03

Performance Analysis

The SO SLATINGTON 44-03 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the SO SLATINGTON 44-03 circuit had 88 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (44); equipment failure (28); nothing found (8); vehicles (5); animal contacts (2); other (1).

Remedial Actions

- In 2020, additional fusing was installed.
- In 2020, an additional single-phase recloser was installed.
- In 2021, additional fusing was installed at seven locations with more to be performed.
- In 2021, two additional single-phase reclosers were installed with three more planned.
- In 2021, a section of single-phase conductor will be relocated.
- In 2022, full circuit trimming will be performed.

- In 2022, six additional single-phase reclosers will be installed.
- In 2022, a section of single-phase conductor will be relocated.

24 Circuit 58401 -- MOUNT ROCK 84-01

Performance Analysis

The MOUNT ROCK 84-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the MOUNT ROCK 84-01 circuit had 40 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (14); animal contacts (10); equipment failure (10); vehicles (4); nothing found (2).

Remedial Actions

- In 2021, the circuit breaker was upgraded.
- In 2021, additional fusing will be installed.
- In 2022, several sections of underground conductor will be replaced.
- In 2022, a section of underground cable will be replaced.
- In 2023, full circuit trimming will be performed.

25 Circuit 46702 -- RENOVO 67-02

Performance Analysis

The RENOVO 67-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 26, 2020, an improper operation occurred on a substation component causing a circuit breaker to trip to lockout. This outage affected 1,259 customers for up to 435 minutes resulting in 539,332 CMI.

In total, the RENOVO 67-02 circuit had 47 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (27); animal contacts (7); equipment failure (6); nothing found (5); Improper Operation (1); vehicles (1).

Remedial Actions

- In 2021, two single-phase reclosers were installed.
- In 2021, additional animal guarding was installed.
- In 2021, a battery energy storage system will be installed.
- In 2022, two substation transformers will be replaced.
- In 2023, full circuit trimming will be performed.

26 Circuit 13601 -- RICHLAND 36-01

Performance Analysis

The RICHLAND 36-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On August 8, 2020, an equipment failure occurred on an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 2,134 customers for up to 0 minutes resulting in 308,352 CMI.

In total, the RICHLAND 36-01 circuit had 20 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (8); equipment failure (7); animal contacts (4); other (1).

Remedial Actions

- In 2020, additional animal guarding was installed.
- In 2020, additional fusing was installed.
- In 2020, two dissimilar metal connections were remediated.
- In 2021, two additional single-phase reclosers were installed.
- In 2021, additional fusing will be installed.
- In 2021, full circuit trimming will be performed.
- In 2021, flood mitigation options will be evaluated for the substation.
- In 2021, a pole with multiple vehicle strikes will be relocated.
- In 2021, an additional Smart Grid device will be evaluated.
- In 2022, an additional single-phase recloser will be installed.

27 Circuit 60801 – BUCK 08-01

Performance Analysis

The BUCK 08-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the BUCK 08-01 circuit had 22 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (13); other (3); animal contacts (2); equipment failure (2); vehicles (2).

Remedial Actions

- In 2021, a three-phase tie was constructed.
- In 2021, two additional fuses were installed with two more to be installed.
- In 2021, a three-phase sectionalizing device will be installed.
- In 2021, full circuit trimming will be performed.
- In 2021, a single-phase tie will be evaluated.
- In 2021, single-phase resourcing will be evaluated.
- In 2022, a single-phase recloser will be installed.

28 Circuit 22003 – BOHEMIA 20-03

Performance Analysis

The BOHEMIA 20-03 circuit experienced two outages of over 100,000 CMI between April 2020 and March 2021.

On October 8, 2020, a tree contacted a pole or pole arm causing a circuit breaker to trip to lockout. This outage affected 567 customers for up to 440 minutes resulting in 249,485 CMI.

On June 3, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 567 customers for up to 516 minutes resulting in 292,572 CMI.

In total, the BOHEMIA 20-03 circuit had 45 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (19); animal contacts (13); equipment failure (8); nothing found (5).

Remedial Actions

- In 2021, a new tie line will be constructed.
- In 2021, a section of difficult-to-access conductor will be relocated.
- In 2021, two additional Smart Grid devices will be installed.
- In 2022, seven additional single-phase reclosers will be installed.
- In 2023, full circuit trimming will be performed.

29 Circuit 56504 – ROCKVILLE 65-04

Performance Analysis

The ROCKVILLE 65-04 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the ROCKVILLE 65-04 circuit had 80 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (48); animal contacts (16); equipment failure (10); other (3); vehicles (2); nothing found (1).

Remedial Actions

- In 2019, multiple single-phase sectionalizing devices were installed.
- In 2020, eight fuses were installed.
- In 2020, 150 hazard trees were removed.
- In 2020, seven single-phase sectionalizing devices were installed.
- In 2021, additional animal guards will be installed.
- In 2021, additional fusing will be installed.
- In 2021, a section of line will be evaluated for resourcing and sectionalizing.

- In 2022, a section of single-phase will be relocated underground.
- In 2022, five additional single-phase reclosers will be installed.

30 Circuit 41602 – CLEVELAND 16-02

Performance Analysis

The CLEVELAND 16-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On April 21, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 249 customers for up to 685 minutes resulting in 169,082 CMI.

In total, the CLEVELAND 16-02 circuit had 56 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (38); equipment failure (8); animal contacts (7); nothing found (2); contact or dig in (1).

Remedial Actions

- In 2019, a single-phase recloser was installed.
- In 2019, a new Smart Grid device was installed.
- In 2020, a Proactive Circuit Analysis was performed.
- In 2020, multiple cross arms and transformer cutouts were replaced as the result of the Proactive Circuit Analysis.
- In 2020, hot spot trimming was performed on this circuit.
- In 2021, multiple porcelain cutouts will be replaced.
- In 2021, an additional sectionalizing device will be installed.
- In 2022, full circuit trimming will be performed.

31 Circuit 13704 – SCHNECKSVILLE 37-04

Performance Analysis

The SCHNECKSVILLE 37-04 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On May 5, 2020, a tree contacted an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 1,570 customers for up to 105 minutes resulting in 102,530 CMI.

In total, the SCHNECKSVILLE 37-04 circuit had 39 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (17); animal contacts (9); equipment failure (7); vehicles (6).

Remedial Actions

- In 2020, the protection scheme for this circuit will be optimized.
- In 2020, additional fusing was installed at nine locations.
- In 2021, four additional single-phase reclosers were installed with three more planned.
- In 2021, additional fusing will be installed.
- In 2022, additional single-phase reclosers will be installed.
- In 2023, full circuit trimming will be performed.

32 Circuit 40201 – BEAR GAP 02-01

Performance Analysis

The BEAR GAP 02-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the BEAR GAP 02-01 circuit had 68 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (42); animal contacts (15); equipment failure (5); nothing found (4); other (1); vehicles (1).

Remedial Actions

- In 2019, additional fusing was installed at eight locations.
- In 2020, a single-phase recloser was replaced.
- In 2020, additional fusing was installed at four locations.
- In 2020, full circuit trimming was performed.
- In 2020, a section of existing conductor was relocated and reconductored.
- In 2021, six single-phase reclosers will be installed.
- In 2021, a single-phase recloser will be replaced.
- In 2022, a section of conductor in a heavily wooded area will be undergrounded.
- In 2022, a section of single-phase will be relocated.

33 Circuit 47704 – BLOOMSBURG 77-04

Performance Analysis

The BLOOMSBURG 77-04 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the BLOOMSBURG 77-04 circuit had 61 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (36); equipment failure (12); animal contacts (8); other (3); nothing found (2).

Remedial Actions

- In 2020, full circuit trimming was performed.
- In 2021, two single-phase reclosers will be installed.
- In 2021, a section of line will be reconductored.
- In 2021, an additional single-phase recloser will be evaluated.
- In 2021, the protection setting on a three-phase device will be evaluated and optimized.
- In 2022, a section of conductor in a heavily wooded area will be undergrounded.

34 Circuit 52403 – GREEN PARK 24-03

Performance Analysis

The GREEN PARK 24-03 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the GREEN PARK 24-03 circuit had 61 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (30); equipment failure (21); animal contacts (6); contact or dig in (2); nothing found (2).

Remedial Actions

- In 2019, four fuses were installed.
- In 2019, two single-phase reclosers were installed.
- In 2020, two sections of single-phase were relocated.
- In 2020, a single-phase recloser was installed.
- In 2020, a transmission upgrade was completed.
- In 2021, a section of single-phase will be relocated underground.
- In 2021, two single-phase reclosers will be installed.
- In 2021, a section of single-phase will be evaluated for relocation.
- In 2021, additional fusing will be installed.
- In 2023, a substation upgrade will be performed.

35 Circuit 45402 – WEST BLOOMSBURG 54-02

Performance Analysis

The WEST BLOOMSBURG 54-02 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the WEST BLOOMSBURG 54-02 circuit had 74 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (53); equipment failure (8); animal contacts (6); nothing found (4); other (2); vehicles (1).

Remedial Actions

- In 2021, fault indicators were installed on a section of this circuit.
- In 2021, three single-phase reclosers will be installed.
- In 2021, undergrounding will be evaluated for a section of this circuit.
- In 2021, hot spot trimming will be evaluated for this circuit.
- In 2022, five single-phase reclosers will be installed.
- In 2022, full circuit trimming will be performed.

36 Circuit 24003 – WILKES-BARRE 40-03

Performance Analysis

The WILKES-BARRE 40-03 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On August 24, 2020, during a period of strong wind, an unidentified issue occurred with an overhead conductor causing a recloser to trip to lockout. This outage affected 702 customers for up to 880 minutes resulting in 412,477 CMI.

In total, the WILKES-BARRE 40-03 circuit had 5 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (2); animal contacts (1); other (1); tree related (1).

Remedial Actions

- In 2020, a Proactive Circuit Review was performed with eight minor remediations identified as a result. These will be performed in 2021.
- In 2021, additional three-phase sectionalizing devices will be evaluated.
- In 2021, underground dips will be evaluated for replacement with overhead.

37 Circuit 54701 – NEW BLOOMFIELD 47-01

Performance Analysis

The NEW BLOOMFIELD 47-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On May 29, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 321 customers for up to 405 minutes resulting in 127,045 CMI.

In total, the NEW BLOOMFIELD 47-01 circuit had 25 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (17); animal contacts (3); equipment failure (2); contact or dig in (1); other (1); vehicles (1).

Remedial Actions

- In 2019, a protection coordination study was conducted, as a result several changes were applied.
- In 2020, four single-phase reclosers were installed.
- In 2020, four single-phase fuses were installed.
- In 2020, full circuit trimming was performed.
- In 2020, a drone patrol and Proactive Circuit Analysis were performed with several minor remediations implemented.
- In 2021, additional fusing will be evaluated.
- In 2022, a new Smart Grid device will be installed.
- In 2022, eight single-phase reclosers will be installed.

38 Circuit 12705 – MACUNGIE 27-05

Performance Analysis

The MACUNGIE 27-05 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the MACUNGIE 27-05 circuit had 8 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (6); animal contacts (1); tree related (1).

Remedial Actions

- In 2020, full circuit trimming was performed.
- In 2021, additional fusing was installed.

39 Circuit 26602 – BROOKSIDE 66-02

Performance Analysis

The BROOKSIDE 66-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On June 3, 2020, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 1,709 customers for up to 688 minutes resulting in 415,595 CMI.

In total, the BROOKSIDE 66-02 circuit had 13 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (6); equipment failure (4); animal contacts (2); other (1).

Remedial Actions

- In 2019, full circuit trimming was performed.
- In 2020, a Smart Grid device was replaced.
- In 2020, several dissimilar metal connections were remediated.
- In 2021, additional fusing will be installed.
- In 2021, a new tie line will be constructed.
- In 2021, numerous porcelain cutouts will be replaced.
- In 2021, additional animal guarding will be installed.
- In 2022, a section of this line will be reconductored.
- In 2022, a section of single-phase will be extended.
- In 2022, additional fusing and single-phase reclosers will be installed.
- In 2022, an existing recloser will be replaced.

40 Circuit 40502 – CRESSONA 05-02

Performance Analysis

The CRESSONA 05-02 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the CRESSONA 05-02 circuit had 53 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (23); animal contacts (11); equipment failure (11); nothing found (3); vehicles (3); other (2).

Remedial Actions

- In 2020, a three-phase sectionalizing device was replaced.
- In 2020, full circuit trimming was performed.
- In 2020, additional fusing was installed.
- In 2021, two single-phase reclosers will be installed.
- In 2021, three poles will be replaced.
- In 2022, four additional single-phase reclosers will be installed.
- In 2023, a section of this line will be transferred to a new line.

41 Circuit 56803 – BENVENUE 68-03

Performance Analysis

The BENVENUE 68-03 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On January 1, 2021, an unidentified issue occurred with an overhead conductor causing a circuit breaker to trip to lockout. This outage affected 765 customers for up to 135 minutes resulting in 103,680 CMI.

In total, the BENVENUE 68-03 circuit had 49 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (27); equipment failure (11); animal contacts (7); nothing found (3); vehicles (1).

Remedial Actions

- In 2019, an additional single-phase recloser was installed.
- In 2019, additional fusing was installed at four locations.
- In 2020, additional fusing was installed at five locations.
- In 2020, additional animal guarding was installed at five locations.
- In 2021, full circuit trimming will be performed.
- In 2021, three additional single-phase sectionalizing devices will be installed.
- In 2021, an additional single-phase recloser will be evaluated.
- In 2021, an additional Smart Grid device will be evaluated.
- In 2022, five additional single-phase sectionalizing devices will be installed.

42 Circuit 27101 – GREENFIELD 71-01

Performance Analysis

The GREENFIELD 71-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On December 18, 2020, during a period of extreme temperatures, an equipment failure occurred on an overhead splice causing a circuit breaker to trip to lockout. This outage affected 1,826 customers for up to 231 minutes resulting in 200,316 CMI.

In total, the GREENFIELD 71-01 circuit had 36 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (16); equipment failure (10); animal contacts (8); nothing found (2).

Remedial Actions

- In 2021, full circuit trimming will be performed.
- In 2021, additional animal guarding will be evaluated.
- In 2021, the protection settings on this circuit will be evaluated.
- In 2021, numerous porcelain cutouts will be replaced.
- In 2022, eight additional single-phase reclosers will be installed.

43 Circuit 43401 – BENTON 34-01

Performance Analysis

The BENTON 34-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the BENTON 34-01 circuit had 34 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (21); equipment failure (6); animal contacts (4); other (2); nothing found (1).

Remedial Actions

- In 2020, full circuit trimming was performed.
- In 2021, a section of difficult-to-access single-phase circuit will be relocated.
- In 2021, a section of difficult-to-access conductor will be evaluated for relocation or undergrounding.
- In 2022, two single-phase reclosers will be installed.

44 Circuit 45702 – LINDEN 57-02

Performance Analysis

The LINDEN 57-02 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the LINDEN 57-02 circuit had 40 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (18); equipment failure (9); nothing found (5); animal contacts (4); other (2); vehicles (2).

Remedial Actions

- In 2020, 80 poles were replaced.
- In 2020, a two-mile section of conductor was replaced and relocated.
- In 2020, three additional fuses were installed.
- In 2020, additional animal guarding was installed.
- In 2021, additional single-phase reclosers will be evaluated.

45 Circuit 41901 – REED 19-01

Performance Analysis

The REED 19-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 5, 2020, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 405 customers for up to 350 minutes resulting in 141,754 CMI.

In total, the REED 19-01 circuit had 21 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (11); equipment failure (7); animal contacts (2); other (1).

Remedial Actions

- In 2020, additional fusing was installed at two locations with two more to be performed in 2021.
- In 2020, a section of difficult-to-access single-phase was relocated.
- In 2020, multiple poles were replaced.
- In 2020, dissimilar metal connections were remediated at two locations.
- In 2021, full circuit trimming will be performed.
- In 2021, reconfiguring a portion of this circuit will be evaluated.
- In 2021 through 2022, 67 poles will be replaced.

46 Circuit 15704 – TANNERSVILLE 57-04

Performance Analysis

The TANNERSVILLE 57-04 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 2, 2020, a tree contacted a pole or pole arm causing a circuit breaker to trip to lockout. This outage affected 725 customers for up to 751 minutes resulting in 230,592 CMI.

In total, the TANNERSVILLE 57-04 circuit had 35 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (18); equipment failure (8); animal contacts (5); vehicles (3); nothing found (1).

Remedial Actions

- In 2019, full circuit trimming was performed.
- In 2020, a recloser was replaced on this circuit.
- In 2020, several dissimilar metal connections were remediated.
- In 2021, additional animal guarding will be installed.
- In 2021, the protection setting on this circuit will be reviewed.
- In 2022, eight additional single-phase reclosers will be installed.
- In 2022, additional fusing will be installed.
- In 2022, full circuit trimming will be performed.
- In 2022, additional storm hardening will be installed.
- In 2022, a section of difficult-to-access conductor will be relocated.

47 Circuit 12301 – LANARK 23-01

Performance Analysis

The LANARK 23-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the LANARK 23-01 circuit had 35 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (12); equipment failure (10); animal contacts (8); vehicles (3); contact or dig in (2).

Remedial Actions

- In 2020, hot spot trimming was performed.
- In 2021, additional animal guarding was installed.
- In 2021, two single-phase reclosers were installed.
- In 2022, full circuit trimming will be performed.
- In 2022, two single-phase reclosers will be installed.

48 Circuit 11402 – FARMERSVILLE 14-02

Performance Analysis

The FARMERSVILLE 14-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On June 12, 2020, a vehicle contacted a pole. This outage affected 2,484 customers for up to 513 minutes resulting in 368,095 CMI.

In total, the FARMERSVILLE 14-02 circuit had 20 outages between April 2020 and March 2021, with the causes breaking down as follows: animal contacts (6); equipment failure (6); tree related (6); vehicles (2).

Remedial Actions

- In 2020, three locations with dissimilar metal connections were remediated.
- In 2020, a Smart Grid device was replaced.
- In 2020, additional fusing was installed at several locations.
- In 2021, additional animal guarding will be installed.
- In 2022, full circuit trimming will be performed.

49 Circuit 26001 – WEST DAMASCUS 60-01

Performance Analysis

The WEST DAMASCUS 60-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On February 16, 2021, during a period of ice/sleet/snow, a tree contacted a pole or pole arm causing an interruption. This outage affected 384 customers for up to 543 minutes resulting in 167,308 CMI.

In total, the WEST DAMASCUS 60-01 circuit had 71 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (35); animal contacts (18); equipment failure (11); nothing found (4); vehicles (2); other (1).

Remedial Actions

- In 2020, additional animal guarding was installed.
- In 2020, eight additional single-phase reclosers were installed.
- In 2021, the protection setting on this circuit will be evaluated.
- In 2021, a section of single-phase will be reconductored and another section evaluated.
- In 2021, numerous porcelain cutouts will be replaced.
- In 2021, additional fusing will be installed.
- In 2021 and 2022, additional single-phase reclosers will be installed.
- In 2023, full circuit trimming will be performed.

50 Circuit 26401 – INDIAN ORCHARD 64-01

Performance Analysis

The INDIAN ORCHARD 64-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the INDIAN ORCHARD 64-01 circuit had 93 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (51); animal contacts (19); equipment failure (11); nothing found (11); other (1).

Remedial Actions

- In 2021, additional animal guarding will be installed.
- In 2021, the protection settings on this circuit will be evaluated.
- In 2021, reconductoring will be evaluated at several locations.
- In 2021, additional fusing will be evaluated.
- In 2021 and 2022, several additional single-phase reclosers will be installed.

51 Circuit 11506 – FREEMANSBURG 15-06

Performance Analysis

The FREEMANSBURG 15-06 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the FREEMANSBURG 15-06 circuit had 48 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (24); equipment failure (11); nothing found (7); animal contacts (4); vehicles (2).

Remedial Actions

- In 2020, a section of three-phase conductor was extended.
- In 2020, a Smart Grid device was replaced.
- In 2020, a switch at the substation was replaced.
- In 2021, three additional single-phase reclosers were installed with another planned.
- In 2021, additional fusing was installed.
- In 2022, a section of this circuit will be reconfigured.
- In 2022, a section of conductor will be split in two and receive single-phase reclosers.
- In 2022, full circuit trimming will be performed.

52 Circuit 46302 – ROHRSBURG 63-02

Performance Analysis

The ROHRSBURG 63-02 circuit experienced two outages of over 100,000 CMI between April 2020 and March 2021.

On July 3, 2020, during a period of strong wind, a tree contacted a pole or pole arm causing a recloser to trip to lockout. This outage affected 296 customers for up to 71 minutes resulting in 149,980 CMI.

On September 30, 2020, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 193 customers for up to 725 minutes resulting in 122,581 CMI.

In total, the ROHRSBURG 63-02 circuit had 45 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (27); equipment failure (8); animal contacts (6); nothing found (3); contact or dig in (1).

Remedial Actions

- In 2021, a sectionalizing device will be relocated.
- In 2021, addition fusing will be installed.
- In 2021, a section of three-phase conductor will be relocated.

53 Circuit 12802 – MICKLEYS 28-02

Performance Analysis

The MICKLEYS 28-02 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the MICKLEYS 28-02 circuit had 5 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (2); nothing found (2); animal contacts (1).

Remedial Actions

- In 2019, full circuit trimming was performed.
- In 2021, additional fusing was installed at four locations.

54 Circuit 44903 – SCOTT 49-03

Performance Analysis

The SCOTT 49-03 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 3, 2020, during a period of heavy rain, a tree contacted a pole or pole arm causing a circuit breaker to trip to lockout. This outage affected 1,745 customers for up to 281 minutes resulting in 285,765 CMI.

In total, the SCOTT 49-03 circuit had 3 outages between April 2020 and March 2021, with the causes breaking down as follows: animal contacts (1); tree related (1); vehicles (1).

Remedial Actions

- In 2020, full circuit trimming was performed.
- In 2021, a section of difficult-to-access conductor will be relocated.
- In 2021, several poles will be upgraded to a larger class.

55 Circuit 15601 – NO STROUDSBURG 56-01

Performance Analysis

The NO STROUDSBURG 56-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the NO STROUDSBURG 56-01 circuit had 31 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (20); other (4); animal contacts (3); equipment failure (3); nothing found (1).

Remedial Actions

- In 2021, full circuit trimming will be performed.
- In 2021, an existing recloser will be replaced.
- In 2021, additional animal guarding will be installed.
- In 2021, additional Smart Grid devices will be evaluated.
- In 2022, two single-phase reclosers will be installed.
- In 2022, additional fusing will be installed.
- In 2022, a section of difficult-to-access conductor will be relocated.

