Application No.:	A.19-08-013
Exhibit No.:	SCE-15 Vol. 05
Witnesses:	D. Daigler B. Fielder R. Fugere K. Gardner R. Roy

SOUTHERN CALIFORNIA EDISON®

(U 338-E)

2021 General Rate Case
Rebuttal Testimony

Wildfire Management

Before the

Public Utilities Commission of the State of California

Rosemead, California
June 12, 2020

SCE-15, Vol. 05: Wildfire Management

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I.

INTRODUCTION

SCE's Wildfire Management testimony identified a portfolio of critical activities necessary to mitigate the risk of ignitions and wildfires associated with SCE's electrical infrastructure. The forecast work associated with these mitigation activities is guided by a continuously improving and risk-informed approach. SCE's wildfire mitigation work is primarily geographically focused in the portion of SCE's service territory that is considered High Fire Risk Areas (HFRA).[1] Cal Advocates, The Utility Reform Network (TURN), and other intervenors made several recommendations relating to SCE's proposals for the Wildfire Management activities for operations and maintenance (O&M) expenses for the 2021 TY and capital expenditures for 2019 through 2021. SCE's rebuttal to intervenor testimony follows.

SCE forecasts $100.765 million (constant 2018 dollars) in O&M expenses for the 2021 TY and $2,179 million[2] (nominal dollars) in capital expenditures for the 2019-2021 period to effectively implement its approved activities in the Grid Safety & Resiliency Program (GS&RP), and 2019 and 2020-22 Wildfire Mitigation Plans (WMP). If approved, this funding request will allow SCE to continue its efforts to deploy measures directed at reducing wildfire risks, further harden the electrical system, and enhance wildfire suppression efforts. It will also allow SCE to uphold its commitment to its customers and communities by employing technologies that help minimize the impact of outages on customers, improving fire agencies' ability to detect and respond to emerging fires, improving coordination between utility, state, and local emergency management personnel, and effectively engaging the public about how to reduce the likelihood of and otherwise prepare for wildfires in SCE's HFRA.

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[1] In August 2019, SCE filed a Petition for Modification (PFM) of D.17-12-024, in which SCE proposed to officially add approximately 1% of SCE's non-CPUC-designated high fire risk area (HFRA) to the CPUC High Fire Threat District (HFTD) map. This area was considered to have a relatively higher potential for a fire to propagate than other non-CPUC HFRA. SCE's amended testimony, Exhibit SCE-04, Vol. 05A (submitted on November 22, 2019), reflected the areas that SCE filed in its PFM. *See also* July 5, 2019 AL 4030-E.

[2] *See* SCE's position on using 2019 recorded expenditures in place of the 2019 forecasts in Exhibit SCE-12, Vol. 01. This number also reflects SCE's rebuttal position, which is less than SCE's original request.

A. Summary Of Rebuttal Position

The forecasts for Wildfire Management O&M expense, and capital expenditures, made by SCE, Cal Advocates, and TURN are shown in the following tables. Table I-1 provides a summary of the 2019-2023 capital expenditure forecast for SCE, Cal Advocates, and TURN, along with the variances from SCE's forecast.

Table I-1
Wildfire Management Capital Expenditures
2019-2023 Forecast
Summary of SCE,[3] Cal Advocates,[4] and TURN Positions
(Nominal $000)

Line No.	Business Planning Element	2019 Forecast				Variance from SCE		SCE Rebuttal Position
		SCE Testimony	Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Wildfire Management	$ 386,970	$ 394,110	$ 386,970	N/A	$ (7,140)	N/A	$ 649,079
2	**Total**	**$ 386,970**	**$ 394,110**	**$ 386,970**	**N/A**	**$ (7,140)**	**N/A**	**$ 649,079**

Line No.	Business Planning Element	2020 Forecast				Variance from SCE		SCE Rebuttal Position
		SCE Testimony	SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Wildfire Management	$ 740,938	$ 734,453	$ 734,453	N/A	$ -	N/A	$ 706,712
2	**Total**	**$ 740,938**	**$ 734,453**	**$ 734,453**	**N/A**	$ -	**N/A**	**$ 706,712**

Line No.	Business Planning Element	2021 Forecast				Variance from SCE		SCE Rebuttal Position
		SCE Testimony	SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Wildfire Management	$ 863,099	$ 859,358	$ 625,800	$ 287,372	$ (233,558)	$ (571,986)	$ 820,057
2	**Total**	**$ 863,099**	**$ 859,358**	**$ 625,800**	**$ 287,372**	**$ (233,558)**	**$ (571,986)**	**$ 820,057**

Line No.	Business Planning Element	2022 Forecast				Variance from SCE		SCE Rebuttal Position
		SCE Testimony	SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Wildfire Management	$1,017,289	$ 1,013,775	$ 625,800	$ 305,533	$ (387,975)	$ (708,242)	$ 967,909
2	**Total**	**$1,017,289**	**$ 1,013,775**	**$ 625,800**	**$ 305,533**	**$ (387,975)**	**$ (708,242)**	**$ 967,909**

Line No.	Business Planning Element	2023 Forecast				Variance from SCE		SCE Rebuttal Position
		SCE Testimony	SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Wildfire Management	$1,210,960	$ 1,207,439	$ 625,800	$ 306,814	$ (581,639)	$ (900,625)	$ 1,151,557
2	**Total**	**$1,210,960**	**$ 1,207,439**	**$ 625,800**	**$ 306,814**	**$ (581,639)**	**$ (900,625)**	**$ 1,151,557**

Table I-2 provides a summary of Wildfire Management 2021 O&M expense forecast by SCE, Cal Advocates, and TURN, along with the variance from SCE's forecast.

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3 SCE's 2019 Rebuttal Position reflects 2019 recorded amounts. 2019 recorded amounts are being litigated in Track 2 of this proceeding.

4 Cal Advocates used the forecast amounts from SCE's original filing and did not use the forecast amounts from SCE's amended testimony. Since Cal Advocates did not oppose SCE's 2020 forecast amount, Cal Advocates' recommendation for 2020 expenditures of $740.938 million was reduced to $734.453 million to reflect SCE's amended testimony. However, since Cal Advocates opposed SCE's 2021 forecast amounts, SCE left the amount as proposed by Cal Advocates.

Table I-2
Wildfire Management O&M Expenses
2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	Business Planning Element	2021 Forecast SCE Testimony	SCE Amended Testimony	Cal Advocates	TURN	Variance from SCE Cal Advocates	TURN	SCE Rebuttal Position
1	Wildfire Management	$ 109,324	$ 105,447	$ 52,827	$ 105,379	$ (52,620)	$ (68)	$ 100,765
2	**Total**	**$ 109,324**	**$ 105,447**	**$ 52,827**	**$ 105,379**	**$ (52,620)**	**$ (68)**	**$ 100,765**

1. Capital Expenditure Summary

Table I-3 and Table I-4 provide the recorded amounts for 2019 and the forecast for 2020-2023 for SCE, Cal Advocates and TURN. For wildfire capital expenditures (but not uniformly across this proceeding), Cal Advocates recommended that SCE's 2019 forecast should be used until the 2019 recorded costs can be audited and reviewed in later phases of this GRC.[5] Cal Advocates did not oppose SCE's capital expenditure forecasts for 2020-2021 for Distribution Fault Anticipation, Enhanced Overhead Inspections (EOI) and Remediations, Enhanced Situational Awareness, Fire Science and Advanced Modeling, Fusing Mitigation, HFRA Sectionalizing Devices, PSPS Execution, and Targeted Undergrounding.[6,7]

Cal Advocates recommended that "[t]he Commission should adopt a 2020 budget for wildfire management-related capital expenditures of $740.9 million."[8,9] For the 2021 forecast, Cal Advocates suggested that "the WCC [Wildfire Covered Conductor] forecast be the same as the 2020

5 *See* Exhibit PAO-09, p. 14.