56 Circuit 56802 – BENVENUE 68-02

Performance Analysis

The BENVENUE 68-02 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the BENVENUE 68-02 circuit had 51 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (29); equipment failure (10); animal contacts (7); contact or dig in (2); nothing found (2); other (1).

Remedial Actions

- In 2020, seven sectionalizing devices were installed,
- In 2020, a section of single-phase line was resourced.
- In 2020, six additional single-phase recloser were installed.
- In 2021, full circuit trimming will be performed.
- In 2021, additional fusing will be evaluated.
- In 2022, a section of single-phase will be relocated and reconfigured.
- In 2022, two single-phase reclosers will be installed.

57 Circuit 57403 – SPANGLER 74-03

Performance Analysis

The SPANGLER 74-03 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the SPANGLER 74-03 circuit had 27 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (14); animal contacts (8); equipment failure (3); contact or dig in (1); nothing found (1).

Remedial Actions

- In 2019, a single-phase reclosers was installed.
- In 2020, additional animal guarding was installed.
- In 2020, four single-phase reclosers were installed.
- In 2020, three additional fuses were installed.
- In 2020, the coordination settings for this circuit were optimized.
- In 2020, one hundred hazard trees were removed from this circuit.
- In 2021, two sections of single-phase will be evaluated for expanded trimming rights.
- In 2021, additional fusing will be installed.
- In 2021, full circuit trimming will be performed.
- In 2021, constructing a tie between two single-phase underground loops will be evaluated.
- In 2021, a section of single-phase will be evaluated for re-sourcing.
- In 2022, two additional Smart Grid devices will be installed.

58 Circuit 23902 – EFFORT MOUNTAIN 39-02

Performance Analysis

The EFFORT MOUNTAIN 39-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On March 28, 2021, during a period of strong wind, a tree contacted an overhead conductor causing a recloser to trip to lockout. This outage affected 769 customers for up to 519 minutes resulting in 398,741 CMI.

In total, the EFFORT MOUNTAIN 39-02 circuit had 38 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (19); animal contacts (10); equipment failure (5); contact or dig in (1); nothing found (1); other (1); vehicles (1).

Remedial Actions

- In 2020, an additional Smart Grid device was installed.
- In 2021, additional animal guarding was installed with more to be completed.
- In 2021, an additional Smart Grid device will be installed.
- In 2021, a section of conductor will be split and a single-phase reclosers installed.
- In 2021, several poles will be replaced.
- In 2021, additional single-phase reclosers will be evaluated.

59 Circuit 25602 – ARROWHEAD 56-02

Performance Analysis

The ARROWHEAD 56-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On April 30, 2020, during a period of strong wind, a tree contacted a pole or pole arm causing a circuit breaker to trip to lockout. This outage affected 1,305 customers for up to 252 minutes resulting in 113,033 CMI.

In total, the ARROWHEAD 56-02 circuit had 18 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (11); equipment failure (4); animal contacts (3).

Remedial Actions

- In 2021, a tie line will be constructed for this circuit.
- In 2021, additional single-phase reclosers will be evaluated for this circuit.
- In 2021, additional fusing will be evaluated for this circuit.
- In 2021, single-phase extensions will be evaluated for this circuit.

60 Circuit 46701 – RENOVO 67-01

Performance Analysis

The RENOVO 67-01 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On July 26, 2020, an improper operation occurred on a substation component causing a circuit breaker to trip to lockout. This outage affected 681 customers for up to 547 minutes resulting in 317,959 CMI.

In total, the RENOVO 67-01 circuit had 16 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (14); equipment failure (1); Improper Operation (1).

Remedial Actions

- In 2020, additional animal guarding was installed.
- In 2021, full circuit trimming will be performed.
- In 2021, a new single-phase recloser will be evaluated.
- In 2021, a Proactive Circuit Review will be performed.

61 Circuit 17001 – RIDGE ROAD 70-01

Performance Analysis

The RIDGE ROAD 70-01 circuit experienced no outages of over 100,000 CMI between April 2020 and March 2021.

In total, the RIDGE ROAD 70-01 circuit had 55 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (38); equipment failure (10); animal contacts (4); nothing found (2); other (1).

Remedial Actions

- In 2020, full circuit trimming was performed.
- In 2020, an additional single-phase recloser was installed.
- In 2021, the protection scheme for this circuit will be evaluated.
- In 2022, an additional Smart Grid device will be installed.
- In 2022, three additional single-phase reclosers will be installed.

62 Circuit 40603 -- PINE GROVE 06-03

Performance Analysis

The PINE GROVE 06-03 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On April 24, 2020, a vehicle contact caused an interruption. This outage affected 1,172 customers for up to 475 minutes resulting in 201,443 CMI.

In total, the PINE GROVE 06-03 circuit had 43 outages between April 2020 and March 2021, with the causes breaking down as follows: tree related (16); equipment failure (9); animal contacts (7); nothing found (6); other (2); vehicles (2); contact or dig in (1).

Remedial Actions

- In 2020, an additional Smart Grid device was installed.
- In 2020, a cross arm and transformer were replaced.
- In 2020, four poles were replaced.
- In 2020, a section of difficult-to-access three-phase conductor was relocated and reconductored.
- In 2020, a section of single-phase was transferred to an adjacent circuit.
- In 2021, a single-phase recloser was replaced.
- In 2021, three poles will be replaced.
- In 2022, full circuit trimming will be performed.

63 Circuit 52002 -- LINGLESTOWN 20-02

Performance Analysis

The LINGLESTOWN 20-02 circuit experienced one outage of over 100,000 CMI between April 2020 and March 2021.

On February 13, 2021, a vehicle contacted a pole or pole arm causing a circuit breaker to trip to lockout. This outage affected 1,954 customers for up to 338 minutes resulting in 112,162 CMI.

In total, the LINGLESTOWN 20-02 circuit had 12 outages between April 2020 and March 2021, with the causes breaking down as follows: equipment failure (5); tree related (3); animal contacts (2); vehicles (2).

Remedial Actions

- In 2020, a set of disconnects was upgraded to increase capacity.
- In 2021, additional single-phase reclosers will be evaluated at several locations.
- In 2021, the circuit breaker will be evaluated for replacement.

5) A rolling 12-month breakdown and analysis of outage causes during the preceding quarter, including the number and percentage of service outages, the number of customers interrupted, and customer interruption minutes categorized by outage cause such as equipment failure, animal contact, tree related, and so forth. Proposed solutions to identified service problems shall be reported.

The following table shows a breakdown of service interruption causes for the 12 months ended at the current quarter.

Cause Description	Trouble Cases	Percent of Trouble Cases	Customer Interruptions	Percent of Customer Interruptions	Customer Minutes	Percent of Customer Minutes
Animals	3,442	15.9%	54,795	4.3%	3,056,219	1.6%
Contact / Dig-In	176	0.8%	22,973	1.8%	1,136,255	0.6%
Directed by Non-PPL Authority	56	0.3%	7,802	0.6%	482,393	0.3%
Equipment Failures	5,302	24.5%	380,859	30.1%	35,025,863	18.8%
Improper Design	2	0.0%	295	0.0%	22,885	0.0%
Improper Installation	2	0.0%	1,162	0.1%	56,505	0.0%
Improper Operation	10	0.0%	4,370	0.3%	960,113	0.5%
Nothing Found	1,035	4.8%	59,545	4.7%	4,763,661	2.6%
Other Controllable	87	0.4%	27,219	2.2%	481,770	0.3%
Other Non Control	246	1.1%	31,077	2.5%	3,525,793	1.9%
Other Public	31	0.1%	5,708	0.5%	256,853	0.1%
Tree Related	10,476	48.5%	558,035	44.2%	125,822,306	67.6%
Unknown	1	0.0%	426	0.0%	613,423	0.3%
Vehicles	732	3.4%	109,444	8.7%	10,040,552	5.4%
Total	**21,598**	**100.0%**	**1,263,710**	**100.0%**	**186,244,592**	**100.0%**

Analysis of causes contributing to the majority of service interruptions:

Weather Conditions: PPL Electric records weather conditions, such as wind or lightning, as contributing factors to service interruptions, but does not code them as direct interruption causes. Therefore, some fluctuations in cause categories, especially tree- and equipment-related causes, are attributable to weather variations. For the current reporting period, weather was considered a significant contributing cause in 53% of cases, 57% of customer interruptions, and 75% of CMI.

Tree Related: Vegetation is one of the largest single contributors to the number of cases of trouble, customer interruptions and customer minutes. For the current reporting period, approximately 81% of the cases of trouble, 83% of the customer interruptions and 91% of the customer minutes attributed to tree related outages were weather-related.

Animals: Animals accounted for approximately 16% of PPL Electric's cases of trouble. Although this represents a significant number of cases, the effect on SAIFI and CAIDI is small because approximately 76% of the number of cases of trouble were associated with individual distribution transformers. However, when animal contacts affect substation equipment, the effect may be widespread and potentially can interrupt thousands of customers on multiple circuits. In addition to guarding new distribution transformers and substations, PPL Electric initiated distribution and substation animal guarding programs in 2009 to focus systematically on protecting existing facilities most at risk of incurring animal-caused interruptions. A complete effectiveness review of this strategy is being evaluated.

Vehicles: Although vehicles cause a small percentage of the number of cases of trouble, they accounted for a large percentage of customer interruptions and customer minutes, because main distribution lines generally are located along major thoroughfares with higher traffic densities. In addition, vehicle-related cases often result in extended repair times to replace broken poles. PPL Electric has a program to identify and relocate poles that are subject to multiple vehicle hits.

Equipment Failure: Equipment failure is one of the largest single contributors to the number of cases of trouble, customer interruptions and customer minutes. However, approximately 38% of the cases of trouble, 48% of the customer interruptions and 48% of the customer minutes attributed to equipment failure were weather-related and, as such, are not considered to be strong indicators of equipment condition or performance.

Nothing Found: This description is recorded when the responding crew can find no cause for the interruption. That is, when there is no evidence of equipment failure, damage, or contact after a line patrol is completed. For example, during heavy thunderstorms, when a line fuse blows or a single-phase OCR locks open and when closed for test, the fuse holds, or the OCR remains closed, and a patrol reveals nothing.

6) ***Quarterly and year-to-date information on progress toward meeting transmission and distribution inspection and maintenance goals/objectives. (For first, second and third quarter reports only.)***

Inspection & Maintenance Goals/Objectives	Annual Budget	1st Quarter		Year-to-date	
		Budget	Actual	Budget	Actual
Transmission					
Transmission C-tag poles (# of structures)	65	35	35	35	35
Transmission arm replacements (# of arms)	8	4	4	4	4
Transmission air break switch inspections (# of switches)	0	0	0	0	0
Transmission surge arrester installations (# of sets)	N/A	128	128	128	128
Transmission structure inspections (# of activities)	12,564	7,603	7,603	7,603	7,603
Transmission tree side trim-Bulk Power (linear feet)	N/A				
Transmission herbicide-Bulk Power (# of acres)	N/A				
Transmission reclearing (# of miles) BES Only	539	162	225	162	225
Transmission reclearing (# of miles) 69 kV	998	20	15	20	15
Transmission reclearing (# of miles) 138 kV	80	248	226	248	226
Transmission danger tree removals-Bulk Power (# of trees)	N/A				
Substation					
Substation batteries (# of activities)	1,032	734	761	734	761
Circuit breakers (# of activities)	1,545	386	134	386	134
Substation inspections (# of activities)	2,058	809	822	809	822
Transformer maintenance (# of activities)	413	46	84	46	84

Inspection & Maintenance Goals/Objectives	Annual Budget	1st Quarter		Year-to-date	
		Budget	Actual	Budget	Actual
Distribution					
Distribution C-tag poles replaced (# of poles)	3,083	245	323	245	323
C-truss distribution poles (# of poles)	N/A	696	696	696	696
Capacitor (MVAR added)	0	0	0	0	0
OCR Replacements (# of)	1	0	0	0	0
Distribution pole inspections (# of poles)	74,500	0	0	0	0
Distribution line inspections (miles)	2,200	0	0	0	0
Group re-lamping (# of lamps)	16,140	2,200	2,208	2,200	2,208
Test sections of underground distribution cable	N/A	N/A	75	N/A	75
Distribution tree trimming (# of miles)	5,848	1,431	1,354	1,431	1,354
Distribution herbicide (# of acres)	N/A				
Distribution >18" removals within R/W (# of trees)	N/A				
Distribution hazard tree removals outside R/W (# of trees)	N/A				
LTN manhole inspections (# of)	519	130	216	130	216
LTN vault inspections (# of)	318	80	96	80	96
LTN network protector overhauls (# of)	69	17	25	17	25
LTN reverse power trip testing (# of)	28	7	6	7	6

7) ***Quarterly and year-to-date information on budgeted versus actual transmission and distribution operation and maintenance expenditures in total and detailed by the EDC's own functional account code or FERC account code as available.***

The following table provides the operation and maintenance (O&M) expenses for PPL Electric, as a whole, which includes the work identified in response to Item (6).

Activity		1st Quarter		Year-to-date	
	2021 Budget (000s)	Budget ($000)	Actual ($000)	Budget ($000)	Actual ($000)
Provide Electric Service	6,239	1,343	1,899	1,343	1,899
Vegetation Management	36,696	9,047	8,410	9,047	8,410
Customer Response	61,140	12,471	15,576	12,471	15,576
Reliability Maintenance	25,438	6,232	8,351	6,232	8,351
System Upgrade	3,625	846	214	846	214
Customer Service/Accounts	119,095	27,481	17,477	27,481	17,477
Others	39,453	9,369	16,345	9,369	16,345
Total O&M Expenses	**291,687**	**66,790**	**68,272**	**66,790**	**68,272**

8) Quarterly and year-to-date information on budgeted versus actual transmission and distribution capital expenditures in total and detailed by the EDC's own functional account code or FERC account code as available.

The following table provides the capital expenditures for PPL Electric, as a whole, which includes transmission and distribution ("T&D") activities.

Activity		4th Quarter		Year-to-date	
	2021 Budget (000s)	Budget ($000)	Actual ($000)	Budget ($000)	Actual ($000)
New Service/Revenue	95,137	21,194	24,512	21,194	24,512
System Upgrade	188,825	41,016	50,675	41,016	50,675
Reliability & Maintenance	422,424	92,690	108,849	92,690	108,849
Customer Response	28,711	5,456	9,748	5,456	9,748
Other	22,271	5,945	1,646	5,945	1,646
Total	**757,367**	**166,301**	**195,428**	**166,301**	**195,428**

9) Quarterly and year-to-date information on distribution substation inspections and reliability metrics.

Quarterly and year-to-date information on distribution substation inspections and reliability metrics.

(a) The Number of Corrective Work Orders by Type (Low-Priority, Mid-Priority, Urgent)

During the 1st quarter of 2021, 110 corrective work orders were created with the following breakdown by priority.

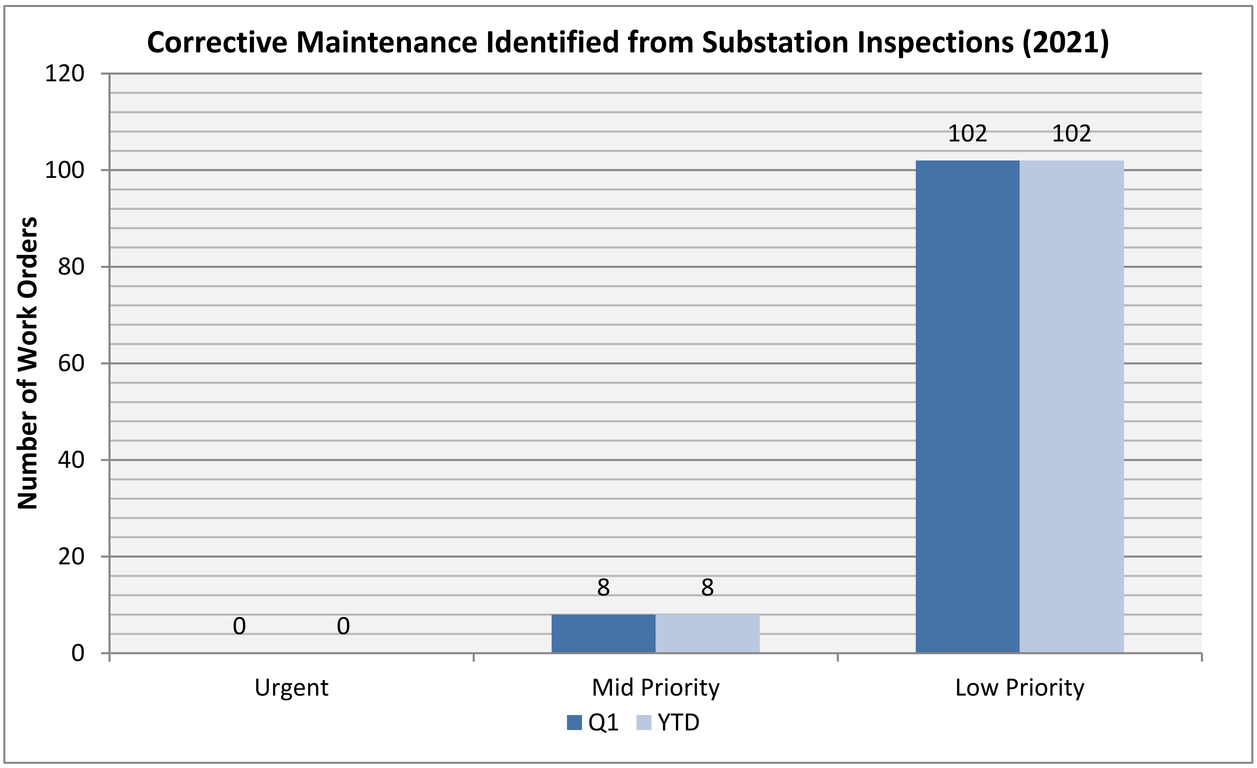


Figure 1: Corrective Maintenance Work Orders by Priority Level for 1st Quarter and Year-to-Date 2021

(b) The Amount Spent on Substation Inspections

During the 1st quarter of 2021, PPL Electric Utilities spent approximately $136,000 on substation inspections.

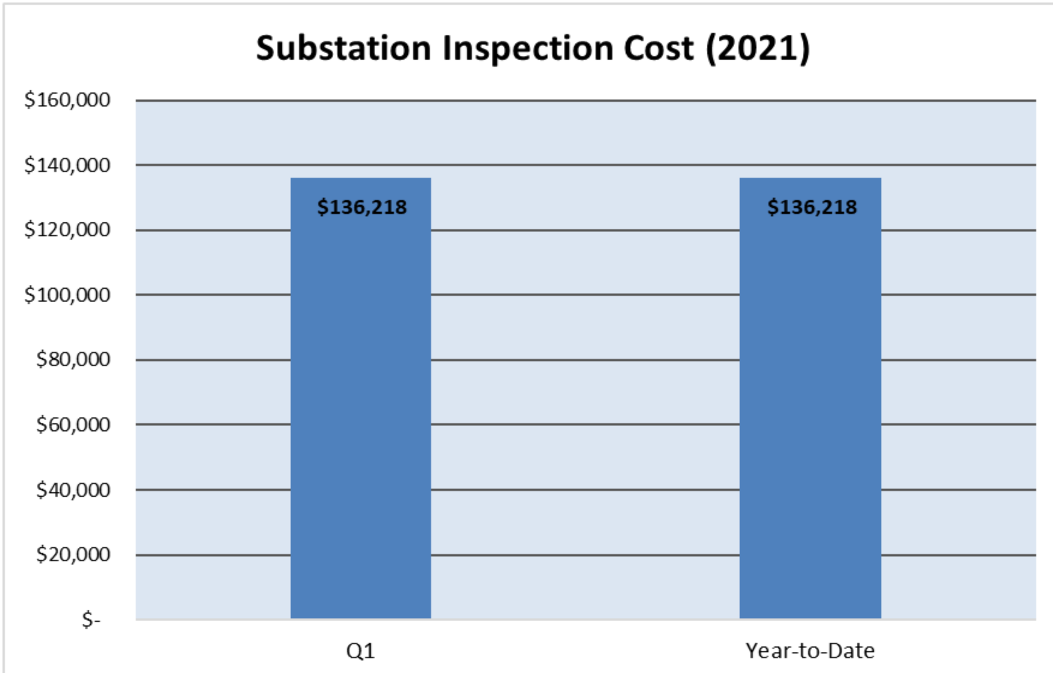


Figure 2: Substation Inspection Costs for 1st Quarter and Year-to-Date 2021.

(c) The Amount Spent on Vegetation Management

Please refer to Section 7 for vegetation management expenses for the 1st quarter and year-to-date 2021.

(d) The Projected CMI Avoidance Due to Substation Inspections

Figure 3 below shows the CMI avoidance that PPL Electric Utilities has estimated for the 1st quarter and year-to-date. During the 1st quarter of 2021, PPL Electric Utilities avoided a projected 133,000 CMI.

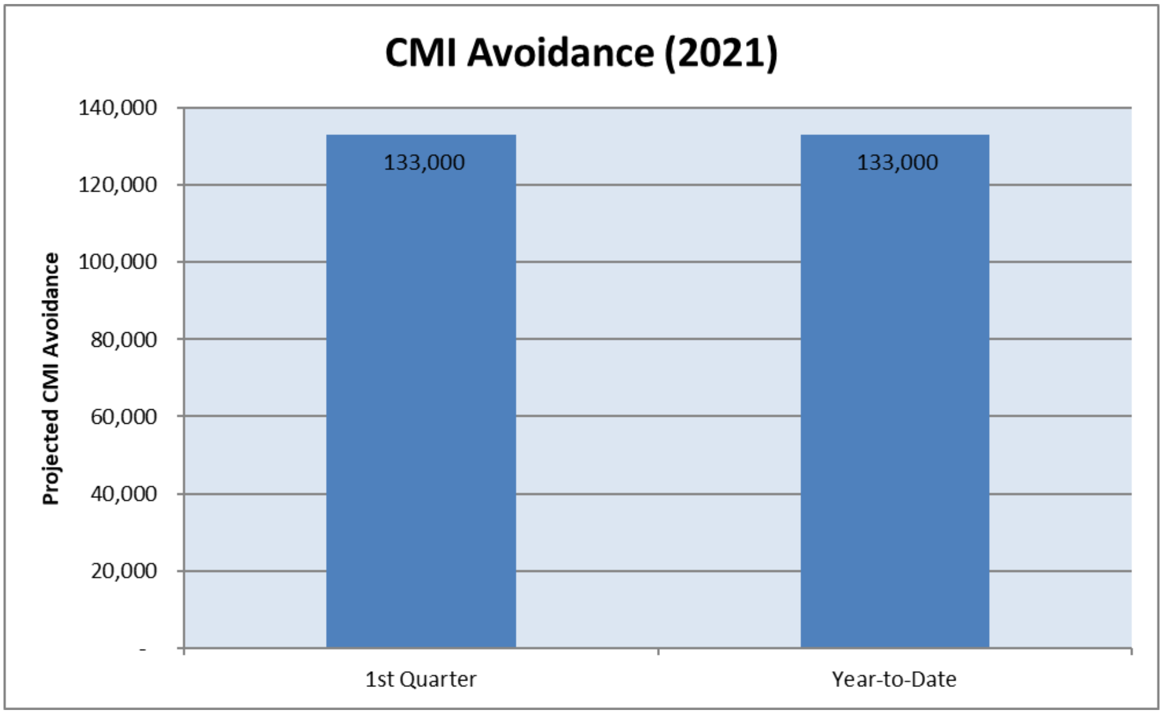


Figure 3: Projected CMI Avoidance Due to Substation Inspections for 1st Quarter and Year-to-Date 2021

(e) Customer Minutes and Number of Customers Affected Due to Substation Sustained Outages

In the past three years, distribution substations have contributed a small amount toward the reliability metrics. During the 1st quarter of 2021, the Company interrupted approximately 9,000 customers for a total of 136,000 CMI. The figures below show these results for the number of customers interrupted and CMI experienced, respectively.