6 *Id.*, pp. 14-15.

7 Note that in SCE's amended testimony, SCE showed a capital expenditure forecast for EOI and Remediations of $149.695 million and $52.432 million for 2020 and 2021, respectively. In the errata filed concurrently with this rebuttal, SCE presents a forecast for EOI and Remediations of $148.312 million and $51.205 million for 2020 and 2021, respectively. *See* Appendix A, p. A313.

8 *See* Exhibit PAO-09, p. 14, lines 15-16.

9 It should be noted that Cal Advocates was using SCE's original testimony, Exhibit SCE-04, Vol. 05, in its references in Exhibit PAO-09, p. 13, Table 9-10; hence the recommendation of $740.9 million.

forecast,"[10] and that the "1,000 circuit miles…should be the basis of the 2021 capital forecast."[11] Cal Advocates' proposal of 1,000 circuit miles for 2021 is a 400-mile reduction from SCE's forecast.

TURN did not oppose SCE's capital expenditure forecasts for Fire Science and Advanced Modeling, HFRA Sectionalizing Devices, PSPS Execution, and Targeted Undergrounding. While TURN did not oppose SCE's proposal to use covered conductor and its unit cost estimate, TURN opposed SCE's scope forecast and recommended a Test Year reduction of $562.902 million (nominal dollars) from SCE's forecast of $771.099 million (nominal dollars) for the Wildfire Covered Conductor Program.[12] TURN recommended $0 funding for Vertical Switches from SCE's forecast of $2.813 million (nominal dollars), while not opposing SCE's forecasts for other mitigation activities within Enhanced Overhead Inspections and Remediations.[13] TURN also recommended $0 funding for Distribution Fault Anticipation from SCE's forecast of $6.270 million (nominal dollars).[14] No other intervenors opposed SCE's capital expenditure forecasts. SCE will address the issues raised by Cal Advocates and TURN's recommendations related to SCE's 2020 - 2023 capital expenditures forecast in the below corresponding chapters.

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10 *See* Exhibit PAO-09, p. 14, lines 25-26.

11 *Id.*, p. 15, lines 2-3.

12 *See* Exhibit TURN-01, pp. 5-7. The amount of $771.099 million was SCE's forecast in its Amended Testimony. SCE's Rebuttal position for the Wildfire Covered Conductor Program is $733.024 million. TURN's proposal would then be a reduction of $524.827 million from SCE's revised forecast of $733.024 million. *See* Appendix A, p. A261.

13 *Id.*

14 *Id.*, pp. 8-10.

Table I-3
Wildfire Management Capital Expenditures
2019 Recorded/2020-2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(Nominal $000)

Line No.	GRC Activity	SCE Recorded	2020 Forecast			Variance from SCE		SCE Rebuttal Position
		2019	SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Distribution Fault Anticipation	$ 3,445	$ -	$ -	N/A	$ -	N/A	$ -
2	Enhanced Overhead Inspections and Remediations	$ 300,592	$ 149,695	$149,695	N/A	$ -	N/A	$ 148,312
3	Enhanced Situational Awareness	$ 5,252	$ 4,159	$ 4,159	N/A	$ -	N/A	$ 4,159
4	Fire Science and Advanced Modeling	$ 6,487	$ 5,685	$ 5,685	N/A	$ -	N/A	$ 5,685
5	Fusing Mitigation	$ 70,298	$ 11,446	$ 11,446	N/A	$ -	N/A	$ 11,446
6	HFRA Sectionalizing Devices	$ 11,951	$ 28,452	$ 28,452	N/A	$ -	N/A	$ 28,452
7	PSPS Execution	$ 1,766	$ 1,212	$ 1,212	N/A	$ -	N/A	$ 1,212
8	Undergrounding	$ -	$ -	$ -	N/A	$ -	N/A	$ -
9	Wildfire Covered Conductor Program	$ 249,288	$ 533,803	$533,803	N/A	$ -	N/A	$ 507,445
10	**Wildfire Management Total**	**$ 649,079**	**$734,453**	**$734,453**	**N/A**	**$ -**	**N/A**	**$ 706,712**

Line No.	GRC Activity	2021 Forecast			Variance from SCE		SCE Rebuttal Position
		SCE	Cal Advocates	TURN	Cal Advocates	TURN	
1	Distribution Fault Anticipation	$ 6,270	$ 6,270	$ -	$ -	$ (6,270)	$ 6,270
2	Enhanced Overhead Inspections and Remediations	$ 52,432	$ 52,432	$ 49,619	$ -	$ (2,813)	$ 51,205
3	Enhanced Situational Awareness	$ -	$ -	$ -	$ -	$ -	$ -
4	Fire Science and Advanced Modeling	$ 1,102	$ 1,102	$ 1,102	$ -	$ -	$ 1,102
5	Fusing Mitigation	$ -	$ -	$ -	$ -	$ -	$ -
6	HFRA Sectionalizing Devices	$ 5,209	$ 5,209	$ 5,209	$ -	$ -	$ 5,209
7	PSPS Execution	$ 738	$ 738	$ 738	$ -	$ -	$ 738
8	Undergrounding	$ 22,507	$ 22,507	$ 22,507	$ -	$ -	$ 22,507
9	Wildfire Covered Conductor Program	$ 771,099	$ 533,803	$ 208,197	$ (237,296)	$ (562,902)	$ 733,024
10	**Wildfire Management Total**	**$ 859,358**	**$ 622,062**	**$ 287,373**	**$ (237,296)**	**$ (571,985)**	**$ 820,057**

Table I-4
Wildfire Management Capital Expenditures
2022-2023 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(Nominal $000)

Line No.	GRC Activity	2022 Forecast			Variance from SCE		SCE Rebuttal Position
		SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Distribution Fault Anticipation	$ 12,903	$ 12,903	$ -	$ -	$ (12,903)	$ 12,903
2	Enhanced Overhead Inspections and Remediations	$ 46,310	$ 46,310	$ 43,497	$ -	$ (2,813)	$ 45,216
3	Enhanced Situational Awareness	$ -	$ -	$ -	$ -	$ -	$ -
4	Fire Science and Advanced Modeling	$ -	$ -	$ -	$ -	$ -	$ -
5	Fusing Mitigation	$ -	$ -	$ -	$ -	$ -	$ -
6	HFRA Sectionalizing Devices	$ 5,360	$ 5,360	$ 5,360	$ -	$ -	$ 5,360
7	PSPS Execution	$ -	$ -	$ -	$ -	$ -	$ -
8	Undergrounding	$ 42,457	$ 42,457	$ 42,457	$ -	$ -	$ 42,457
9	Wildfire Covered Conductor Program	$ 906,746	$ 533,803	$ 214,219	$ (372,943)	$ (692,527)	$ 861,973
10	**Wildfire Management Total**	**$ 1,013,776**	**$ 640,833**	**$ 305,533**	**$ (372,943)**	**$ (708,243)**	**$ 967,909**