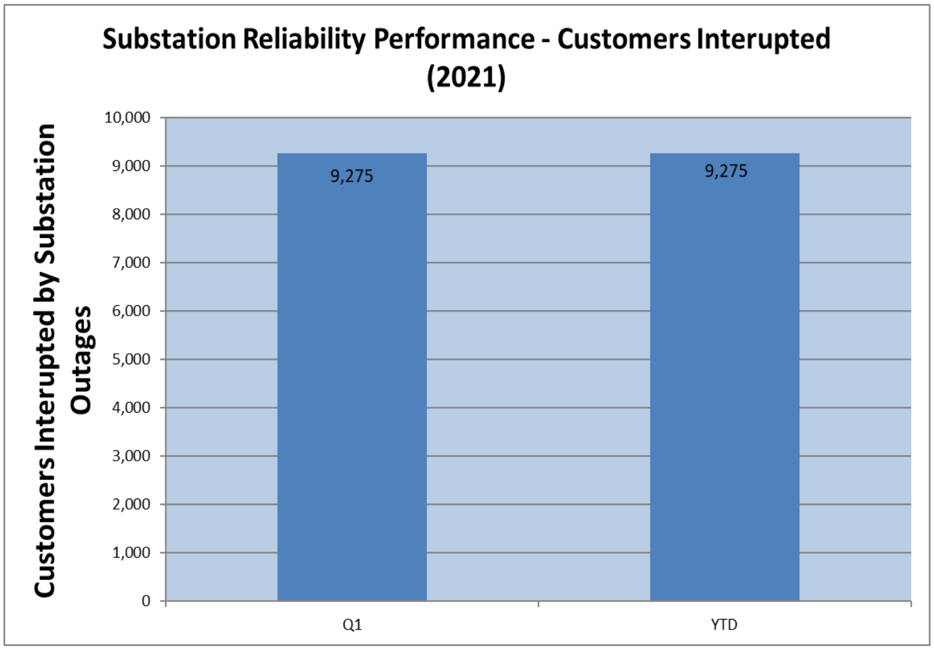


Figure 4: Substation Customers Interrupted for 1st Quarter and Year-to-Date 2021

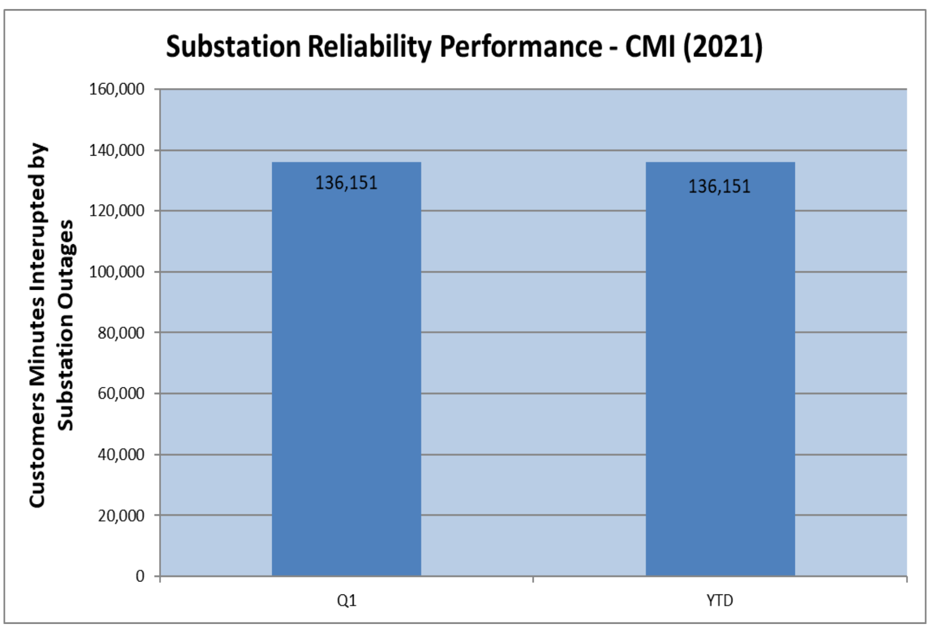


Figure 5: Substation Customer Minutes of Interruption for 1st Quarter and Year-to-Date 2021

(f) Substation SAIFI Contribution

Overall, substation outages contributed approximately 4% of the total SAIFI experienced by PPL Electric customers in the 1st quarter of 2021. Historically, PPL Electric Utilities has ranked in the first quartile for substation SAIFI performance on the Southeastern Electric Exchange (SEE) Survey and is on-track to maintain its ranking among other electric utilities.

(g) Number of Substations with Remote Monitoring and Communication Technologies

PPL Electric Utilities has the capability of remotely monitoring its distribution substations through SCADA installations and other telemetered equipment. This equipment allows PPL Electric to closely track the performance of its substation assets and respond to any trouble that is experienced on the distribution system. The table below shows the number of distribution substations that have this functionality.

	1st Quarter	Year-to-Date
Substations with Remote Monitoring	354	354
Total Number of Substations	356	356

PPL Electric has launched a project to install smart relaying onto all 12kV circuit breakers at its distribution substations. These relays will allow the Company to quickly perform automated switching for lesser system impact during an outage event, and better-estimate fault locations for quicker system restoration. By 2022, the Company expects all 12kV circuit breakers to have these functionalities to enhance reliability performance.

10) Dedicated staffing levels for transmission and distribution operation and maintenance at the end of the quarter, in total and by specific category (for example, linemen, technician and electrician).

The following table shows the dedicated staffing levels as of the end of the quarter. Job descriptions are provided in Appendix B.

Transmission and Distribution	
Lineman Leader	63
Journeyman Lineman	183
Journeyman Lineman-Trainee	42
Helper	16
Groundhand	2
Troubleman	51
T&D Total	**357**
Electrical	
Elect Leaders-UG	2
Elect Leaders-Net	10
Elect Leaders-Sub	21
Journeyman Elect-UG	9
Journeyman Elect-Net	27
Journeyman Elect-Sub	53
Electrical Total	**122**
Overall Total	**479**

11) 52 Pa. Code 57.198(l) – EDC Updates

Pursuant to 52 Pa. Code § 57.198(l), PPL Electric hereby submits redline copies of its Commission-approved 2020-2021 and 2022-2023 Biennial Inspection, Maintenance, Repair and Replacement Plans ("I&M Plans"), as Addendum-1 and Addendum-2, respectively, to this Quarterly Reliability Report. The redline copies of the I&M Plans contain proposed revisions to PPL Electric's pole inspection process, show the prospective and past revisions to the I&M Plans and provide the reasons for the proposed revisions.

Appendix A

PPL Electric Utilities Corporation

Worst Performing Circuit Definition

PPL Electric uses an equal weighting of circuit SAIDI and system SAIFI contribution over the previous four quarters to define the worst performing circuits on its system. IEEE Major Event days are excluded. This ranking system was put in place as of the first quarter of 2020, for the following reasons:

- Increased targeting of problem areas versus circuits that may be reasonable performers but are simply long circuits that have been in storms.
- It prioritizes the circuits contributing the most toward system SAIFI.
- It is less biased towards long, rural circuits and more reflective of the customer experience.

Appendix B

PPL Electric Utilities Corporation

Job Descriptions

Transmission and Distribution

Groundhand	• Performs manual labor and assists employees in higher job classifications.
Helper	• Performs semi-skilled labor at any work location on de-energized overhead and underground transmission, and distribution facilities to prepare the employee for entrance into the Journeyman Lineman Apprenticeship Program.
Journeyman Lineman	• Works alone or as part of a crew on the maintenance, operation, and construction activities of the transmission and distribution systems associated with, but not limited to, PPL Electric facilities.
Journeyman Lineman-Trainee	• Works alone or as part of a crew on the maintenance, operation, and construction activities of the transmission and distribution systems associated with, but not limited to, PPL Electric facilities.
Lineman Leader	• Responsible for completing assigned work by directing one or multiple groups of employees involved in the maintenance, operation, and construction activities of the transmission and distribution systems associated with, but not limited to, PPL Electric facilities. • Engage in and perform work along with providing the necessary leadership, all-around knowledge, program, judgment, and experience to produce a quality job. • Performs all the direct duties of the Journeyman Lineman when not acting as a Lineman Leader.
Troubleman	• Investigates and resolves trouble calls, voltage abnormalities on transmission and distribution systems associated with, but not limited to, PPL Electric facilities.

Electrical

Electrician Leader - Substation - Network - Underground	• Responsible for completing assigned work by directing one or multiple groups of employees involved in the construction and maintenance activities of the transmission and distribution systems associated with, but not limited to, PPL Electric facilities. • Engage in and perform work along with providing the necessary leadership, all-around knowledge, program, judgment, and experience to produce a quality job. • Performs all direct duties of the Journeyman Electrician when not acting as a leader.
Helper - Substation - Network - Underground	• Performs manual labor at any work location including those areas containing non-exposed energized electrical equipment, and to prepare the employee for entrance into the Apprenticeship Program.
Laborer - Substation - Network - Underground	• Performs manual labor and assists employees in higher job classifications.
Journeyman Electrician - Substation - Network - Underground	• Normally under limited supervision performs and is responsible for work associated with, but not limited to, PPL Electric facilities involving the highest degree of skill in construction and maintenance work associated with substations, LTN or underground distribution and transmission. • Uses microprocessor based equipment for troubleshooting and revising relay logic and its control systems related to the field services electrical discipline.

Journeyman Electrician - Trainee - Substation - Network - Underground	• Normally under limited supervision performs and is responsible for work associated with, but not limited to, PPL Electric facilities involving the highest degree of skill in construction and maintenance work associated with substations, LTN or underground distribution and transmission. • Uses microprocessor based equipment for troubleshooting and revising relay logic and its control systems related to the field services electrical discipline.

ADDENDUM-1

PPL Electric Utilities Corporation

Biennial Inspection, Maintenance, Repair and Replacement Plan of PPL Electric Utilities Corporation

For the Period of January 1, 2020 – December 31, 2021

Submitted by:

David Gladey
Director - Distribution Asset Management & Engineering
Two North Ninth Street
Allentown, PA 18101
(610) 774-2941
dlgladey@pplweb.com

Dated: ~~November 1, 2019~~April 30, 2021

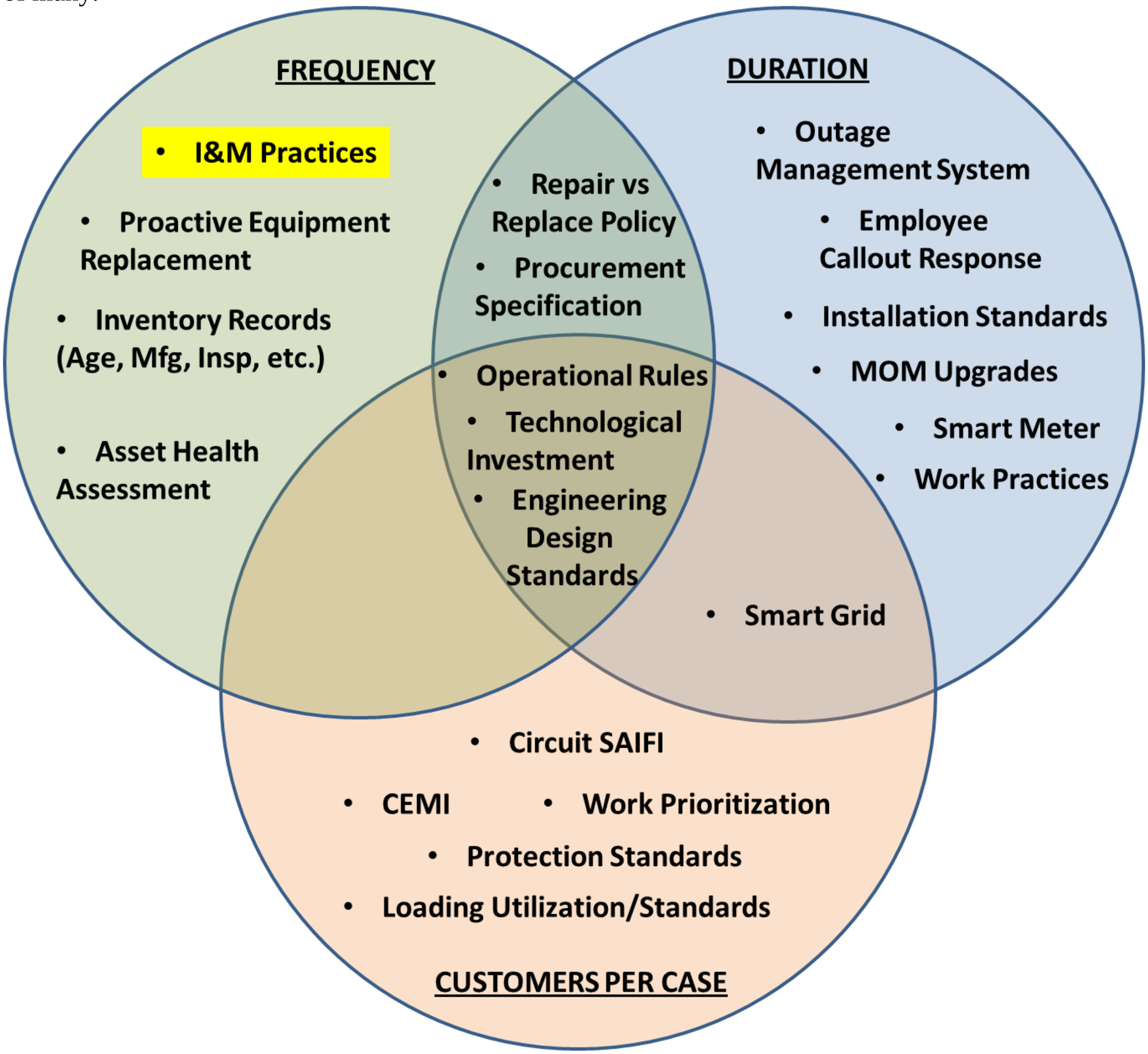
Table of Contents

Introduction

PPL Electric Utilities Corporation ("PPL Electric" or "Company") is firmly committed to maintaining high levels of customer satisfaction. Customer surveys demonstrate that high levels of customer satisfaction depend upon providing reliable performance coupled with reasonable cost. PPL Electric has established a strong, long-term record of customer satisfaction and electric reliability. PPL Electric has earned 26 J. D. Power customer satisfaction awards – more than any other investor-owned utility in the country – since J. D. Power began studying customer satisfaction among electric utility customers. PPL Electric has ranked highest among large electric utilities in the eastern United States in J. D. Power annual study of residential customer satisfaction 15 times: in 1999 and from 2001-2007 and 2012-2018.

Ultimately, all of the costs of maintaining reliability are borne by the ratepayers. Therefore, managing finite resources to produce optimal results is essential in order to deliver excellence in customer satisfaction. The criteria for program inclusion is not whether any given activity produces a positive reliability result, but, rather, what portfolio of activities produces the best result for a given expenditure of resources given the specific reliability challenges faced by PPL Electric at this point in time, and for the foreseeable future. PPL Electric's goal is focused on results (i.e., the reliability experienced by customers), not the rote execution of particular tasks.

Reliability performance is driven by a mixture of manageable and unmanageable factors. The most impactful of the unmanageable factors is the frequency and severity of weather events, which can vary dramatically over time and geography. The manageable factors have an effect on service interruption frequency, duration, or number of customers affected, or a combination of all three. The figure below depicts a portfolio of manageable factors with inspection and maintenance ("I&M") practices being one of many.



Reliability Programs and Policies

PPL Electric's philosophy is that the first step in improving reliability is to prevent outages altogether. The primary focus is, therefore, on the manageable factors that reduce the frequency (number) of cases. Efforts that typically overlap are those designed to minimize the number of customers affected should an outage occur. Realizing that not all outages are preventable, PPL Electric also directs rigorous efforts designed to reduce the duration of the outages that do occur. Examples of PPL Electric initiatives addressing each of the three reliability sectors, frequency (number of cases), customers affected per case, and duration are addressed below.

Frequency (number of cases)

- **Inspection and maintenance practices and programs:** PPL Electric remains focused on equipment performance and service interruption avoidance through the application of effective inspection and maintenance practice and programs. A comprehensive discussion has been provided to the Pennsylvania Public Utility Commission ("PUC" or "Commission") via PPL Electric's I&M filing on a biennial basis since the initial report in 2010. The scope of these programs, procedures and activities covers all areas of the electrical infrastructure to include transmission, substations, distribution, and vegetation.

Transmission
Transmission inspection programs include aerial patrols and structure inspections, treatments and replacements. The patrols focus on comprehensive inspections, routine inspections, stop-go inspections, and identification of emergency work. The inspections encompass all equipment, including poles, arms, line switches, interrupters, arresters, grounding, guying, anchors and other key transmission components.

Substation
Substation maintenance programs include inspections, condition testing, and preventative maintenance of equipment, such as power transformers, circuit breakers, disconnects, power cables, and security equipment. Some equipment is maintained on a time basis; other equipment is condition monitored. These two methods help ensure that maintenance work is performed in a timely manner. In addition to time and condition-based maintenance, thermographic inspections help to ensure that substation equipment does not operate at elevated temperature levels, which could lead to premature failures.

Distribution
Distribution encompasses many maintenance aspects similar to transmission and substations, and also includes load surveys that assist in determining peak load requirements, and circuit analyses that help identify lines requiring maintenance work, voltage relief, or other capital improvements. Overhead line inspections identify the weak links in the system so that damaged or deteriorated equipment can be repaired or replaced. In addition, distribution maintenance includes inspections of poles, voltage regulators, line switches, capacitors, and other key distribution equipment. PPL Electric also tests underground cable for integrity to determine if the cable needs to be replaced, repaired or cured to prevent future failures.

Vegetation
The vegetation on PPL Electric's transmission and distribution rights-of-way is maintained using a combination of several management techniques. These include

reclearing, ground-to-sky trimming, hazard tree removal, tree pruning, and herbicide application. The work is prioritized based on the conditions observed and past performance.

Each of these programs is more fully described in Appendices A through D.

- **Asset Optimization Strategy ("AOS"):** PPL Electric conducted a major condition assessment and maintenance study of its distribution system in 2009. This project was initiated to identify and address the challenges created by the Company's aging infrastructure. The objectives were to assess equipment health in seventeen distribution asset classes comprising approximately 30,000,000 units of equipment, and generate a strategy for capital replacements and maintenance improvements to address these challenges. PPL Electric conducts effectiveness reviews of the various programs comprising this strategy to ensure that aging infrastructure continues to be appropriately addressed.

- **Asset Health Assessment:** In 2015, asset health and criticality scores for substation and LTN ("Low Tension Network") vital equipment were captured and evaluated. As a result, AOS replacement programs for these asset classes were further refined based on the score ranking to achieve the most effective reliability impact per dollar invested. Additionally, Low Tension Network ("LTN") inspections and replacement programs are being adjusted to optimize cost and reliability based on the health and criticality scoring. PPL Electric continuously monitors the accuracy and effectiveness of these asset health and criticality scores, and in early 2018, as more data records were captured, began an initiative to develop predictive failure models of these vital assets with the intention of continuously improving the health and criticality scores. These continued health calculation efforts enable PPL Electric to more effectively mitigate risk and optimize reliability.

- **Long Term Infrastructure Improvement Plan:** In January 2018 the Commission approved PPL Electric's second Long Term Infrastructure Improvement Plan ("LTIIP") This Plan was submitted pursuant to the requirements of Subchapter B, Distribution Systems, of the Public Utility Code, 66 Pa.C.S. §§ 1350-1360, and the PUC's Implementation Order for Establishment of a Distribution System Improvement Charge ("DSIC"). The Plan is a continuation of AOS infrastructure replacements in addition to prudent capital investments such as the proactive installation of animal guards, new sectionalizing devices, distribution automation, asset life extension methods, replacement of deteriorated equipment, and capital projects aimed at addressing worst performing circuits ("WPCs").

- **Customers Experiencing Multiple Interruptions ("CEMI") Program:** The goal of the CEMI Program is to reduce the number of interruptions experienced by customers such that no customer has an excessive number of outages in any rolling 12 month period, and to communicate in an effective and timely manner with customers when multiple service interruptions do occur. CEMI performance is monitored closely by regional distribution planners and reliability supervisors to identify cost-effective solutions which are submitted to the CEMI Task Force for evaluation and consideration.

The CEMI program is structured around three key attributes:

- Anticipate – monitor, forecast, and attempt to prevent multiple service interruptions from occurring.
- Mitigate – when multiple service interruptions occur, determine root causes, develop solutions, and ultimately implement corrective actions to reduce the risk of future interruptions.
- Communicate – following multiple service interruptions, contact customers to inform them that PPL Electric is aware that a service interruption has occurred, provide the cause of the service interruption, and the Company's plans to prevent future service interruptions, among other pertinent details. In addition, when solutions are implemented, contact customers and advise them of the improvements.

- **Distribution and substation animal guarding:** Two programs were established in 2009 to limit service interruptions caused by animals. The first was to install animal guards on distribution overhead transformers and switches in locations with a high density of animal-related service outages, and the second was to install animal guard materials at all distribution substations by 2019. This has proven effective. Since the program's rollout, animal outages have decreased by 34%.

Customers affected per case

- **Expanded Operational Reviews ("EOR"):** EORs are performed on each circuit on a four-year cycle. The review analyzes and addresses both operational and reliability characteristics of each circuit. Voltage support, phase balancing, protection coordination, power factor maintenance and loading issues are addressed from an operational perspective. Service outage analysis, exposure analysis and field checks address reliability and power quality.