Line No.	GRC Activity	2023 Forecast			Variance from SCE		SCE Rebuttal Position
		SCE Amended Testimony	Cal Advocates	TURN	Cal Advocates	TURN	
1	Distribution Fault Anticipation	$ 13,274	$ 13,274	$ -	$ -	$ (13,274)	$ 13,274
2	Enhanced Overhead Inspections and Remediations	$ 42,755	$ 42,755	$ 42,755	$ -	$ -	$ 41,570
3	Enhanced Situational Awareness	$ -	$ -	$ -	$ -	$ -	$ -
4	Fire Science and Advanced Modeling	$ -	$ -	$ -	$ -	$ -	$ -
5	Fusing Mitigation	$ -	$ -	$ -	$ -	$ -	$ -
6	HFRA Sectionalizing Devices	$ -	$ -	$ -	$ -	$ -	$ -
7	PSPS Execution	$ -	$ -	$ -	$ -	$ -	$ -
8	Undergrounding	$ 43,678	$ 43,678	$ 43,678	$ -	$ -	$ 43,678
9	Wildfire Covered Conductor Program	$ 1,107,732	$ 533,803	$220,380	$ (573,929)	$ (887,351)	$ 1,053,035
10	**Wildfire Management Total**	**$1,207,439**	**$633,510**	**$306,814**	**$(573,929)**	**$ (900,625)**	**$1,151,557**

2. O&M Expense Summary

Table I-5 provides the recorded amounts for 2014-2018 and the forecast for 2021 for SCE, Cal Advocates and TURN. Cal Advocates does not oppose SCE's Wildfire Management O&M expense forecasts for Distribution Fault Anticipation, Fusing Mitigation, Infrared Inspection Program, PSPS Customer Support, and PSPS Execution.[15] Cal Advocates proposes changes to SCE's forecasts in several wildfire mitigation activities, including Organizational Support, Enhanced Overhead Inspections (EOI) and Remediations, Community Resiliency Equipment Incentive Program, Enhanced Situational Awareness, and Fire Science and Advanced Modeling. Cal Advocates recommends a total reduction of $52.620 million from SCE's forecast of $100.765 million for Test Year 2021.[16,17,18]

TURN does not oppose SCE's Wildfire Management O&M expense forecasts, except for Distribution Fault Anticipation, where TURN proposed $0 funding, a reduction of $68 thousand from SCE's forecast of $100.765 million for Test Year 2021. No other intervenor opposed SCE's O&M expense forecasts. SCE will address the issues raised by Cal Advocates and TURN's recommendations related to SCE's 2021 O&M forecast in the below corresponding sections.

[15] *See* Exhibit PAO-06, p. 51, lines 7-11.

[16] *Id.*, p. 63.

[17] Note that in SCE's amended testimony, SCE showed a Test Year O&M expense forecast for EOI and Remediations of $58.914 million. In the errata being served concurrently with this rebuttal testimony, SCE presents a forecast for EOI and Remediations of $54.232 million. *See* Appendix A, p. A318.

[18] *See* Exhibit TURN-02, p. 10. The $100.765 million is SCE's rebuttal position.

Table I-5
Wildfire Management O&M Expenses
2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	GRC Activity	SCE Recorded		2021 Forecast						Variance from SCE					
		2018		SCE Amended Testimony		Cal Advocates		TURN		Cal Advocates		TURN		SCE Rebuttal Position	
1	Asset Reliability Risk Analytics	$	128	$	-	$	-	$	-	$	-	$	-	$	-
2	Community Resiliency Equipment Incentive Program	$	-	$	3,450	$	1,150	$	3,450	$	(2,300)	$	-	$	3,450
3	Distribution Fault Anticipation	$	-	$	68	$	68	$	-	$	-	$	(68)	$	68
4	Enhanced Overhead Inspections and Remediations	$	4,863	$	58,914	$	14,225	$	58,914	$	(44,689)	$	-	$	54,232
5	Enhanced Situational Awareness	$	382	$	3,594	$	3,060	$	3,594	$	(534)	$	-	$	3,594
6	Fire Science and Advanced Modeling	$	1,873	$	3,948	$	2,204	$	3,948	$	(1,744)	$	-	$	3,948
7	Fusing Mitigation	$	-	$	1,089	$	1,089	$	1,089	$	-	$	-	$	1,089
8	Grid Resiliency PMO	$	57	$	-	$	-	$	-	$	-	$	-	$	-
9	HFRA Sectionalizing Devices	$	2,727	$	-	$	-	$	-	$	-	$	-	$	-
10	Infrared Inspection Program	$	-	$	3,797	$	3,797	$	3,797	$	-	$	-	$	3,797
11	Organizational Support	$	-	$	3,354	$	-	$	3,354	$	(3,354)	$	-	$	3,354
12	PSPS Customer Support	$	825	$	13,311	$	13,311	$	13,311	$	-	$	-	$	13,311
13	PSPS Execution	$	169	$	13,922	$	13,922	$	13,922	$	-	$	-	$	13,922
14	Weather Stations	$	253	$	-	$	-	$	-	$	-	$	-	$	-
15	Wildfire Covered Conductor Program	$	-	$	-	$	-	$	-	$	-	$	-	$	-
16	**Wildfire Management Total**	**$**	**11,278**	**$**	**105,447**	**$**	**52,827**	**$**	**105,379**	**$**	**(52,621)**	**$**	**(68)**	**$**	**100,765**