- **Reliability Principles and Practices ("P&P") Revisions:** The P&P sets forth a set of principles that PPL Electric follows to plan, protect and operate the Electrical Distribution System ("EDS"). These principles are implemented through a set of standard practices that are used as guidelines in designing the EDS. These practices are reviewed regularly to ensure they remain reasonable and acceptable, and align well in accordance with good utility practices. Additional revisions to PPL Electric's P&P are underway to reduce the overall impact to our customers as the Company implements smart grid strategies.

- **Circuit SAIFI:** In 2013, PPL Electric launched a system wide initiative to install approximately 1,000 new fuses on single phase taps to limit the number of customers exposed to an outage on a given circuit. The Company continues to evaluate areas where fuse installation may reduce customer exposure to outages. As of 2018, over 2,600 locations have been fused, with more installations planned.

- **MAIFI**: In 2016, PPL Electric became one of the first electric utility companies in the nation to launch a concentrated effort to reduce momentary interruptions (defined as any power interruption less than five minutes) that customers experience. Through tracking momentary interruptions and concentrating on circuits that experience higher than average momentary interruptions per customer, PPL Electric is reducing the number of momentary power outages on the system.

Duration (minutes/case)

- **Restore App / Storm Event Management** ("STEM"): As of 2017, two mobile applications are available that significantly improve storm response efficiency and situational awareness. The Restore App is an application that enables non-PPL crews to receive information about outages directly to their smart devices or PCs. Previously this information was provided via phone calls or hand-delivered documents. The Restore App also enables field personnel to send photographs of damaged equipment to PPL Electric support staff. To support command center situational awareness and strategy development, an application known as Storm Event Management ("STEM") now makes outage information, resource allocation, and estimated restoration times available on smart devices and PCs.

- **Automated Callout:** As of 2013, an automated system has been employed to call employees into work for after-hours emergencies. This system performs callouts simultaneously, whereas the previous system performed callouts sequentially, which shortens response time under storm conditions when large numbers of employees must be called out to restore service to customers.

- **Outage Management System ("OMS") enhancements:** In 2015, PPL Electric completed an upgrade of its OMS system. Numerous improvements were made to the software, including a stronger model of the network grid, improved system response time, and improved outage scenario modeling.

- **Storm Central:** Storm Central is a user friendly tool that allows personnel to quickly find the information and tools, developed under PPL Electric's Emergency Response Plan, needed to support the restoration of service to our customers after an emergency event.

- **Distribution Automation:** In 2010, PPL Electric launched a "smart grid" pilot project that enables the Company to react rapidly to changes on the delivery system, and automatically re-route power around problems that occur. The project initially focused on the Harrisburg, Pa. area, but has since been rapidly expanded to cover all of our service territory. The project included the implementation of an advanced Distribution Management Systems ("DMS"), which is a breakthrough technology that enables our operators to see the status of our distribution network in real-time. In 2016, PPL Electric completed a system wide rollout of FISR (Fault Isolation and Service Restoration) technology. FISR identifies faulted sections and quickly develops an optimized restoration plan, then automatically executes that plan. Customers typically can be restored within five minutes from the start of the outage. This milestone is an industry first and looks to significantly reduce overall outage durations. Over 7,500 automated smart devices have been installed to date. Such installations allow for remote operation and monitoring of circuit sectionalizing equipment, and advanced fault location technology. The goals of these improvements are threefold:

    - Reduce the number of upstream customers affected by a service outage.

- Reduce the time necessary to restore customers by transferring circuit sections to alternate sources and limiting long-duration service outages to smaller circuit sections involving fewer customers.
- Facilitate fault location and reduce the time necessary for repair and restoration.

The end-result will be a delivery system that operates more efficiently, recognizes problems immediately, and responds in seconds to restore the service for many customers who otherwise need to wait for crews to physically respond to an outage.

- **Smart Meter Technology**: PPL Electric is a national leader in the use of advanced metering technology for the benefit of customers, having installed an advanced metering system for all customers between 2002 and 2004. The Company has used the technology to improve the efficiency of responding to service outages – especially during storm emergencies – and as a tool for reliability planning. PPL Electric began exchanging its power line carrier meters with radio frequency ("RF") based meters, in December 2016. The RF meters will allow for even more improvements in outage detection and restoration as well as proactive reliability planning and customer service. As of August 31, the Company has installed 950,659 RF meters with deployment to be completed by the end of 2019.

PPL Electric Reliability Results

The reliability planning and investment process employed by PPL Electric have been very effective, as evidenced by its reliability performance. This has been accomplished while preserving a reasonable cost of providing service.

PPL Electric Reliability Planning Process

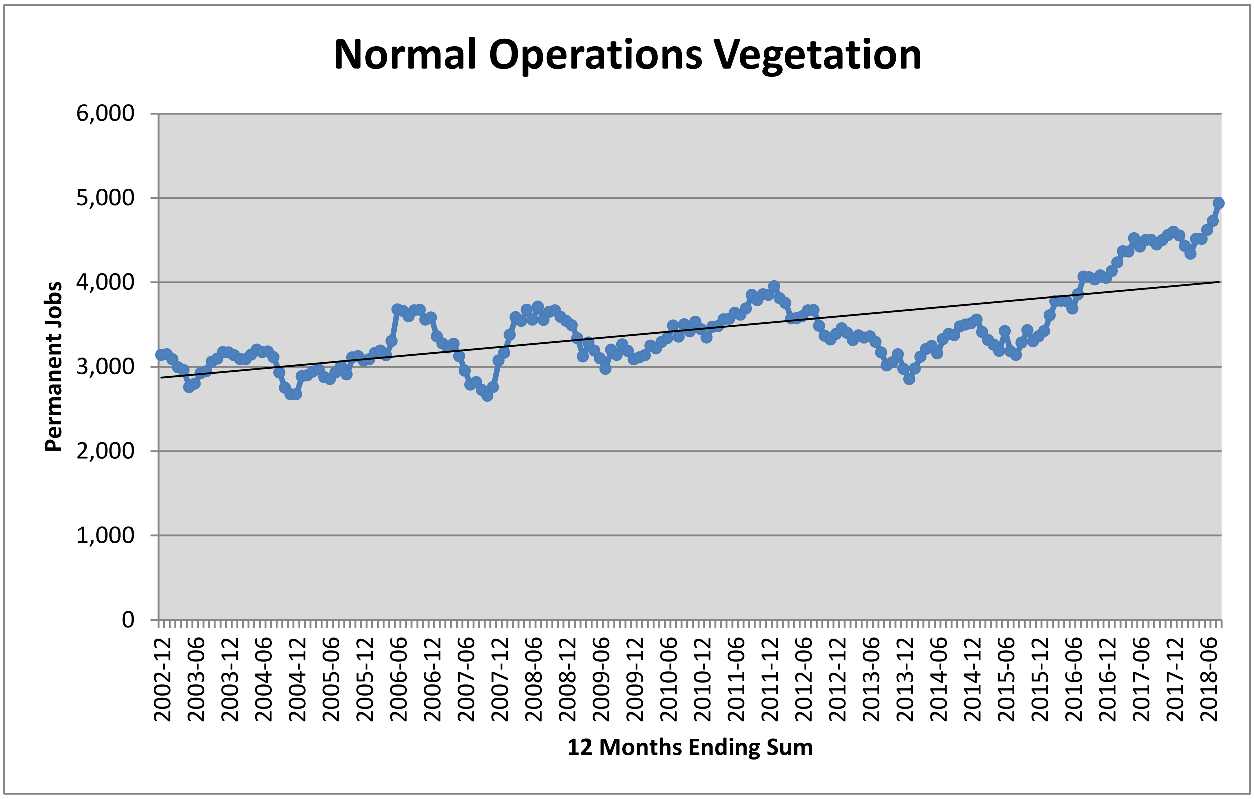
PPL Electric's process is forward-looking and proactive. It consists of the following:

- Analyze the historical trends of causes of service outages and other power service problems.
- Identify the drivers of those trends.
- Forecast future reliability metrics (SAIDI, SAIFI, CAIDI, and MAIFI) given existing mitigation programs' effect on the identified drivers.
- Identify new programs, policies and activities to add to or substitute for existing mitigation programs to avoid any forecasted gaps between future reliability and the desired levels.
- Identify, evaluate and implement new technologies that enhance its condition monitoring strategy
- Continually evaluate and adjust programs, policies and activities to produce the desired future results.
- The resulting portfolio of existing and new programs, policies and activities are incorporated in to PPL Electric's I&M plan.

PPL Electric Utilities Corporation

PPL Electric Reliability Analysis

Identification and understanding of trends creates the opportunity to plan programs to mitigate undesirable trends. Most of the year-to-year variation in service interruptions is explained by differences in storm experience. Therefore, PPL Electric generally removes all declared-storm caused service outages (though not all weather related outages) for internal analysis to identify other causal trends affecting reliability. Each data point in the following charts represents a 12-month ending value to eliminate the effect of seasonal variation.

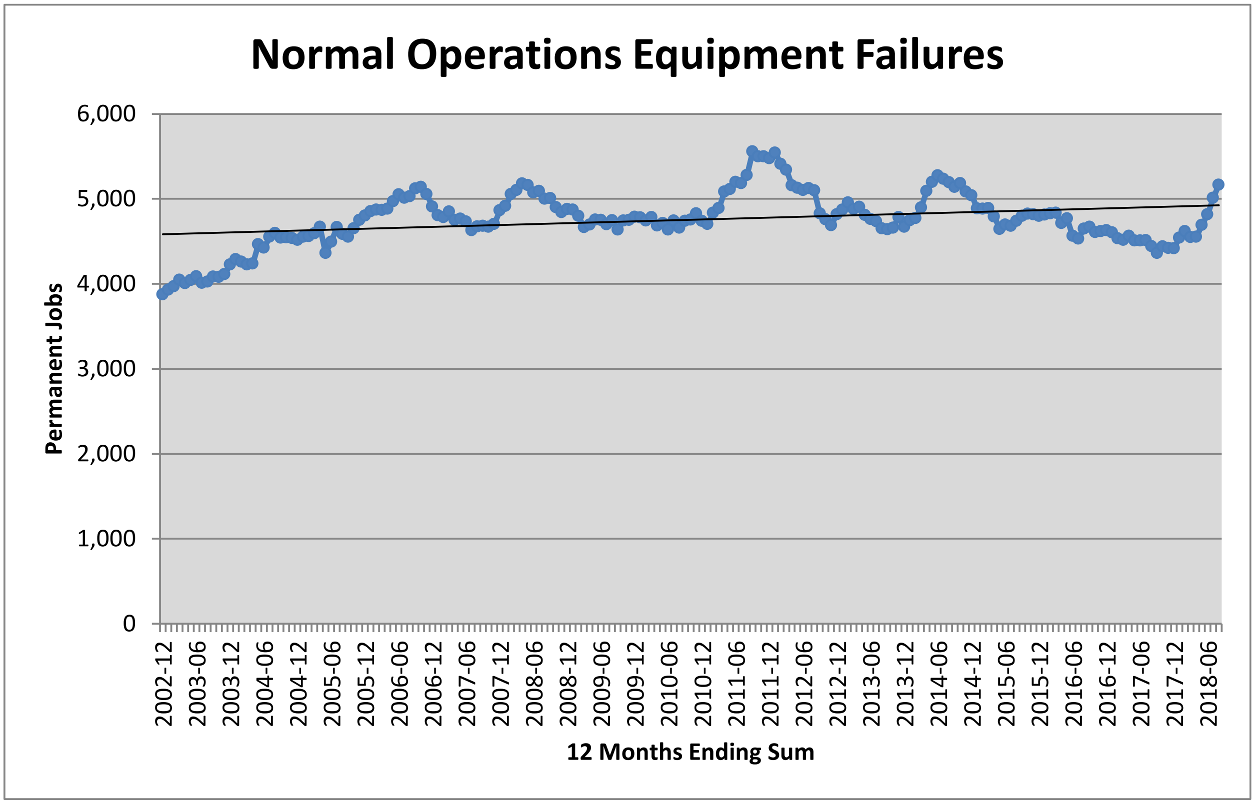


Vegetation Related Service Interruption Cases

PPL Electric is committed to continuing an aggressive tree trimming program to address the threat of tree related outages. It is worth noting that even when excluding major and PUC reportable storm events, 75% of vegetation related outages occur during adverse weather conditions. The saturated ground conditions prevalent in 2018 have resulted in higher than normal occurrences of healthy trees toppling into overhead conductor. Also of note is the ongoing infestation of the emerald ash borer in Pennsylvania, which is having a negative impact on vegetation related interruptions.

A significant risk to PPL Electric's ability to meet reliability benchmarks is the large portion of distribution facilities, which were installed in the 1960's and 1970's, that are now beyond or nearing the end of their design lifetime. The resultant effect on non-storm-related equipment failure is illustrated by the chart below.

PPL Electric Utilities Corporation



Equipment Failure Service Interruption Cases

The annual number of outages due to equipment failure rose steadily through mid-2011 and has generally stabilized or declined since then. The recent spike in equipment failures is partially a result of the addition of thousands of additional fuse locations: currently a fuse operation where no clear cause can be found is coded into outage data as an equipment failure. However, if the fault was caused by a transient contact that is no longer apparent, the fuse operated as intended and no equipment failed. This practice is being reviewed.

Other initiatives contributing to this stabilization are equipment replacements identified through Expanded Operational Reviews of 25% of circuits annually, aggressive worst performing circuit remediation, implementation of PPL Electric's Asset Optimization Strategy, enhanced pole inspection and treatment, distribution automation including a new Distribution Management System, and infrared inspections.

Although these programs have successfully slowed equipment failure growth rates in the short-term, PPL Electric faces a long-term challenge regarding aging infrastructure. PPL Electric is committed to mitigating the aging infrastructure challenge through effective use of proactive replacement programs. Scheduled replacement of that infrastructure is necessary to avoid accelerating failure rates due to end of life fatigue.

Reliability is the largest contributor to overall customer satisfaction. Satisfaction levels vary depending upon the amount of information provided to the customer regarding their outage. Providing customers with accurate information about their outage is increasingly important. Customers are more understanding of storm and weather-related service outage impacts than they are of other outage causes, such as utility equipment failures.

If it is more cost-effective to offset an increase in equipment failure cases with a program to reduce vegetation-related cases, the ratepayer is better served by this cost-effective choice. Similarly, if a program that reduces the average number of customers affected by each service outage is more cost-effective than a program to reduce the gross number of service outages, the more cost-effective program should be chosen. The management challenge is to maintain reliability within acceptable parameters in the most cost-effective manner, while keeping customer satisfaction levels high.

52. Pa. Code § 57.198 (b) Plan Consistency. *The plan must be consistent with the National Electrical Safety Code, Codes and Practices of the Institute of Electrical and Electronic Engineers, Federal Energy Regulatory Commission Regulations and the provisions of the American National Standards Institute, Inc.*

PPL Electric's I&M Plan is consistent with the National Electric Safety Code ("NESC"), Codes and Practices of the Institute of Electrical and Electronic Engineers ("IEEE"), Federal Energy Regulatory Commission Regulations ("FERC") and the provisions of the American National Standards Institute, Inc. ("ANSI").

52. Pa. Code § 57.198 (c) Requested Deviations *The plan must comply with the inspection and maintenance standards in subsection (n). A justification for the inspection and maintenance time frames selected shall be provided, even if the time frame falls within the intervals prescribed in subsection (n). However, an EDC may propose a plan that, for a given standard, uses intervals outside the Commission standard, provided that the deviation can be justified by the EDC's unique circumstances or a cost/benefit analysis to support an alternative approach that will still support the level of reliability required by law.*

PPL Electric is again requesting acceptance of the following deviations from the intervals in the Commission standard as were included in the four previous I&M reports (2012-2013, 2014-2015, 2016-2017, and 2018-2019):

- Section 57.198 (n)(2). Pole Inspections. (vi) A load calculation.
- Section 57.198 (n)(4). Distribution overhead line inspections.
- Section 57.198 (n)(6). Distribution transformer inspections.

PPL Electric is again requesting acceptance of the following deviations from the intervals in the Commission standard as were included in the two previous I&M reports (2016-2017, 2018-2019):

- Section 57.198 (n)(7). Recloser inspections.

PPL Electric Utilities Corporation

PPL Electric is again requesting acceptance of the following deviation from the intervals in the Commission standard as were included in the previous I&M report (2018-2019):

- Section 57.198(n)(8). Substation inspections.

52. Pa. Code § 57.198 (m) Recordkeeping(m) *An EDC shall maintain records of its inspection and maintenance activities sufficient to demonstrate compliance with its distribution facilities inspection, maintenance, repair and replacement programs as required by subsection (n). The records shall be made available to the Commission upon request within 30 days. Examples of sufficient records include: (1) Date-stamped records signed by EDC staff who performed the tasks related to inspection. (2) Maintenance, repair and replacement receipts from independent contractors showing when and what type of inspection, maintenance, repair or replacement work was done.*

Inspection and maintenance activities performed by PPL Electric employees are tracked by electronic work requests in the Company's Work & Asset Management System (WAM) software application which date-stamps transactions and captures an electronic signature of the employee certifying completion.

Inspection and maintenance activities performed by PPL Electric contractors are documented with itemized records, which identify when and what type of work was performed, before invoices for the work are paid.

52. Pa. Code § 57.198 (n)(1). Vegetation Management. *The Statewide minimum inspection and treatment cycle for vegetation management is between 4-8 years for distribution facilities. An EDC shall submit a condition-based plan for vegetation management for its distribution system facilities explaining its treatment cycle.*

Program Description

PPL Electric employs four-year and five-year inspection and trim cycles for its distribution circuits in its southern and northern territories respectively. The demarcation line for the northern and southern areas is the ridgeline of the Blue Mountains, which does not follow the borders of PPL Electric's regions. Based on conditions the cycle schedule may be modified, but not beyond established regulations. Additionally, a three-year inspection and trim cycle is currently applied to transmission lines in all of PPL Electric service territories.

PPL Electric rights-of-way will be maintained to the originally established clearances or the limits as defined in the right-of-way agreement, whichever is greater.

- Purpose

To safeguard the reliability of its electric distribution system, PPL Electric has developed a comprehensive program to manage vegetation around power lines. Keeping trees and other vegetation away from high-voltage lines is important. Tree contacts can result in short-circuits and subsequent service outages.

Taller species of trees that are permitted to grow under power lines eventually will contact the wires, causing service interruptions and unsafe conditions. It is necessary for PPL Electric to trim or remove these trees to continue safe and reliable electric service.

- Process

Distribution

Multi-phase lines will be pruned to the full extent of the established tree line, not to exceed 25' from centerline and ground to sky pruning will be utilized.

Single-phase lines will be pruned to the full extent of the established tree line, not to exceed 15' from centerline and to a distance of 15' above the line. All dead or structurally weak limbs which could fall or blow into the conductor are removed regardless of their distance above the conductor.

Exceptions: Trees on the opposite side of any thoroughfare, where normal line construction exists (not alley arms), should be considered for proper lateral pruning using the centerline of the thoroughfare as a guideline. Fast growing tree species may need more aggressive pruning.

Another enhancement is hazard tree removal. "Hazard trees" are those trees outside the right of way that may be leaning, diseased, or otherwise pose a threat of falling on a distribution line. PPL Electric bears all costs of removing hazard trees and conducts the removal either based on right of way agreements or with property owner permission.

PPL Electric Utilities Corporation

Transmission

PPL Electric Utilities operates thousands of miles of high-voltage transmission lines. The Company's vegetation management program is designed to promote the safe and reliable operation of the electric grid, while taking into account the concerns of property owners and our obligations to electric customers. Low-growing grasses and other compatible species are permitted within the wire zone. In the remainder of the right-of-way, certain compatible trees and shrubs are allowed if they do not pose a reliability risk.

Inspection Plan

Distribution Vegetation Management			
	Area *(Line Miles)*	**Scheduled Trimming** *(Line Miles)*	
		2020	**2021**
PPL Electric Utilities Corporation *Total Line Miles (28,094)*	Lehigh (3,469)	788	795
	Northeast (5,190)	928	925
	Central (4,535)	900	903
	Susquehanna (5,769)	999	984
	Harrisburg (4,822)	1202	1004
	Lancaster (4,309)	964	972
	Totals	**5,781**	**5,583**

52. Pa. Code § 57.198 (n)(2). Pole Inspections. *Distribution poles shall be inspected at least as often as every 10-12 years except for the new southern yellow pine creosoted utility poles which shall be initially inspected within 25 years, then within 12 years annually after the initial inspection. Pole inspections must include:*

(i) Drill tests at and below ground level.
(ii) A shell test.
(iii) Visual inspection for holes or evidence of insect infestation.
(iv) Visual inspection for evidence of unauthorized backfilling or excavation near the pole.
(v) Visual inspection for signs of lightning strikes.
(vi) A load calculation.

Program Description

- Cycle

  Every twelve years.[1]

- Purpose

  Distribution poles are inspected to identify and measure the extent of decay and defects that may adversely affect safety or service reliability.

- Process

  ~~Beginning in 2020, each pole will be inspected on a 12-year cycle. Poles younger than 25 years are visually inspected only. Pole inspection program includes a visual inspection looking for holes or evidence of insect infestation, evidence of unauthorized backfilling or excavation near the pole, and signs of lightning strikes. Based on inspection results subsequent treatment, reinforcement, or replacement of Distribution poles is identified as defined in Appendix C. All poles greater than or equal 25 years of age are examined for deterioration, and the degree of decay is measured along with a treatment process applied to extend pole life.~~

  PPL Electric visually inspects all poles on a 12-year frequency and conducts a drill test at and below ground line for poles greater than or equal to 26 years of age. Safe drill testing below the ground line, in some cases, may be prevented by the location and obstructions on the pole. When drill testing is required, it is performed by methods including, but not limited to, a resistance drill test at and below the ground line or a standard industry sound

[1] On November 1, 2019, PPL Electric filed its 3rd quarter Quarterly Reliability Report pursuant to 52 Pa. Code § 57.195(d)-(e) and, in accordance with 52 Pa. Code § 57.198(l), proposed a change to the pole inspection interval set forth in its approved 2020-2021 Biennial Inspection, Maintenance, Repair, and Replacement Plan (I&M Plan) from every 10 years (as provided for in its original I&M Plan) to every 12 years. On December 23, 2019, the Commission issued a Secretarial Letter approving the change to a pole inspection interval of every 12 years.

and bore test with below grade excavation. Based on the drill testing, applicable measurements, including all measurable decay, are entered into an engineering-based program to determine the percentage of remaining strength, taking into consideration ANSI and NESC standards. A visual inspection is performed to identify holes or evidence of animal damage including insect infestation, evidence of unauthorized backfilling or excavation near the pole, mechanical damage and lightning strikes. Based upon the inspection and testing results, additional actions at the pole may include treatment with a preservative, reinforcement (by truss or fiber wrap) or replacement.

Discussion of the reasons for the proposed change:

PPL Electric's proposed change identifies an additional method of drill testing to be included in PPL Electric's pole inspection program. A resistance drill test uses "smart drill" technology that can sense decays or voids in the wood poles based on resistance of a drill bit. It also permits drilling on an angle, which enables PPL Electric to conduct drill tests below the ground line as required by the regulation and where obstructions would otherwise prevent safe drill testing, such as poles embedded in concrete or other hard surfaces. It is PPL Electric's experience that traditional sound and bore testing has limitations in consistently being able to determine a pole's health and remaining structural strength. As a result, PPL Electric expects to be able to significantly increase drill testing to determine pole decay on the majority of its poles with greater accuracy and consistency beyond the limitations of traditional sound and bore testing that PPL Electric experiences in today's pole inspection program. This change in how PPL Electric conducts its drill testing and determines a pole's remaining strength will improve its ability to manage the pole's health and limit pole failures as a result of decay.

- Justification for waiver

  PPL Electric's pole inspection program generally complies with the intervals set forth in 52. Pa. Code § 57.198(n)(2), NESC rules and is consistent with industry practices. PPL Electric proposes a continuance of the deviation from the requirement in 52 Pa. Code § 57.198(n)(2)(vi) for a load calculation to be performed for each pole inspected. The design of PPL Electric's lines is based on its Distribution Engineering Instructions which are based upon NESC heavy loading conditions. These instructions provide adequate safety factors such that the allowable percentage of strength reduction does not compromise the ability of the pole to support the load. PPL Electric requires entities attaching facilities to its poles to perform their own load calculations before making the attachment. Load calculations are performed on every pole where new attachments are requested by third parties.

Inspection Plan

PPL Electric Utilities Corporation

Distribution Wood Pole Inspections			
	Area *(Poles)*	**Inspections Planned** *(Poles)*	
		2020	**2021**
PPL Electric Utilities Corporation *Total Poles (885,040)*	Lehigh (118,218)	9,851	9,851
	Northeast (175,862)	14,655	14,655
	Central (158,243)	13,186	13,186
	Susquehanna (160,991)	13,415	13,415
	Harrisburg (140,595)	11,716	11,716
	Lancaster (131,131)	10,927	10,927
	Totals	**73,750**	**73,750**

52. Pa. Code § 57.198 (n)(3). Pole inspection failure. *If a pole fails the groundline inspection and shows dangerous conditions that are an immediate risk to public or employee safety or conditions affecting the integrity of the circuit, the pole shall be replaced within 30 days of the date of inspection.*

Corrective Maintenance

- PPL Electric obtains pole replacement data weekly. Critical poles, those that pose an immediate safety concern, are reinforced or replaced as soon as possible, and not later than 30 days after notification. Other non-restorable rejected poles generally are replaced within one year of identification. Pole strength and loading calculations are provided for each rejected pole to assist in reinforce versus replace decisions and schedule prioritization.

- Reinforcement by steel C-Truss, a galvanized steel truss which is banded around the pole in order to regain the pole's original strength or fiber wrap, several layers of high-strength fiberglass wrapped onto the pole and saturated with resin is completed within 90 days of identification. The method of reinforcement is determined by the circumstances and/or location of the pole.

52. Pa. Code § 57.198 (n)(4). Distribution overhead line inspections. *Distribution lines shall be inspected by ground patrol a minimum of once every 1-2 years. A visual inspection must include checking for:*

(i) Broken insulators.
(ii) Conditions that may adversely affect operation of the overhead transformer.
(iii) Other conditions that may adversely affect operation of the overhead distribution line.

Program Description

- Cycle

  Infrared inspection: Multi-phase overhead lines adjacent to roadways every two years.

  Visual inspection: Condition based – selected line segments. Inspections are scheduled under various conditions to include CEMI and WPC circuits, if warranted based on EORs, and if power quality issues are experienced. Additional patrols are conducted to ensure continued reliability include those in support of distribution construction projects as well as summer and winter readiness patrols.

  Pole inspection: See section ***52. Pa. Code § 57.198 (n)(2). Pole Inspections.***
- Purpose

  The objective of an overhead line inspection is to identify and correct hardware or equipment defects that may lead to a future service interruption or pose a safety hazard. Defects are identified by inspection, ranked in order of priority and scheduled for repair.

- Process

  Infrared: Multi-phase distribution lines adjacent to roadways are scanned from vehicles. A roof-mounted infrared camera is employed to capture a thermal image of components carrying electrical current. Heat emission measurements are compared to reference temperatures. Probability of failure is estimated based upon the magnitude of temperature difference from reference. The method detects problems in current carrying components such as transformers, connections, splices, hot line clamps, disconnects, switches, lightning arresters, bridges disconnects, terminators, etc., whether or not there are visible defects. A detailed report of findings is prepared and at-risk items are prioritized and mitigated by repair or replacement.

Visual: An analysis of actual service interruptions is conducted on selected circuits (e.g., poor performing circuits as measured by PPL Electric's WPC process, circuits with higher CEMI customers, and circuits undergoing expanded operational reviews.) If an analysis indicates a pattern of equipment failure exists, a visual line inspection is scheduled. In addition to looking for visible defects in current-carrying components, visual inspection looks for mechanical defects in anchors, guys, crossarms, insulators, offset brackets, grounding systems and poles.

Pole Inspection: As an integral part of the ten-year pole inspection process, the wood poles are observed, with at-risk conditions of all pole attachments, specifically crossarms, braces, conductors, transformers, fuse cutouts, lightning arresters, reclosers, regulators, capacitors, switches, wildlife protection, vegetation encroachment, guys, anchors, ground wires and rods noted and reported.

- Justification for waiver

PPL Electric hereby proposes a continued deviation from the 1-2 year inspection cycle on the basis of an effectiveness evaluation and cost benefit analysis in favor of the program described herein. Resources that would be applied to shorter visual cycles than this proposal would reduce the resources applied to other more cost-effective reliability programs described in this plan.

PPL Electric conducted a trial of infrared inspections of multi-phase lines in 2006. The trial inspections cost $122,500 and identified repairs costing $100,000, saving an estimated 1,460,000-2,600,000 Customer Minutes Interrupted ("CMI"), at a cost of $0.09 to $0.15 per CMI saved. PPL Electric restructured the infrared service contract gaining further efficiencies in 2014. The cost benefit as calculated by the 2018 program effectiveness review suggested that the two programs, at a yearly cost of $327,000, save an estimated 719,000 CMI, at a cost of $0.45 per CMI saved.

PPL Electric employs a $2.00 per CMI saved cost threshold[2] as a principal criteria for evaluating new projects for inclusion in the portfolio of reliability programs. Costs below that threshold are generally considered to be prudent investments, while those above typically provide less benefit for the cost. The cost threshold assists in applying finite resources to programs producing better results, thus enabling the most effective portfolio of programs. Because infrared costs per CMI saved are well below the threshold, PPL Electric instituted a two-year infrared cycle for accessible multi-phase lines.

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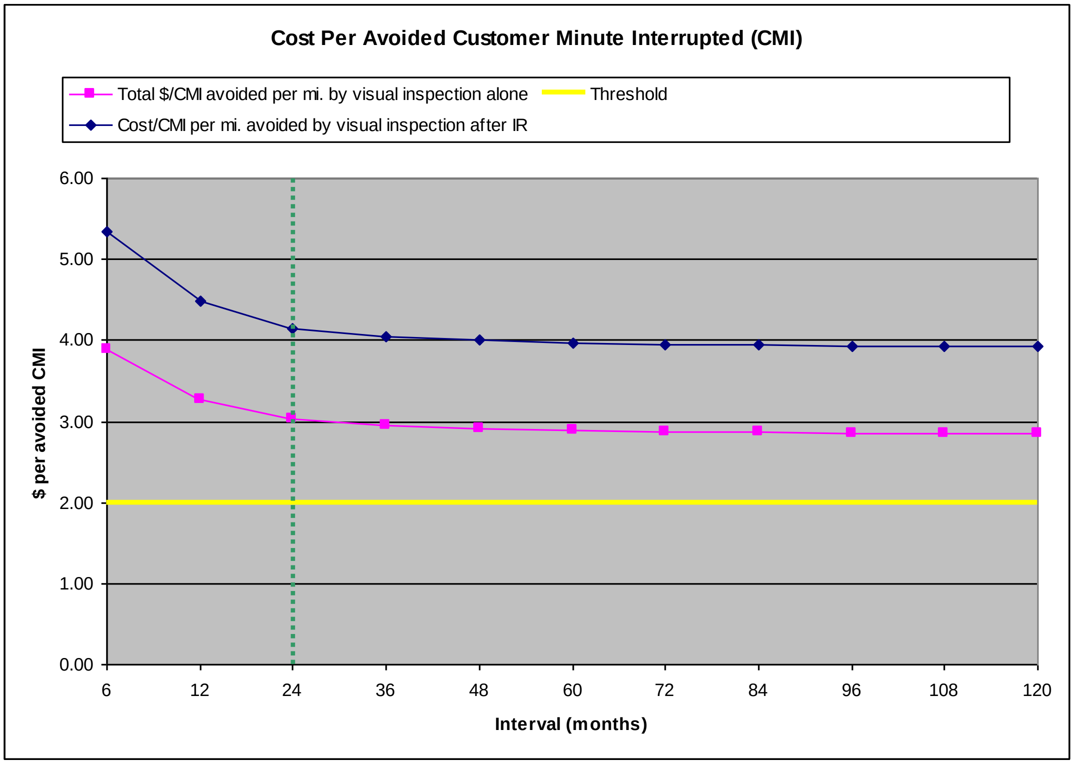
[2] Cost threshold recommended by Richard E. Brown, Sr. Vice President and co-founder of Quanta Technology, a firm specializing in technical and management consulting for utilities. Dr. Brown has provided consulting services to most major utilities in the U.S. Dr. Brown has published more than 90 technical papers related to asset management and is the author of Electric Power Distribution Reliability, CRC Press, 2009.

PPL Electric also conducted an overhead line visual inspection cost benefit study in 2010. The study calculated a reliability benefit as a probability that inspections and the associated repairs will reduce equipment failure service interruptions. The overall probability is the product of (a) the probability that an equipment failure service outage is preceded by a visible condition, (b) the probability that the visible condition exists at the time of inspection, (c) the probability that an existing condition is detected and (d) the probability that the condition is repaired before a service interruption occurs. For seven of the thirteen overhead distribution component codes, actual inspection data established little likelihood of visible conditions preceding failure. For the remaining six component codes, subject matter experts were surveyed. The resulting probability estimates were applied to actual service outage data to estimate avoided CMI per mile. The inspection and repair cost per mile divided by CMI avoided per mile yielded an estimate of cost per CMI avoided. The graph below shows these costs per CMI for various inspection intervals.

The study also estimated avoided CMI/mile for visual inspections that follow infrared inspections because there is significant overlap between the two methods: infrared identifies both visible and hidden defects in current carrying components, while visual inspection detects only visible defects in electrical and mechanical components. The second graph below shows these costs per CMI for various inspection intervals.

As the graphs below depict, given PPL Electric's reliability parameters, there is no interval for visual overhead inspections that meets the established cost threshold, particularly when performed in conjunction with infrared inspections. Visual inspections alone at two-year intervals are 50% above the threshold; two year visuals done in conjunction with infrared are 100% above the threshold.



Overhead Line Inspection Cost per Avoided CMI

Although universal overhead visual inspections are not cost-effective, targeted visual inspections have more value. In a typical year, less than 15% of the circuits are responsible for 80% of equipment failure CMI. For the period 2002 to 2009, 30% of the circuits were responsible for 80% of equipment failure CMI.

Consequently, PPL Electric employs the condition-based visual inspection approach described above, combined with Expanded Operational Review field checks and overhead inspections in conjunction with pole inspections.

PPL Electric Utilities Corporation

Inspection Plan

PPL Electric will inspect multi-phase drivable lines every other year, per the total mileage listed in the chart below.

Distribution Overhead Multi-phase Line Infrared Inspections			
Total Line Miles/Drivable Line Miles[3]	**Line Miles by Region**	**Infrared Inspections Planned** *(Line Miles)*	
		2020	**2021**
PPL Electric Utilities Corporation *(Total System Line Miles: 8,626/8,195)*	Lehigh (1,337/1,270)	635	635
	Northeast (1,446/1,374)	687	687
	Central (1,618/1,537)	768	769
	Susquehanna (1,264/1,201)	601	600
	Harrisburg (1,411/1,340)	670	670
	Lancaster (1,550/1,473)	737	736
	Annual totals	**4,098**	**4,097**

[3] For planning purposes, an assumption that 95% of multi-phase line miles are drivable is employed.

PPL Electric Utilities Corporation

Distribution Overhead Visual Inspections			
	Line Miles by Region	**Estimated Visual Inspections** *(Line Miles)*	
		2020	**2021**
PPL Electric Utilities Corporation *Total System Line Miles (28,094)*	Lehigh (3,469)	390	390
	Northeast (5,190)	540	540
	Central (4,535)	480	480
	Susquehanna (5,769)	600	600
	Harrisburg (4,822)	510	510
	Lancaster (4,309)	480	480
	Annual totals	**3,000**	**3,000**

52. Pa. Code § 57.198 (n)(5). Inspection failure. *If critical maintenance problems are found that affect the integrity of the circuits, they shall be repaired or replaced no later than 30 days from discovery.*

Corrective Maintenance Description

- Infrared

  Priorities for corrective maintenance are determined by the magnitude of the variance from normal operating temperature.

Distribution Overhead Infrared Inspections Corrective Maintenance		
	Variance from Normal Operating Temp.	**Days Allowed After Report Receipt for Service**
Secondaries	+20-60^{o} C	8 weeks
	> +60^{o} C	2 weeks
Disconnect Switches	+20-60^{o} C	8 weeks
	> +60^{o} C	2 weeks
All Other Facilities	+10-40^{o} C	8 weeks
	> +40^{o} C	2 weeks

- Visual

  The urgency for repairs is determined and an appropriate order of priority is assigned from four categories (Emergency, Priority, Unsatisfactory, and System Improvement) described below.

Distribution Overhead Visual Inspections Corrective Maintenance	
Definition	**I&M Standard**
Emergency; Defects which: (1) Threaten the safety of the public or employees; or (2) Will cause a service interruption at any moment Scheduling Priority: 1	Corrective Action taken Immediately
Priority; Defects with a high probability of causing a service interruption if not corrected promptly. Scheduling Priority: 2	Corrective Action must be taken within 30 days.
Unsatisfactory; Defects with a lower probability of causing a service interruption if not corrected promptly. Scheduling Priority: 3	Corrective action must be taken within 3 months.
System Improvement; Conditions which could be altered to improve service reliability, with no immediate reduction of risk of service interruption. Scheduling Priority: 5	Corrective action may or may not be taken.

PPL Electric Utilities Corporation

52. Pa. Code § 57.198 (n)(6). Distribution transformer inspections. *Overhead distribution transformers shall be visually inspected as part of the distribution line inspection every 1-2 years. Above-ground pad-mounted transformers shall be inspected at least as often as every 5 years and below-ground transformers shall be inspected at least as often as every 8 years. An inspection must include checking for:*

(i) Rust, dents or other evidence of contact.
(ii) Leaking oil.
(iii) Installation of fences or shrubbery that could adversely affect access to and operation of the transformer.
(iv) Unauthorized excavation or changes in grade near the transformer.

Program Description

- Cycle

  Overhead: Overhead transformers are inspected as part of overhead visual line inspections, infrared inspections, and pole inspections. Additionally, load profiles are analyzed to identify and remedy overhead transformer locations that have consistent load demands exceeding design parameters.

  Pad-mount and below-ground: Inspections are scheduled when indicated by circuit performance and confirmed by an analysis of actual service interruptions that identifies underground failures addressable by visual inspection.

  Pad-mount and below-ground transformers may be inspected as part of the underground residential development cable testing, replacement and curing program, which tests approximately 500-600 sections per year and cures approximately 600-800 sections per year.

  During 2012, PPL Electric performed a pilot of single phase pad-mounted transformer inspections of some of the older underground residential developments. The result was that, apart from some minor rusting, the conditions of the pad-mount transformers were in good working condition. These transformers were generally reliable so a formal inspection program would add little reliability benefit for excessive costs to the customer as outlined in the justification.

- Purpose

  The objective of a transformer inspection is to identify and correct hardware or equipment defects that may lead to a future service interruption or pose a safety hazard. Defects are identified by inspection, ranked in order of priority and scheduled for repair.

- Process

  Overhead and underground transformers are visually inspected for damage (rust, dents, cracks, locking devices, broken bushings, etc.), integrity of connections and leaks. In addition, pad-mounts and below-ground transformers have cables and elbows inspected for deterioration, foundations and covers inspected and animals, nests, cobwebs and vegetation removed.

- Justification for waiver

  PPL Electric hereby proposes a continued deviation from the fixed inspection cycle for transformers in favor of the condition-based inspection program described herein.

  The overhead line inspection cost benefit study described previously estimated that about 20,000 CMI annually could be saved via visual overhead transformer inspections. In 2016, the estimated cost to inspect those transformers every two years was $1.3 million or $65 per CMI avoided, well above the threshold employed by PPL Electric of $2.00 per CMI saved for identifying prudent reliability investments.

  Similarly pad-mount transformers only contribute 500,000 CMI on average to overall system reliability. An inspection and maintenance program for transformer condition would cost millions in expense for little improved reliability over other underground reliability improvement programs.

  Resources that would be applied to shorter cycles than this proposal would reduce the resources applied to other more cost-effective reliability programs described in this plan.

52. Pa. Code § 57.198 (n)(7). Recloser inspections. *Three-phase reclosers shall be inspected on a cycle of 8 years or less. Single-phase reclosers shall be inspected as part of the EDC's individual distribution line inspection plan.*

Program Description

- Cycle

  PPL Electric has initiated an upgrade program to replace all three phase oil circuit reclosers ("OCRs") with vacuum circuit reclosers ("VCRs") based upon a review of the dominant failure modes and causes. The newer technology replaces oil with a vacuum as the interrupting media. This eliminates the OCR maintenance issues of carbonized oil, contact deterioration and the timing issues that sometimes occur with OCRs. In addition, the communication capabilities of the devices allows for PPL Electric to track data pertaining to the asset health which will allow PPL Electric to do condition based maintenance on these devices. PPL Electric received approval from the commission on January 3, 2014 to complete these replacements on a 10-year cycle starting in 2015.

Three-phase VCRs are subjected to infrared inspection on the same 2-year cycle as OCRs.

Three-phase OCR: 2-year infrared; 10-year replacement.

Single-phase OCRs: inspected as part of PPL Electric's distribution line inspection program.

- Purpose

The purpose of the recloser replacement program is to ensure the reliable operation of reclosers by replacing deprecated equipment with new installations.

- Process

Three-phase oil and vacuum reclosers are included in the two-year infrared line inspection program.

Three-phase OCRs are replaced with new communicating VCR units based upon installation date and type.

- Justification for waiver

PPL Electric hereby proposes a continued deviation for reclosers in favor of the program described herein.

A recloser's function is to isolate faults while minimizing the number of customers affected by permanent service outages. Visual inspection of an OCR provides relatively little useful information about the unit's capability to perform its function compared to testing. Testing in place would require almost all of the same steps that are involved in replacement. Bench testing is preferable to testing in place and refurbishment requires the unit's removal from service. With the planned installation of these communicating vacuum units, the devices have a longer life expectancy, and inspections can be planned.

As PPL Electric has been replacing older oil reclosing three phased units, reliability has improved from the decreasing number of failed units. In addition, PPL Electric experienced close to a 50% improvement in reliability within the initial smart grid pilot area.

Replacement Plan

Actual scope is determined annually based upon the number of OCRs on the system, age, and model type of OCR. The projections below are tentative until replacement recommendations are provided.

Distribution Three Phase OCR Replacements			
	Area *(Number of Three Phase OCRs)*	**OCR Replacements Planned**	
		2020	**2021**
PPL Electric Utilities Corporation *Total Three Phase OCRs (473)*	Lehigh (94)	10	10
	Northeast (117)	12	12
	Central (101)	11	11
	Susquehanna (53)	6	6
	Harrisburg (51)	5	5
	Lancaster (57)	6	6
	Totals	**50**	**50**

52. Pa. Code § 57.198 (n)(8). Substation inspections. *Substation equipment, structures and hardware shall be inspected on a cycle of 5 weeks or less.*

Program Description

- Cycle

	Visual	**Infrared**
Distribution- Supervisory control and data acquisition ("SCADA") Controlled	Quarterly	Annual
Distribution-Non SCADA	Quarterly	Annual

- Purpose

  Periodic substation inspections verify the integrity of station physical security, record and correct any security breaches, verify the proper fluid levels and gas pressures, and identify any leaks, verify the proper operation of essential station equipment and initiate any necessary corrective actions.

- Process

  Inspection of substation equipment and recording abnormal conditions of the equipment. Equipment inspected includes, but is not limited to:

  - Power transformers
  - Circuit breakers
  - Auxiliary equipment
  - Batteries and chargers
  - Control house
  - Yard and perimeter

- Justification for waiver

In 2017, PPL Electric was granted a deviation from the five-week inspection cycle for substations in favor of the quarterly program described herein.

From 2016-2018, PPL Electric estimates that a yearly average of 826k CMI was avoided through repairs identified via the monthly substation inspection. The costs of inspection plus repair averaged $1.24 million per year, or $1.50 per CMI avoided, which is under the threshold employed by PPL Electric of $2.00 per CMI saved for identifying prudent reliability investments.

PPL Electric plans to have SCADA at every substation, which provides real-time telemetry of potential issues. As of August 2018, PPL Electric has SCADA installed in 352 of the 353 total substations. The relay packages provide advanced health information about the breakers and signal when maintenance is required, negating the need for visual inspections of these assets. PPL Electric implemented an upgrade to the data historian software which allows the Company to be automatically alerted when substation abnormalities are detected, and automatically calculate remaining life on smart assets when operations occur.

Over the last four years, none of the repairs scheduled due to the monthly inspections have been critical repairs due to imminent failure risk. The repairs have been minor, and could have waited 90 additional days to be identified.

Resources that would be applied to shorter cycles than this proposal would reduce the resources applied to other more cost-effective reliability programs described in this plan.

Inspection Plan

Distribution Substation Visual Inspections			
	Area *(# of Substations)*	**Inspections Planned**	
		2020	**2021**
PPL Electric Utilities Corporation *Total Substations 361*	Lehigh (63)	252	252
	Northeast (58)	232	232
	Central (69)	276	276
	Susquehanna (50)	200	200
	Harrisburg (60)	240	240
	Lancaster (61)	244	244
	Totals	**1,444**	**1,444**

Appendix A: Transmission Programs and Procedures

Program	**Activity**
Helicopter Inspections – Stop-go	Aerial linemen perform annual routine transmission line patrols from a helicopter. They identify damaged or deteriorated equipment and any apparent vegetation issues. Engineers review the findings and develop plans for repair, replacement or remediation.
Helicopter Inspections – Comprehensive	Aerial linemen perform an overhead comprehensive inspection of transmission line facilities on a four-year or eight-year cycle. Detailed condition reports with close-up digital photos are prepared for each specific component problem found along the transmission line and right-of-way. Engineers review the findings and schedule corrective maintenance as needed.
Helicopter Inspections – Emergency	Aerial linemen perform patrols of transmission lines that operate abnormally. This inspection focuses on identifying damage that may have been caused by lightning, inclement weather, equipment failure or vandalism. Because of the nature of this work, corrective actions generally are expedited.
Steel Structures – Inspection, Treatment, Replacement, Reinforcement/Repair	Steel transmission structures are examined and measured for the degree of decay and deterioration. Any issues identified by the inspection are then categorized with a priority rating and are scheduled for follow-up actions based on the criticality. Follow-up actions may include remediation or replacement of steel members or foundations to extend the life of the asset.
Equipment Maintenance	During helicopter and foot patrols, equipment and facilities are identified that require repairs. Based on need and criticality, repairs are either scheduled or completed as soon as possible. Repairs are either completed by line crews or aerial line crews to ensure efficient and effective repairs.
Line Switches – Maintenance and Inspection	Line personnel inspect, maintain and perform operational tests on 138kV and 69kV line air break switches on an as-needed basis to assure proper operation. Corrective action is taken as needed.
Line Switch Upgrades	Line personnel install lightning arresters on 138kV and 69kV line switches to increase system reliability. Existing parallel break air breaks and load sectionalizing air breaks are being upgraded to motor operated load break air breaks to improve switching capabilities, outage restoration times, and sectionalizing ability. Corrective action is taken as needed.

PPL Electric Utilities Corporation

Program	Activity
Circuit Analysis	Engineers analyze circuit loading and performance to identify areas needing increased line capacity or improved line reliability. Circuits are also reviewed based on operational performance and ranked yearly in a WPC list, with appropriate circuits identified for targeted reliability improvements.

Appendix B: Substation Programs and Procedures

Program	**Activity**
Load Survey	Automatic monitoring devices such as SCADA provide continuous, real-time loading information. Engineers review equipment loading and identify facilities and transfer capabilities approaching capacity limits. A portion of the load may be supplied from a different source, the existing facilities may be upgraded, new lines and equipment may be added, or a new substation may be built to address capacity deficiencies.
Substation Inspection/Repair	Electricians inspect substations for security and equipment reliability on a time-based maintenance cycle. They identify and correct potential equipment problems before a failure or service interruption occurs.
Equipment Service	Electricians perform operational tests on power transformers, load tap changers ("LTC"), voltage regulators, circuit breakers, circuit switchers, vacuum switches, air break switches and transformer protective switches on a time-based maintenance cycle to assure that equipment is operating within established parameters. Equipment serviced includes batteries, battery chargers, protective relays, high voltage fuses and high-speed automatic grounding switches. Depending on the type of equipment, "service" can include actions other than operational testing.
Inspection and Condition Assessment	Electricians inspect and perform condition assessments of circuit breakers, wave traps, ground switches, stick-operated disconnects, gang-operated disconnects and motor-operated disconnects on a time-based maintenance cycle to assure proper operation. Corrective action is taken as needed.
Insulation Testing	Technicians perform power factor testing on power transformers, potential transformers, lightning arresters, current transformers, select circuit breakers and power cables on a time-based maintenance cycle. Testing also includes other instrument transformers (capacitance coupled voltage transformer, coupling capacitors, potential devices, etc.). They also perform high-potential testing on12kV oil, air and vacuum circuit breakers to assure proper operation.

Program	Activity
Condition Monitoring of Station Equipment	Electricians/Technicians perform dissolved gas-in-oil analysis, dielectric, and physical properties oil tests for oil in power transformers, and impedance and select capacity tests on station batteries, to assure equipment is within normal parameters. Periodically, AC power factor tests, hi-potential tests, contact resistance tests and motion tests are performed on circuit breakers. Oil dielectric testing is conducted for oil circuit breakers.
Thermographic Inspections	Electricians perform infrared surveys of substation facilities to identify components operating at elevated temperature. Based on the findings, engineers develop plans to repair or replace the component(s) prior to failure.
Minor Improvements	Maintenance activities may identify conditions where additions or upgrades are needed to assure reliability. Engineers evaluate the need and develop action plans and schedules to complete the work.
DC Station Service Improvements	Repairmen and Testing identify deteriorated station batteries, battery chargers and battery components. Engineers schedule repair or replacement as necessary.
Capacitor Bank Protection	Engineers monitor the need for synchronous closing schemes on vacuum switches on 69kV capacitor banks. They plan and schedule installations as needed.
Area/Regional Supply	Engineers develop specific projects aimed at improving capacity shortfalls, or replacing deteriorated or substandard station equipment.
SCADA Replacement	Engineers identify deteriorating substation SCADA equipment and develop plans to repair or replace it.

Appendix C: Distribution Programs and Procedures

Program	**Activity**
Load Survey – of equipment that is not continuously monitored	Line personnel measure the loading of facilities during peak periods. Engineers use this data for system studies.
Load Survey – by automatic monitoring devices	Automatic monitoring devices such as SCADA provide continuous, real-time loading information. Operators use this data to assure that loads do not exceed design limits. Engineers use this data for system studies.
Circuit Analysis	Engineers analyze circuit voltage profiles to balance loads and to identify areas requiring voltage support to maintain required voltage at the customer's facility.
Capacitor – Inspection and Maintenance	Line personnel inspect and maintain associated electronic control equipment to assure proper operation. Line personnel repair or replace any defective equipment.
Voltage Regulator – Inspection and Maintenance	Line personnel inspect existing equipment for potential failure, and inspect and maintain controls and tap changers to assure proper operation. Line personnel repair or replace any defective equipment.
Overhead Line Switch – Inspection and Maintenance	Line personnel inspect switch installations to identify cracked or broken insulators / bushings, stuck or misaligned blades, insulation or gasket deterioration or other operational problems. Line personnel repair or replace any defective equipment.
Transformer Maintenance	Engineers analyze customer usage data to identify overloaded transformers. Transformers that are heavily loaded are replaced with higher capacity units or portions of the load are transferred to other nearby transformers.
Wood Pole – Inspection, Maintenance, Reinforcement, Replacement	Wood poles are examined for deterioration and the degree of decay is measured. Based on the results, the pole may be treated with preservative to extend its life, treated and reinforced for extended life or replaced.
Overhead Line Inspection	Line inspection personnel examine overhead facilities to identify damaged, deteriorated or substandard equipment. Line personnel repair or replace any defective equipment.

Program	Activity
Circuit Performance Review	Engineers use PPL Electric's WPC score to ascertain the need for additional circuit reviews or inspections. The improved index looks at a circuit's overall impact to system SAIDI. Actual service interruption history is analyzed to identify causal or geographic patterns.
Underground Primary Cable – Testing, Maintenance, Replacement, Curing	Line personnel perform insulation and neutral tests on cable in residential developments with potential problems to identify deteriorated cable. Based on the results, the cable is placed back in service, repaired or replaced.
LTN Maintenance	Electricians inspect, service, maintain and overhaul LTN vaults, manholes, cables, transformers, low-voltage network protectors and primary transformer disconnect switches. Based on results, defective equipment is either repaired or replaced.
Public Damaged Facilities Review	A program aimed at identifying the locations of facilities that have been damaged by public contact more than once. Technicians evaluate those installations and, if relocation is deemed appropriate, schedule work to move the facilities.
Underground Service Cable	Engineers resolve customer service problems that are due to deteriorated underground service conductors.
Oil Circuit Reclosers	Line personnel replace in-service oil circuit reclosers on a time-based maintenance cycle. Removed units are tested, and may be refurbished and placed in inventory.
Line Protection Equipment	Line personnel replace in-service three phase oil circuit reclosers with communicating vacuum devices on a time-based maintenance cycle.
Capacitor and Voltage Regulator Installation	Engineers perform voltage profiles to determine the need, location and size of any new voltage support equipment required to maintain adequate service voltage levels at customer facilities and provide needed reactive support for system stability. Line personnel install the required equipment.

Appendix D: Vegetation Applications

Program	**Activity**
Tree Pruning	Tree pruning is scheduled based on field conditions observed and/or a system prioritization process. All pruning is done in accordance with American National Standard for Tree Care Operations-Tree, Shrub and Other Woody Plant Maintenance – Standard Practices (ANSI A300).
Hazard Tree Removal	Trees located outside the right-of-way that represent a threat to line performance/ safety are removed when it is feasible to do so.
Herbicide Application	Tall-growing, undesirable vegetation growing within the right-of-way corridors is selectively treated with herbicides. Low-growing vegetation that does not represent a hazard to the safe, reliable operation of PPL Electric's facilities is preserved wherever possible.
Reclearing	Tall-growing, undesirable vegetation growing within the right-of-way corridors is selectively removed in those situations where herbicides cannot be utilized. Low-growing vegetation that does not represent a hazard to the safe, reliable operation of PPL Electric's facilities is preserved wherever possible.

ADDENDUM-2

PPL Electric Utilities Corporation

Biennial Inspection, Maintenance, Repair and Replacement Plan of PPL Electric Utilities Corporation

For the Period of January 1, 2022 – December 31, 2023

Submitted by:

Dave Gladey
Director – Distribution Asset Management and Engineering
Two North Ninth Street
Allentown, PA 18101
(610) 774-6580
dlgladey@pplweb.com

Dated: April 30, 2021~~October 1, 2020~~

PPL Electric Utilities Corporation

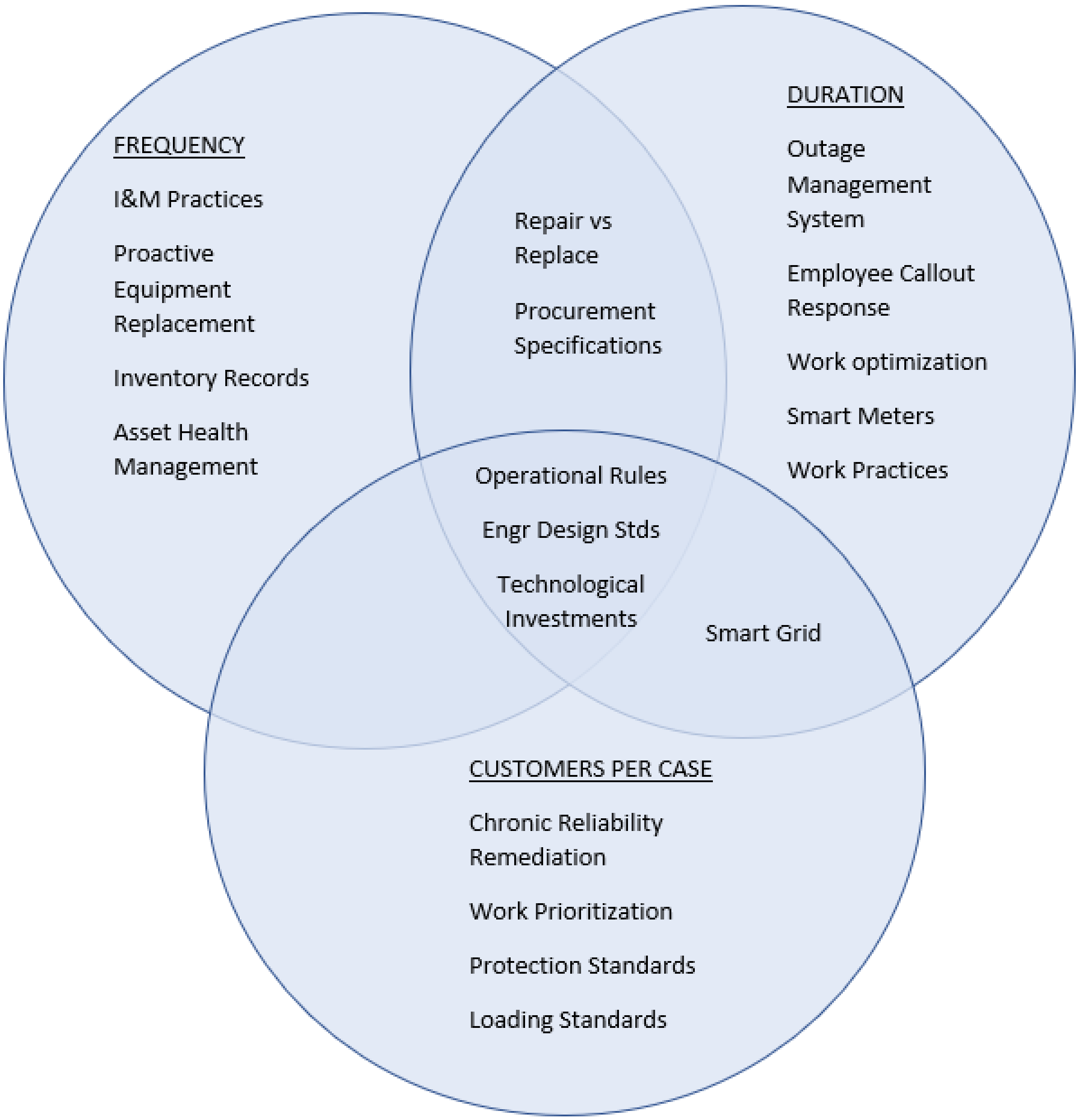
Table of Contents

Introduction

PPL Electric Utilities Corporation ("PPL Electric" or "Company") is firmly committed to maintaining high levels of customer satisfaction. Customer surveys show that high levels of customer satisfaction are achieved by providing reliable performance at a reasonable cost. PPL Electric has established a strong, long-term record of customer satisfaction and electric reliability. PPL Electric has earned 26 J. D. Power customer satisfaction awards – more than any other investor-owned utility in the country – since J. D. Power began studying customer satisfaction among electric utility customers. PPL Electric has ranked highest among large electric utilities in the eastern United States in J. D. Power annual study of residential customer satisfaction 16 times: in 1999 and from 2001-2007 and 2012-2019.

Ultimately, all of the costs of maintaining reliability are borne by the ratepayers. Therefore, managing finite resources to produce optimal results is essential in order to deliver excellence in customer satisfaction. The criteria for program inclusion is not whether any given activity produces a positive reliability result, but, rather, what portfolio of activities produces the best result for a given expenditure of resources given the specific reliability challenges faced by PPL Electric at this point in time, and for the foreseeable future. PPL Electric's goal is focused on results (i.e., the reliability experienced by customers), not the rote execution of particular tasks.

Reliability performance is driven by a mixture of manageable and unmanageable factors. The most impactful of the unmanageable factors is the frequency and severity of weather events, which can vary dramatically over time and geography. The manageable factors have an effect on service interruption frequency, duration, or number of customers affected, or a combination of all three. The figure below depicts a portfolio of manageable factors with inspection and maintenance ("I&M") practices being one of many.



Reliability Programs and Policies

PPL Electric's philosophy is that the first step in improving reliability is to prevent outages altogether. The primary focus is, therefore, on the manageable factors that reduce the frequency (number) of cases. Efforts that typically overlap are those designed to minimize the number of customers affected should an outage occur. Realizing that not all outages are preventable, PPL Electric also directs rigorous efforts designed to reduce the duration of the outages that do occur. Examples of PPL Electric initiatives addressing each of the three reliability sectors, frequency (number of cases), customers affected per case, and duration are addressed below.

Frequency (number of cases)

- **Inspection and maintenance practices and programs:** PPL Electric remains focused on equipment performance and service interruption avoidance through the application of effective inspection and maintenance practice and programs. A comprehensive discussion has been provided to the Pennsylvania Public Utility Commission ("PUC" or "Commission") via PPL Electric's I&M filing on a biennial basis since the initial report in 2010. The scope of these programs, procedures and activities covers all areas of the electrical infrastructure to include transmission, substations, distribution, and vegetation.

Transmission
Transmission inspection programs include aerial patrols and structure inspections, treatments, and replacements. The patrols focus on comprehensive inspections, routine inspections, stop-go inspections, and identification of emergency work. The inspections encompass all equipment, including poles, arms, line switches, interrupters, arresters, grounding, guying, anchors, and other key transmission components.

Substation
Substation maintenance programs include inspections, condition testing, and preventative maintenance of equipment, such as power transformers, circuit breakers, disconnects, power cables, and security equipment. Some equipment is maintained on a time basis; other equipment is condition monitored. These two methods help ensure that maintenance work is performed in a timely manner. In addition to time and condition-based maintenance, thermographic inspections help to ensure that substation equipment does not operate at elevated temperature levels, which could lead to premature failures.

Distribution
Distribution encompasses many maintenance aspects similar to transmission and substations, and also includes load surveys that assist in determining peak load requirements, and circuit analyses that help identify lines requiring maintenance work, voltage relief, or other capital improvements. Overhead line inspections identify the weak links in the system so that damaged or deteriorated equipment can be repaired or replaced. In addition, distribution maintenance includes inspections of poles, voltage regulators, line switches, capacitors, and other key distribution equipment. PPL Electric also tests underground cable for integrity to determine if the cable needs to be replaced or repaired.

Vegetation
The vegetation on PPL Electric's transmission and distribution rights-of-way is maintained using a combination of several management techniques. These include

reclearing, ground-to-sky trimming, hazard tree removal, tree pruning, and herbicide application. The work is prioritized based on the conditions observed and past performance.

Each of these programs is more fully described in Appendices A through D.

- **Asset Optimization Strategy ("AOS"):** Since 2018, PPL Electric has developed several data-driven failure probability models based on relevant failure modes. These data model projects were initiated to drive smarter, targeted asset investment strategies throughout the portfolio and to address the challenges created by the Company's aging infrastructure. As a result, several asset investment strategies across multiple asset classes have been revised to address these challenges. PPL Electric conducts effectiveness reviews of the various programs comprising this strategy to ensure that aging infrastructure continues to be appropriately addressed.

- **Asset Health Assessment:** PPL Electric is continuously expanding its use of data-driven decision making. Where feasible, asset health and criticality scores are captured and employed to refine programs to deliver the most effective reliability impact per dollar invested. PPL Electric continuously monitors the accuracy and effectiveness of these asset health and criticality scores, and in early 2018 began an initiative to develop predictive failure models of vital assets with the intention of continuously improving the health and criticality scores. These continued health calculation efforts enable PPL Electric to mitigate risk and optimize reliability more effectively. Among the areas where health and criticality scores are employed are substation and Low Tension Network equipment, reclosers, and underground cables.

- **Long Term Infrastructure Improvement Plan:** In January 2018, the Commission approved PPL Electric's second Long Term Infrastructure Improvement Plan ("LTIIP"). This Plan was submitted pursuant to the requirements of Subchapter B, Distribution Systems, of the Public Utility Code, 66 Pa.C.S. §§ 1350-1360, and the PUC's Implementation Order for Establishment of a Distribution System Improvement Charge ("DSIC"). The Plan is a continuation of AOS infrastructure replacements in addition to prudent capital investments such as the proactive installation of animal guards, new sectionalizing devices, distribution automation, asset life extension methods, replacement of deteriorated equipment, and capital projects aimed at addressing worst performing circuits ("WPCs").

    Reliability Preservation Program: In 2019, the legacy Customers Experiencing Multiple Interruptions ("CEMI") and MAIFI Programs were combined with the Reliability Preservation Program. This was strategically done to ensure all reliability-based projects were prioritized and addressed together for efficiency and timeliness of remediation. All projects are vetted and prioritized against a common prioritization methodology to ensure consistency and systematic benefits are quantified across the portfolio. Reliability performance of PPL Electric's circuits are reviewed on a quarterly basis to ensure investment plans are optimized.

PPL Electric Utilities Corporation

- **Proactive Circuit Analysis ("PCA"):** PCAs are performed on each circuit on a four-year cycle. The review analyzes and addresses both operational and reliability characteristics of each circuit. Voltage support, phase balancing, protection coordination, power factor maintenance and loading issues are addressed from an operational perspective. Service outage analysis, exposure analysis and field checks address reliability and power quality.

- **Reliability Principles and Practices ("P&P") Revisions:** The P&P sets forth a set of principles that PPL Electric follows to plan, protect, and operate the Electrical Distribution System ("EDS"). These principles are implemented through a set of standard practices that are used as guidelines in designing the EDS. These practices are reviewed regularly to ensure they remain reasonable and acceptable and align well in accordance with good utility practices. Additional revisions to PPL Electric's P&P are underway to reduce the overall impact to our customers as the Company implements smart grid strategies.

Duration (minutes/case)

- **Distribution Automation:** In 2010, PPL Electric launched a "smart grid" pilot project that enables the Company to react rapidly to changes on the delivery system, and to automatically re-route power around problems that occur. The project initially focused on the Harrisburg, Pa. area, but has since been expanded to cover all of our service territory. The project included the implementation of an advanced Distribution Management Systems ("DMS"), which was a breakthrough technology that enables our operators to see the status of our distribution network in real-time. In 2016, PPL Electric completed a system wide rollout of FISR (Fault Isolation and Service Restoration) technology. FISR identifies faulted sections and quickly develops an optimized restoration plan, then automatically executes that plan. Customers typically can be restored within five minutes from the start of the outage. This milestone is an industry first and looks to significantly reduce overall outage durations. Over 8,600 automated smart devices have been installed to date. Such installations allow for remote operation and monitoring of circuit sectionalizing equipment, and advanced fault location technology. The goals of these improvements are threefold:

    - Reduce the number of upstream customers affected by a service outage.
    - Reduce the time necessary to restore customers by transferring circuit sections to alternate sources and limiting long-duration service outages to smaller circuit sections involving fewer customers.
    - Facilitate fault location and reduce the time necessary for repair and restoration.

    The end-result will be a delivery system that operates more efficiently, recognizes problems immediately, and responds in seconds to restore the service for many customers who otherwise need to wait for crews to physically respond to an outage.

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PPL Electric Reliability Results

The reliability planning and investment process employed by PPL Electric have been very effective, as evidenced by its reliability performance. This has been accomplished while preserving a reasonable cost of providing service.

PPL Electric Reliability Planning Process

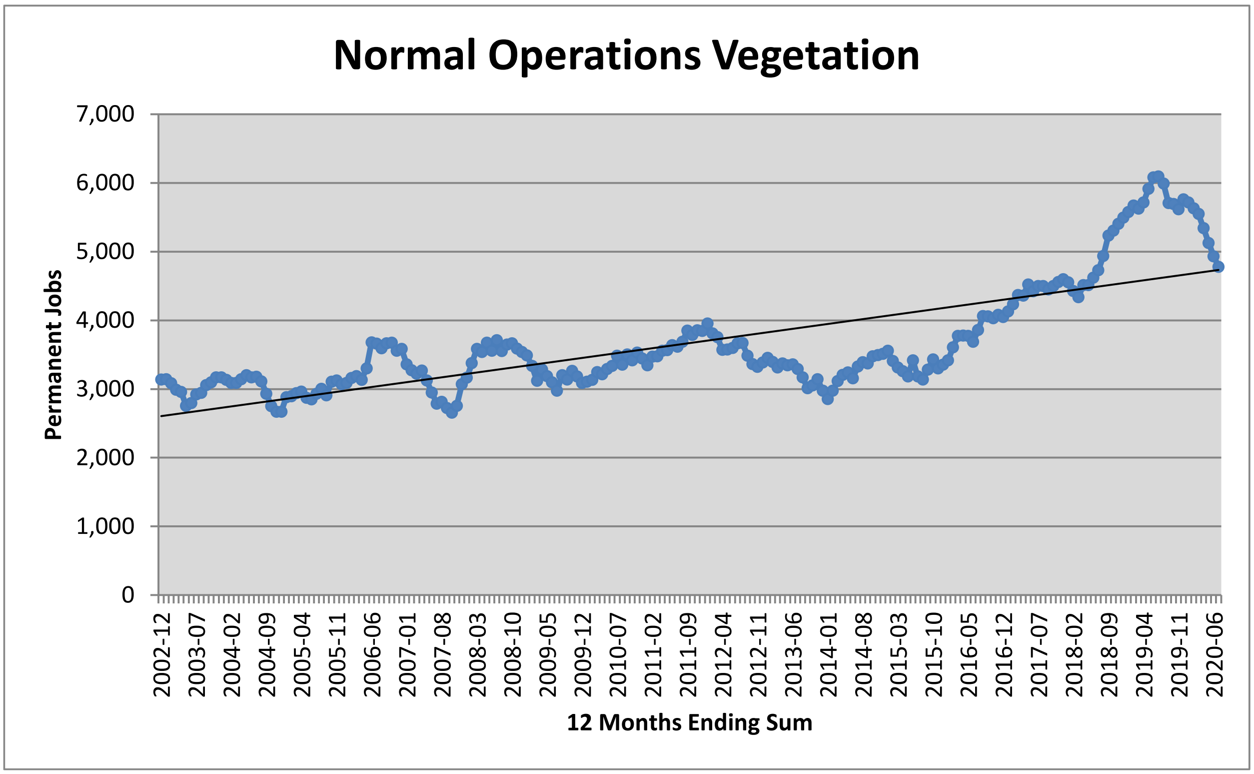
PPL Electric's process is forward-looking and proactive. It consists of the following:

- Analyze the historical trends of causes of service outages and other power service problems.
- Identify the drivers of those trends.
- Forecast future reliability metrics (SAIDI, SAIFI, CAIDI, and MAIFI) given existing mitigation programs' effect on the identified drivers.
- Identify new programs, policies, and activities to add to or substitute for existing mitigation programs to avoid any forecasted gaps between future reliability and the desired levels.
- Identify, evaluate, and implement new technologies that enhance its condition monitoring strategy
- Continually evaluate and adjust programs, policies and activities to produce the desired future results.
- The resulting portfolio of existing and new programs, policies and activities are incorporated into PPL Electric's I&M plan.

PPL Electric Utilities Corporation

PPL Electric Reliability Analysis

Identification and understanding of trends create the opportunity to plan programs to mitigate undesirable trends. Most of the year-to-year variation in service interruptions is explained by differences in storm experience. Therefore, PPL Electric generally removes all declared-storm caused service outages (though not all weather related outages) for internal analysis to identify other causal trends affecting reliability. Each data point in the following charts represents a 12-month ending value to eliminate the effect of seasonal variation.



Vegetation Related Service Interruption Cases

PPL Electric is committed to continuing an aggressive Vegetation Management program to address the threat of tree related outages. It is worth noting that even when excluding major and PUC reportable storm events, 77% of vegetation related outages occur during adverse weather conditions. The strong storms and saturated ground conditions prevalent in 2018 and 2019 resulted in higher than normal occurrences of vegetation outages, including healthy trees toppling into overhead conductor.

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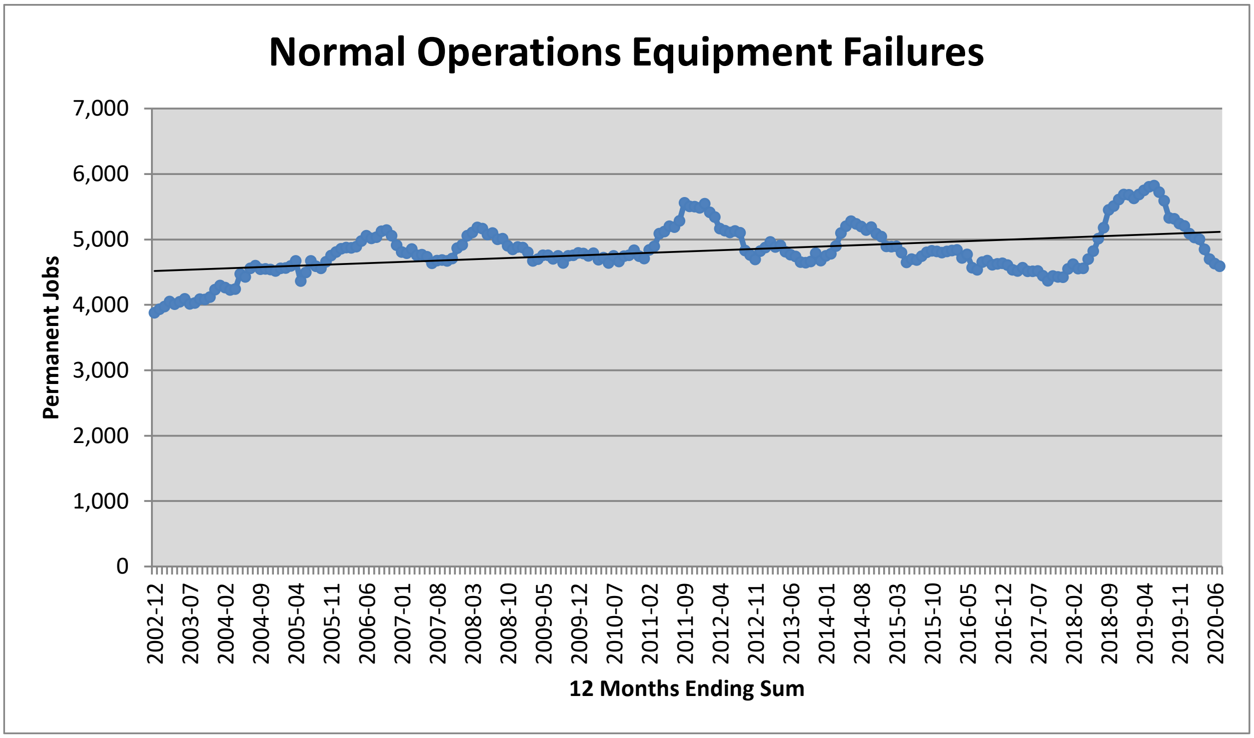
A significant risk to PPL Electric's ability to meet reliability benchmarks is the large portion of distribution facilities, which were installed in the 1960's and 1970's, that are now beyond or nearing the end of their design lifetime. The resultant effect on non-storm-related equipment failure is illustrated by the chart below**.**



Equipment Failure Service Interruption Cases

The annual number of outages due to equipment failure was generally stable or declining from 2005 through 2018. Beginning in July of 2018, a period of severe weather brought about a spike in failed equipment that is just now rolling out of the 12-month rolling window.

Initiatives contributing to the reversal of the failed equipment trend include equipment replacements identified through Expanded Operational Reviews of 25% of circuits annually, aggressive worst performing circuit remediation, implementation of PPL Electric's Asset Optimization Strategy, enhanced pole inspection and treatment, distribution automation, and infrared inspections.

Although these programs have successfully reversed equipment failure growth rates in the short-term, PPL Electric faces a long-term challenge regarding aging infrastructure. PPL Electric is committed to mitigating the aging infrastructure challenge through effective use of proactive replacement programs and data-driven failure probability models. Scheduled replacement of that infrastructure is necessary to avoid accelerating failure rates due to end of life fatigue.

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Reliability is the largest contributor to overall customer satisfaction. Satisfaction levels vary depending upon the amount of information provided to the customer regarding their outage. Providing customers with accurate information about their outage is increasingly important. Customers are more understanding of storm and weather-related service outage impacts than they are of other outage causes, such as utility equipment failures.

If it is more cost-effective to offset an increase in equipment failure cases with a program to reduce vegetation-related cases, the customer is better served by this cost-effective choice. Similarly, if a program that reduces the average number of customers affected by each service outage is more cost-effective than a program to reduce the gross number of service outages, the more cost-effective program should be chosen. The management challenge is to maintain reliability within acceptable parameters in the most cost-effective manner, while keeping customer satisfaction levels high.

52. Pa. Code § 57.198 (b) Plan Consistency. *The plan must be consistent with the National Electrical Safety Code, Codes and Practices of the Institute of Electrical and Electronic Engineers, Federal Energy Regulatory Commission Regulations and the provisions of the American National Standards Institute, Inc.*

PPL Electric's I&M Plan is consistent with the National Electric Safety Code ("NESC"), Codes and Practices of the Institute of Electrical and Electronic Engineers ("IEEE"), Federal Energy Regulatory Commission Regulations ("FERC") and the provisions of the American National Standards Institute, Inc. ("ANSI").

52. Pa. Code § 57.198 (c) Requested Deviations *The plan must comply with the inspection and maintenance standards in subsection (n). A justification for the inspection and maintenance time frames selected shall be provided, even if the time frame falls within the intervals prescribed in subsection (n). However, an EDC may propose a plan that, for a given standard, uses intervals outside the Commission standard, provided that the deviation can be justified by the EDC's unique circumstances or a cost/benefit analysis to support an alternative approach that will still support the level of reliability required by law.*

PPL Electric is again requesting acceptance of the following deviations from the intervals in the Commission standard as were included in the five previous I&M reports (2012-2013, 2014-2015, 2016-2017, 2018-2019, and 2020-2021):

- Section 57.198 (n)(2). Pole Inspections. (vi) A load calculation.
- Section 57.198 (n)(4). Distribution overhead line inspections.
- Section 57.198 (n)(6). Distribution transformer inspections.

PPL Electric is again requesting acceptance of the following deviations from the intervals in the Commission standard as were included in the three previous I&M reports (2016-2017, 2018-2019, 2020-2021):

- Section 57.198 (n)(7). Recloser inspections.

PPL Electric is again requesting acceptance of the following deviation from the intervals in the Commission standard as were included in the two previous I&M reports (2018-2019, 2020-2021):

- Section 57.198(n)(8). Substation inspections.

<u>52. Pa. Code § 57.198 (m) Recordkeeping(m)</u> *An EDC shall maintain records of its inspection and maintenance activities sufficient to demonstrate compliance with its distribution facilities inspection, maintenance, repair and replacement programs as required by subsection (n). The records shall be made available to the Commission upon request within 30 days. Examples of sufficient records include: (1) Date-stamped records signed by EDC staff who performed the tasks related to inspection. (2) Maintenance, repair and replacement receipts from independent contractors showing when and what type of inspection, maintenance, repair or replacement work was done.*

Inspection and maintenance activities performed by PPL Electric employees are tracked by electronic work requests in the Company's Work & Asset Management System (WAM) software application which date-stamps transactions and captures an electronic signature of the employee certifying completion.

Inspection and maintenance activities performed by PPL Electric contractors are documented with itemized records, which identify when and what type of work was performed, before invoices for the work are paid.

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52. Pa. Code § 57.198 (n)(1). Vegetation Management. *The Statewide minimum inspection and treatment cycle for vegetation management is between 4-8 years for distribution facilities. An EDC shall submit a condition-based plan for vegetation management for its distribution system facilities explaining its treatment cycle.*

Program Description

PPL Electric employs a condition-based five-year inspection and maintenance cycle for its distribution circuits where trimming, hazard tree removals and brush control are performed. All Transmission lines have two complementary condition-based maintenance programs performed on four-year cycles. One focuses on herbicide application to manage vegetation on the floor of the corridor and the other focuses on trimming along the edge of the corridor. Inspections for and removals of hazard trees occur on both cycles. Each program is offset by two years, so each line receives a physical inspection and maintenance every two years. Additionally, an aerial LiDAR inspection is performed annually to verify clearances of vegetation from Transmission facilities. Based on conditions the cycle schedule may be modified, but not beyond established regulations.

- Purpose

To safeguard the reliability of its electric distribution system, PPL Electric has developed a comprehensive program to manage vegetation around power lines. Keeping trees and other vegetation away from high-voltage lines is important. Tree contacts can result in short-circuits and subsequent service outages.

Taller species of trees that are permitted to grow under power lines eventually will contact the wires, causing service interruptions and unsafe conditions. It is necessary for PPL Electric to trim or remove these trees to continue safe and reliable electric service.

- Process

Distribution

Multi-phase lines will be pruned to the full extent of the established tree line, not to exceed 25’ from centerline and ground to sky pruning will be utilized.

Single-phase lines will be pruned to the full extent of the established tree line, not to exceed 15’ from centerline and to a distance of 15’ above the line. All dead or structurally weak limbs which could fall or blow into the conductor are removed regardless of their distance above the conductor.

Exceptions: Trees on the opposite side of any thoroughfare, where normal line construction exists (not alley arms), should be considered for proper lateral pruning using the centerline of the thoroughfare as a guideline. Fast growing tree species may need more aggressive pruning.

Another enhancement is hazard tree removal. “Hazard trees” are those trees outside the right of way that may be leaning, diseased, or otherwise pose a threat of falling on a distribution line. PPL Electric bears all costs of removing hazard trees and conducts the removal either based on right of way agreements or with property owner permission.

Transmission

PPL Electric Utilities operates thousands of miles of high-voltage transmission lines. The Company’s vegetation management program is designed to promote the safe and reliable operation of the electric grid, while considering the concerns of property owners and our obligations to electric customers. Low-growing grasses and other compatible species are permitted within the wire zone. In the remainder of the right-of-way, certain compatible trees and shrubs are allowed if they do not pose a reliability risk.

52. Pa. Code § 57.198 (n)(2). Pole Inspections. *Distribution poles shall be inspected at least as often as every 10-12 years except for the new southern yellow pine creosoted utility poles which shall be initially inspected within 25 years, then within 12 years annually after the initial inspection. Pole inspections must include:*

(i) Drill tests at and below ground level.
(ii) A shell test.
(iii) Visual inspection for holes or evidence of insect infestation.
(iv) Visual inspection for evidence of unauthorized backfilling or excavation near the pole.
(v) Visual inspection for signs of lightning strikes.
(vi) A load calculation.

Program Description

- Cycle

  Every twelve years.

- Purpose

  Distribution poles are inspected to identify and measure the extent of decay and defects that may adversely affect safety or service reliability.

- Process

  ~~PPL Electric conducts a full excavation program, in which each pole over the age of twenty-five years that is not set in concrete, asphalt or with a riser is fully excavated to a depth of 18 inches. The pole is inspected visually, sounded and bored above ground in addition to the full excavation. All measurable decay is entered into the contractor's engineering-based software program to determine the percentage of remaining strength, taking into consideration ANSI and NESC standards. Poles younger than twenty-five years are visually inspected only.~~

  ~~Based upon the inspection and testing results, the pole is treated with a preservative, reinforced (by truss or fiber wrap) or replaced.~~

  PPL Electric visually inspects all poles on a 12-year frequency and conducts a drill test at and below ground line for poles greater than or equal to 26 years of age. Safe drill testing below the ground line, in some cases, may be prevented by the location and obstructions on the pole. When drill testing is required, it is performed by methods including, but not limited to, a resistance drill test at and below the ground line or a standard industry sound and bore test with below grade excavation. Based on the drill testing, applicable measurements including all measurable decay are entered into an engineering-based program to determine the percentage of remaining strength, taking into consideration ANSI and NESC standards. A visual inspection is performed to identify holes or evidence of animal damage including insect infestation, evidence of unauthorized backfilling or excavation near the pole, mechanical damage and lightning strikes. Based upon the inspection and testing results, additional actions at the pole may include treatment with a preservative, reinforcement (by truss or fiber wrap) or replacement.

Discussion of the reasons for the proposed change:

PPL Electric's proposed change identifies an additional method of drill testing to be included in PPL Electric's pole inspection program. A resistance drill test uses "smart drill" technology that can sense decays or voids in the wood poles based on resistance of a drill bit. It also permits drilling on an angle, which enables PPL Electric to conduct drill tests below the ground line as required by the regulation and where obstructions would otherwise prevent safe drill testing, such as poles embedded in concrete or other hard surfaces. It is PPL Electric's experience that traditional sound and bore testing has limitations in consistently being able to determine a pole's health and remaining structural strength. As a result, PPL Electric expects to be able to significantly increase drill testing to determine pole decay on the majority of its poles with greater accuracy and consistency beyond the limitations of traditional sound and bore testing that PPL Electric experiences in today's pole inspection program. This change in how PPL Electric conducts its drill testing and determines a pole's remaining strength will improve its ability to manage the pole's health and limit pole failures as a result of decay.

- Justification for waiver

PPL Electric's pole inspection program generally complies with the intervals set forth in 52. Pa. Code §57.198 (n)(2), NESC rules and is consistent with industry practices. PPL Electric proposes a continuance of the deviation from the requirement for a load calculation to be performed for each pole inspected. The design of PPL Electric's lines is based on its Distribution Engineering Instructions which are based upon NESC heavy loading conditions. These instructions provide adequate safety factors such that the allowable percentage of strength reduction does not compromise the ability of the pole to support the load. PPL Electric requires entities attaching facilities to its poles to perform their own load calculations before making the attachment. Load calculations are performed on every pole where new attachments are requested by third parties.

PPL Electric does not track service outages caused by pole equipment failure as a discrete category. Poles are contained within a category that includes poles arms, brackets, guys, push braces, pole top extensions and any other mounting hardware. In 2017, equipment failures requiring replacement in this category amounted to 374 (7.6% of total cases), of which only a small fraction are poles. Excluding pole fires, only 9 cases (0.3% of total cases) suggest broken PPL Electric-owned poles. (Nine poles represent 1/1000 of one percent of PPL Electric's 885,000 wood distribution pole inventory.) Most of the limited numbers of pole failures are aggravated by weather conditions such as trees being blown into lines, so the potential risk reduction through a load calculation is insignificant.

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Beginning in 2010, the Company's wood pole maintenance program was enhanced from an inspection-only process to an inspection and treat program, whereby all poles passing the inspection are chemically treated to arrest decay at the same visit. The preservative treatment permits the next inspection to be at a uniform twelve years, rather than the former one to nine-year cycle after original inspection applied to individual poles. Changing to a uniform twelve-year cycle will enable more economic geographic-based inspections where all poles in a defined area are inspected, rather than the current method of inspecting scattered poles with individually specified intervals which maximizes the employee travel involved.

52. Pa. Code § 57.198 (n)(3). Pole inspection failure. *If a pole fails the groundline inspection and shows dangerous conditions that are an immediate risk to public or employee safety or conditions affecting the integrity of the circuit, the pole shall be replaced within 30 days of the date of inspection.*

Corrective Maintenance

- PPL Electric obtains pole replacement data weekly. Critical poles, those that pose an immediate safety concern, are reinforced or replaced as soon as possible, and not later than 30 days after notification. Other non-restorable rejected poles generally are replaced within one year of identification. Pole strength is provided for each rejected pole to assist in reinforce versus replace decisions and schedule prioritization. Reinforcement by steel C-Truss, a galvanized steel truss which is banded around the pole in order to regain the pole's original strength or fiber wrap, several layers of high-strength fiberglass wrapped onto the pole and saturated with resin is generally completed within 180 days of identification. The method of reinforcement is determined by the circumstances and/or location of the pole.

52. Pa. Code § 57.198 (n)(4). Distribution overhead line inspections. *Distribution lines shall be inspected by ground patrol a minimum of once every 1-2 years. A visual inspection must include checking for:*

(i) Broken insulators.
(ii) Conditions that may adversely affect operation of the overhead transformer.
(iii) Other conditions that may adversely affect operation of the overhead distribution line.

Program Description

- Cycle

  Infrared inspection: Multi-phase overhead lines adjacent to roadways every two years.

  Visual inspection: Condition based – selected line segments. Inspections are scheduled under various conditions to include CEMI and WPC circuits, if warranted based on Proactive Circuit Reviews, and/or if power quality issues are experienced. Additional patrols are conducted to ensure continued reliability include those in support of distribution construction projects as well as summer and winter readiness patrols.

  Pole inspection: Every twelve years.

- Purpose

  The objective of an overhead line inspection is to identify and correct hardware or equipment defects that may lead to a future service interruption or pose a safety hazard. Defects are identified by inspection, prioritized and scheduled for repair.

- Process

  Infrared: Multi-phase distribution lines adjacent to roadways are scanned from vehicles. A roof-mounted infrared camera is employed to capture a thermal image of components carrying electrical current. Heat emission measurements are compared to reference temperatures. Probability of failure is estimated based upon the magnitude of temperature difference from reference. The method detects problems in current carrying components such as transformers, connections, splices, hot line clamps, disconnects, switches, lightning arresters, bridges disconnects, terminators, etc., whether or not there are visible defects. A detailed report of findings is prepared and at-risk items are prioritized and mitigated by repair or replacement.

  Visual: An analysis of actual service interruptions is conducted on selected circuits (e.g., poor performing circuits as measured by PPL Electric's WPC process, circuits with higher CEMI customers, and circuits undergoing proactive circuit analysis.) If an analysis indicates a pattern of equipment failure exists, a visual line inspection is scheduled. In addition to looking for visible defects in current-carrying components, visual inspection looks for mechanical defects in anchors, guys, crossarms, insulators, offset brackets, grounding systems and poles.

  Pole Inspection: As an integral part of the twelve-year pole inspection process, the wood poles are observed, with at-risk conditions of all pole attachments, specifically crossarms, braces, conductors, transformers, fuse cutouts, lightning arresters, reclosers, regulators, capacitors, switches, wildlife protection, vegetation encroachment, guys, anchors, ground wires and rods noted and reported.

- Justification for waiver

  PPL Electric hereby proposes a continued deviation from the 1-2 year inspection cycle on the basis of an effectiveness evaluation and cost benefit analysis in favor of the program described herein. Resources that would be applied to shorter visual cycles than this proposal would reduce the resources applied to other more cost-effective reliability programs described in this plan.

  PPL Electric conducted a trial of infrared inspections of multi-phase lines in 2006. The trial inspections cost $122,500 and identified repairs costing $100,000, saving an estimated 1,460,000-2,600,000 Customer Minutes Interrupted ("CMI"), at a cost of $0.09 to $0.15 per CMI saved. PPL Electric restructured the infrared service contract gaining further efficiencies in 2014. The cost benefit as calculated by the 2018 program effectiveness review suggested that the two programs, at a yearly cost of $327,000, save an estimated 719,000 CMI, at a cost of $0.45 per CMI saved.

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PPL Electric employs a $2.00 per CMI saved cost threshold[1] as a principal criterion for evaluating new projects for inclusion in the portfolio of reliability programs. Costs below that threshold are generally considered to be prudent investments, while those above typically provide less benefit for the cost. The cost threshold assists in applying finite resources to programs producing better results, thus enabling the most effective portfolio of programs. Because infrared costs per CMI saved are well below the threshold, PPL Electric instituted a two-year infrared cycle for accessible multi-phase lines.

PPL Electric also conducted an overhead line visual inspection cost benefit study in 2010. The study calculated a reliability benefit as a probability that inspections and the associated repairs will reduce equipment failure service interruptions. The overall probability is the product of (a) the probability that an equipment failure service outage is preceded by a visible condition, (b) the probability that the visible condition exists at the time of inspection, (c) the probability that an existing condition is detected and (d) the probability that the condition is repaired before a service interruption occurs. For seven of the thirteen overhead distribution component codes, actual inspection data established little likelihood of visible conditions preceding failure. For the remaining six component codes, subject matter experts were surveyed. The resulting probability estimates were applied to actual service outage data to estimate avoided CMI per mile. The inspection and repair cost per mile divided by CMI avoided per mile yielded an estimate of cost per CMI avoided. The graph below shows these costs per CMI for various inspection intervals.

The study also estimated avoided CMI/mile for visual inspections that follow infrared inspections because there is significant overlap between the two methods: infrared identifies both visible and hidden defects in current carrying components, while visual inspection detects only visible defects in electrical and mechanical components. The second graph below shows these costs per CMI for various inspection intervals.

As the graphs below depict, given PPL Electric's reliability parameters, there is no interval for visual overhead inspections that meets the established cost threshold, particularly when performed in conjunction with infrared inspections. Visual inspections alone at two-year intervals are 50% above the threshold; two-year visuals done in conjunction with infrared are 100% above the threshold.

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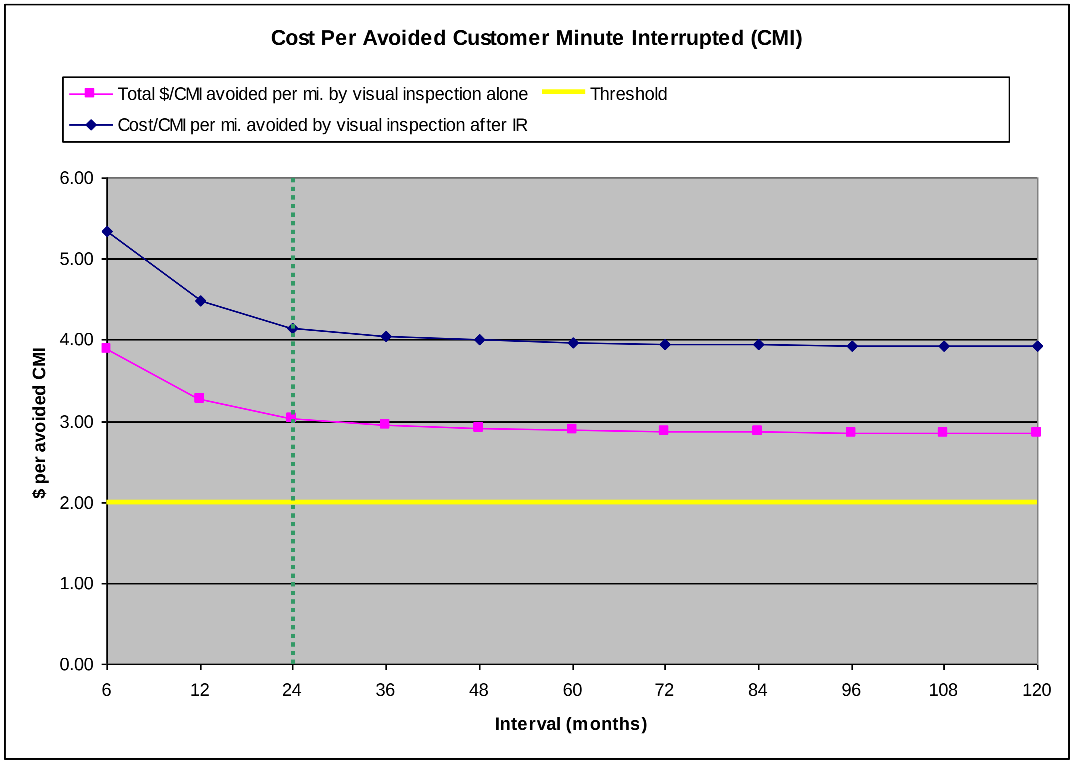
[1] Cost threshold recommended by Richard E. Brown, Sr. Vice President and co-founder of Quanta Technology, a firm specializing in technical and management consulting for utilities. Dr. Brown has provided consulting services to most major utilities in the U.S. Dr. Brown has published more than 90 technical papers related to asset management and is the author of Electric Power Distribution Reliability, CRC Press, 2009.



Overhead Line Inspection Cost per Avoided CMI

Although universal overhead visual inspections are not cost-effective, targeted visual inspections have more value. In a typical year, less than 15% of the circuits are responsible for 80% of equipment failure CMI. For the period 2002 to 2009, 30% of the circuits were responsible for 80% of equipment failure CMI.

Consequently, PPL Electric employs the condition-based visual inspection approach described above, combined with Expanded Operational Review field checks and overhead inspections in conjunction with pole inspections.

52. Pa. Code § 57.198 (n)(5). Inspection failure. *If critical maintenance problems are found that affect the integrity of the circuits, they shall be repaired or replaced no later than 30 days from discovery.*

Corrective Maintenance Description

- Infrared

  Priorities for corrective maintenance are determined by the magnitude of the variance from normal operating temperature.

Distribution Overhead Infrared Inspections Corrective Maintenance		
	Variance from Normal Operating Temp.	**Days Allowed After Report Receipt for Service**
Secondaries	+20-60° C	8 weeks
	> +60° C	2 weeks
Disconnect Switches	+20-60° C	8 weeks
	> +60° C	2 weeks
All Other Facilities	+10-40° C	8 weeks
	> +40° C	2 weeks

- Visual

  The urgency for repairs is determined and an appropriate order of priority is assigned from four categories (Emergency, Priority, Unsatisfactory, and System Improvement) described below.

Distribution Overhead Visual Inspections Corrective Maintenance	
Definition	**I&M Standard**
Emergency; Defects which: (1) Threaten the safety of the public or employees; or (2) Will cause a service interruption at any moment Scheduling Priority: 1	Corrective Action taken Immediately
Priority; Defects with a high probability of causing a service interruption if not corrected promptly. Scheduling Priority: 2	Corrective Action must be taken within 30 days.
Unsatisfactory; Defects with a lower probability of causing a service interruption if not corrected promptly. Scheduling Priority: 3	Corrective action must be taken within 3 months.
System Improvement; Conditions which could be altered to improve service reliability, with no immediate reduction of risk of service interruption. Scheduling Priority: 5	Corrective action may or may not be taken.

PPL Electric Utilities Corporation

52. Pa. Code § 57.198 (n)(6). Distribution transformer inspections. *Overhead distribution transformers shall be visually inspected as part of the distribution line inspection every 1-2 years. Above-ground pad-mounted transformers shall be inspected at least as often as every 5 years and below-ground transformers shall be inspected at least as often as every 8 years. An inspection must include checking for:*

(i) Rust, dents or other evidence of contact.
(ii) Leaking oil.
(iii) Installation of fences or shrubbery that could adversely affect access to and operation of the transformer.
(iv) Unauthorized excavation or changes in grade near the transformer.

Program Description

- Cycle

  Overhead: Overhead transformers are inspected as part of overhead visual line inspections, infrared inspections, and pole inspections. Additionally, load profiles are analyzed to identify and remedy overhead transformer locations that have consistent load demands exceeding design parameters.

  Pad-mount and below-ground: Inspections are scheduled when indicated by circuit performance and confirmed by an analysis of actual service interruptions that identifies underground failures addressable by visual inspection.

  Pad-mount and below-ground transformers may be inspected as part of the underground residential development cable testing or replacement programs.

- Purpose

  The objective of a transformer inspection is to identify and correct hardware or equipment defects that may lead to a future service interruption or pose a safety hazard. Defects are identified by inspection, prioritized and scheduled for repair.

- Process

  Overhead and underground transformers are visually inspected for damage (rust, dents, cracks, locking devices, broken bushings, etc.), integrity of connections and leaks. In addition, pad-mounts and below-ground transformers have cables and elbows inspected for deterioration, foundations and covers inspected and animals, nests, cobwebs, and vegetation removed.

- Justification for waiver

  PPL Electric hereby proposes a continued deviation from the fixed inspection cycle for transformers in favor of the condition-based inspection program described herein.

  The overhead line inspection cost benefit study described previously estimated that about 20,000 CMI annually could be saved via visual overhead transformer inspections. In 2016, the estimated cost to inspect those transformers every two years was $1.3 million or $65 per CMI avoided, well above the threshold employed by PPL Electric of $2.00 per CMI saved for identifying prudent reliability investments.

  Similarly pad-mount transformers only contribute 500,000 CMI on average to overall system reliability. An inspection and maintenance program for transformer condition would cost millions in expense for little improved reliability over other underground reliability improvement programs.

  Resources that would be applied to shorter cycles than this proposal would reduce the resources applied to other more cost-effective reliability programs described in this plan.

52. Pa. Code § 57.198 (n)(7). Recloser inspections. *Three-phase reclosers shall be inspected on a cycle of 8 years or less. Single-phase reclosers shall be inspected as part of the EDC's individual distribution line inspection plan.*

Program Description

- Cycle

  PPL Electric has initiated an upgrade program to replace three-phase oil circuit reclosers ("OCRs") with vacuum circuit reclosers ("VCRs") based upon a review of the dominant failure modes and causes. The newer technology replaces oil with a vacuum as the interrupting media. This eliminates the OCR maintenance issues of carbonized oil, contact deterioration and the timing issues that sometimes occur with OCRs. In addition, the communication capabilities of the devices allow for PPL Electric to track data pertaining to the asset health which will allow PPL Electric to implement a more targeted, condition-based replacement strategy. PPL Electric received approval from the commission on January 3, 2014 to complete these replacements on a 10-year cycle starting in 2015.

Three-phase VCRs are subjected to infrared inspection on the same 2-year cycle as OCRs.

Three-phase OCR: 2-year infrared; 10-year replacement.

Single-phase OCRs: inspected as part of PPL Electric's distribution line inspection program.

- Purpose

The purpose of the recloser inspection program is to ensure the reliable operation of reclosers by replacing deteriorated equipment with new installations.

- Process

Three-phase oil and vacuum reclosers are included in the two-year infrared line inspection program.

- Justification for waiver

PPL Electric hereby proposes a continued deviation for reclosers in favor of the program described herein.

A recloser's function is to isolate faults while minimizing the number of customers affected by permanent service outages. Visual inspection of an OCR provides relatively little useful information about the unit's capability to perform its function compared to testing. Testing in place would require almost all of the same steps that are involved in replacement. Bench testing is preferable to testing in place and refurbishment requires the unit's removal from service. With the planned installation of these communicating vacuum units, the devices have a longer life expectancy, and inspections can be planned.

As PPL Electric has been replacing older oil reclosing three phased units, reliability has improved from the decreasing number of failed units. In addition, PPL Electric experienced close to a 50% improvement in reliability within the initial smart grid pilot area.

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52. Pa. Code § 57.198 (n)(8). Substation inspections. *Substation equipment, structures and hardware shall be inspected on a cycle of 5 weeks or less.*

Program Description

- Cycle

	Visual	**Infrared**
Distribution- Supervisory control and data acquisition ("SCADA") Controlled	Quarterly	Annual

- Purpose

  Periodic substation inspections verify the integrity of station physical security, record and correct any security breaches, verify the proper fluid levels and gas pressures, and identify any leaks, verify the proper operation of essential station equipment and initiate any necessary corrective actions.

- Process

  Inspection of substation equipment and recording abnormal conditions of the equipment. Equipment inspected includes, but is not limited to:

  - Power transformers
  - Circuit breakers
  - Auxiliary equipment
  - Batteries and chargers
  - Control house
  - Yard and perimeter

- Justification for waiver

In 2017, PPL Electric was granted a deviation from the five-week inspection cycle for substations in favor of the quarterly program described herein.

From 2016-2018, PPL Electric estimates that a yearly average of 826k CMI was avoided through repairs identified via the monthly substation inspection. The costs of inspection plus repair averaged $1.24 million per year, or $1.50 per CMI avoided, which is under the threshold employed by PPL Electric of $2.00 per CMI saved for identifying prudent reliability investments.

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PPL Electric employs SCADA at every substation, which provides real-time telemetry of potential issues. The relay packages provide advanced health information about the breakers and signal when maintenance is required, negating the need for visual inspections of these assets. PPL Electric implemented an upgrade to the data historian software which allows the Company to be automatically alerted when substation abnormalities are detected, and automatically calculate remaining life on smart assets when operations occur.

Over the last four years, none of the repairs scheduled due to the monthly inspections have been critical repairs due to imminent failure risk. The repairs have been minor and could have waited 90 additional days to be identified.

Resources that would be applied to shorter cycles than this proposal would reduce the resources applied to other more cost-effective reliability programs described in this plan.

Appendix A: Transmission Programs and Procedures

Program	**Activity**
Helicopter Inspections – Stop-go	Aerial linemen perform annual routine transmission line patrols from a helicopter. They identify damaged or deteriorated equipment and any apparent vegetation issues. Engineers review the findings and develop plans for repair, replacement or remediation.
Helicopter Inspections – Comprehensive	Aerial linemen perform an overhead comprehensive inspection of transmission line facilities on a four-year or eight-year cycle. Detailed condition reports with close-up digital photos are prepared for each specific component problem found along the transmission line and right-of-way. Engineers review the findings and schedule corrective maintenance as needed.
Helicopter Inspections – Emergency	Aerial linemen perform patrols of transmission lines that operate abnormally. This inspection focuses on identifying damage that may have been caused by lightning, inclement weather, equipment failure or vandalism. Because of the nature of this work, corrective actions generally are expedited.
Steel Structures – Inspection, Treatment, Replacement, Reinforcement/Repair	Steel transmission structures are examined and measured for the degree of decay and deterioration. Any issues identified by the inspection are then categorized with a priority rating and are scheduled for follow-up actions based on the criticality. Follow-up actions may include remediation or replacement of steel members or foundations to extend the life of the asset.
Equipment Maintenance	During helicopter and foot patrols, equipment and facilities are identified that require repairs. Based on need and criticality, repairs are either scheduled or completed as soon as possible. Repairs are either completed by line crews or aerial line crews to ensure efficient and effective repairs.
Line Switches – Maintenance and Inspection	Line personnel inspect, maintain and perform operational tests on 138kV and 69kV line air break switches on an as-needed basis to assure proper operation. Corrective action is taken as needed.
Line Switch Upgrades	Line personnel install lightning arresters on 138kV and 69kV line switches to increase system reliability. Existing parallel break air breaks and load sectionalizing air breaks are being upgraded to motor operated load break air breaks to improve switching capabilities, outage restoration times, and sectionalizing ability. Corrective action is taken as needed.

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Program	Activity
Circuit Analysis	Engineers analyze circuit loading and performance to identify areas needing increased line capacity or improved line reliability. Circuits are also reviewed based on operational performance and ranked yearly in a WPC list, with appropriate circuits identified for targeted reliability improvements.

Appendix B: Substation Programs and Procedures

Program	**Activity**
Load Survey	Automatic monitoring devices such as SCADA provide continuous, real-time loading information. Engineers review equipment loading and identify facilities and transfer capabilities approaching capacity limits. A portion of the load may be supplied from a different source, the existing facilities may be upgraded, new lines and equipment may be added, or a new substation may be built to address capacity deficiencies.
Substation Inspection/Repair	Electricians inspect substations for security and equipment reliability on a time-based maintenance cycle. They identify and correct potential equipment problems before a failure or service interruption occurs.
Equipment Service	Electricians perform operational tests on power transformers, load tap changers ("LTC"), voltage regulators, circuit breakers, circuit switchers, vacuum switches, air break switches and transformer protective switches on a time-based maintenance cycle to assure that equipment is operating within established parameters. Equipment serviced includes batteries, battery chargers, protective relays, high voltage fuses and high-speed automatic grounding switches. Depending on the type of equipment, "service" can include actions other than operational testing.
Inspection and Condition Assessment	Electricians inspect and perform condition assessments of circuit breakers, wave traps, ground switches, stick-operated disconnects, gang-operated disconnects and motor-operated disconnects on a time-based maintenance cycle to assure proper operation. Corrective action is taken as needed.
Insulation Testing	Technicians perform power factor testing on power transformers, potential transformers, lightning arresters, current transformers, select circuit breakers and power cables on a time-based maintenance cycle. Testing also includes other instrument transformers (capacitance coupled voltage transformer, coupling capacitors, potential devices, etc.). They also perform high-potential testing on12kV oil, air and vacuum circuit breakers to assure proper operation.

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Program	Activity
Condition Monitoring of Station Equipment	Electricians/Technicians perform dissolved gas-in-oil analysis, dielectric, and physical properties oil tests for oil in power transformers, and impedance and select capacity tests on station batteries, to assure equipment is within normal parameters. Periodically, AC power factor tests, hi-potential tests, contact resistance tests and motion tests are performed on circuit breakers. Oil dielectric testing is conducted for oil circuit breakers.
Thermographic Inspections	Electricians perform infrared surveys of substation facilities to identify components operating at elevated temperature. Based on the findings, engineers develop plans to repair or replace the component(s) prior to failure.
Minor Improvements	Maintenance activities may identify conditions where additions or upgrades are needed to assure reliability. Engineers evaluate the need and develop action plans and schedules to complete the work.
DC Station Service Improvements	Repairmen and Testing identify deteriorated station batteries, battery chargers and battery components. Engineers schedule repair or replacement as necessary.
Capacitor Bank Protection	Engineers monitor the need for synchronous closing schemes on vacuum switches on 69kV capacitor banks. They plan and schedule installations as needed.
Area/Regional Supply	Engineers develop specific projects aimed at improving capacity shortfalls or replacing deteriorated or substandard station equipment.
SCADA Replacement	Engineers identify deteriorating substation SCADA equipment and develop plans to repair or replace it.

Appendix C: Distribution Programs and Procedures

Program	Activity
Load Survey – of equipment that is not continuously monitored	Line personnel measure the loading of facilities during peak periods. Engineers use this data for system studies.
Load Survey – by automatic monitoring devices	Automatic monitoring devices such as SCADA provide continuous, real-time loading information. Operators use this data to assure that loads do not exceed design limits. Engineers use this data for system studies.
Circuit Analysis	Engineers analyze circuit voltage profiles to balance loads and to identify areas requiring voltage support to maintain required voltage at the customer's facility.
Transformer Replacements	Engineers analyze customer usage data to identify overloaded transformers. Transformers that are heavily loaded are replaced with higher capacity units or portions of the load are transferred to other nearby transformers.
Wood Pole – Inspection, Maintenance, Reinforcement, Replacement	Wood poles are examined for deterioration and the degree of decay is measured. Based on the results, the pole may be treated with preservative to extend its life, treated and reinforced for extended life or replaced.
Overhead Line Inspection	Line inspection personnel examine overhead facilities to identify damaged, deteriorated or substandard equipment. Equipment examines include but is not limited to capacitors, regulators, switches, and reclosers. Line personnel repair or replace any defective equipment.
Circuit Performance Review	Engineers use PPL Electric's WPC score to ascertain the need for additional circuit reviews or inspections. The improved index looks at a circuit's overall impact to system SAIFI and circuit SAIDI. Actual service interruption history is analyzed to identify causal or geographic patterns.
Underground Primary Cable – Replacement	Based on a data-driven failure probability model and risk assessment, underground cable is identified for proactive replacements.
LTN Maintenance	Electricians inspect, service, maintain and overhaul LTN vaults, manholes, cables, transformers, low-voltage network protectors and primary transformer disconnect switches. Based on results, defective equipment is either repaired or replaced.

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Program	Activity
Public Damaged Facilities Review	A program aimed at identifying the locations of facilities that have been damaged by public contact more than once. Technicians evaluate those installations and, if relocation is deemed appropriate, schedule work to move the facilities.
Underground Service Cable	Engineers resolve customer service problems that are due to deteriorated underground service conductors.
Oil Circuit Reclosers	Line personnel replace in-service oil circuit reclosers conditionally.
Line Protection Equipment	Line personnel replace in-service three phase oil circuit reclosers with communicating vacuum devices conditionally.
Capacitor and Voltage Regulator Installation	Engineers perform voltage profiles to determine the need, location and size of any new voltage support equipment required to maintain adequate service voltage levels at customer facilities and provide needed reactive support for system stability. Line personnel install the required equipment.

Appendix D: Vegetation Applications

Program	**Activity**
Tree Pruning	Tree pruning is scheduled based on field conditions observed and/or a system prioritization process. All pruning is done in accordance with American National Standard for Tree Care Operations-Tree, Shrub and Other Woody Plant Maintenance – Standard Practices (ANSI A300).
Hazard Tree Removal	Trees located outside the right-of-way that represent a threat to line performance/ safety are removed when it is feasible to do so.
Herbicide Application	Tall-growing, undesirable vegetation growing within the right-of-way corridors is selectively treated with herbicides. Low-growing vegetation that does not represent a hazard to the safe, reliable operation of PPL Electric's facilities is preserved wherever possible.
Reclearing	Tall-growing, undesirable vegetation growing within the right-of-way corridors is selectively removed in those situations where herbicides cannot be utilized. Low-growing vegetation that does not represent a hazard to the safe, reliable operation of PPL Electric's facilities is preserved wherever possible.