II.

WILDFIRE MANAGEMENT

A. Wildfire Management Ratemaking Proposals

SCE notes that there are various ratemaking proposals presented by both SCE and intervenors related to Wildfire Management in this GRC. These proposals, which involve balancing account treatment, removal of assets recently installed in rate base, and other cost recovery considerations, are addressed in Exhibit SCE-18, Volumes 1 and 3.

1. SCE Proposes A Two-way Balancing Account To Provide Customer Protection[19]

Given that Cal Advocates' primary objection to SCE's forecast is its expectation that the rate of expansion of SCE's covered conductor circuit miles will be less than what SCE has put forth in its forecast, it would stand to reason that Cal Advocates would be in favor of the two-way Wildfire Risk Mitigation Balancing Account[20] (WRMBA) proposed by SCE. Cal Advocates was silent on this proposal but did recommend that the Commission adopt SCE's proposal for two-way balancing accounts for both wildfire liability insurance and vegetation management.[21,22] The two-way WRMBA would provide customer protection and should obviate any concerns about feasibility in achieving the forecast scope for covered conductor. Given the significant threats that wildfires pose to the state of California, it is prudent and consistent with public policy for SCE to accelerate high-risk-reducing wildfire mitigations, such as covered conductor, to the maximum extent possible.

2. TURN's Recommendation Of Removing Recently Installed Assets From Rate Base Goes Against Regulatory Principles And Precedence

For assets, such as poles and other distribution infrastructures that are replaced under the WCCP, TURN proposes "to remove from rate base the net recorded plant amount for assets installed less than five years from when SCE replaces the asset." TURN claims that "SCE's proposed capital investments will, in some cases, replace existing assets which are still operational and do not otherwise

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[19] *See* Exhibit SCE-07, Vol. 1CA2, pages 28-35.

[20] California Public Utility Code § 8386.3(d) states that "an electrical corporation shall not divert revenues authorized to implement the plan to any activities or investments outside of the plan."

[21] *See* Exhibit PAO-10, page 22, lines 1-8.

[22] *See* Exhibit PAO-06, page 4, lines 33-35.

face any near-term risk of failure,"[23] and concludes that "[the customers] would bear costs for two pieces of equipment even though only one is installed." SCE's rebuttal to this can be found in Exhibit SCE-18, Vol. 02.

B. Wildfire Covered Conductor Program

1. Capital Expenditures

a) SCE Application

SCE's Wildfire Covered Conductor Program (WCCP) is SCE's primary grid hardening wildfire mitigation solution. The WCCP is designed to address and reduce wildfire ignition risks associated with the overhead electrical distribution system when faults occur. The program replaces existing bare overhead conductor in HFRA with covered conductor that is specifically designed to withstand contact from foreign objects and minimize ignitions from wire-related events.[24] Considering the devastating impacts of wildfires in recent years, SCE believes it is prudent and necessary to drive wildfire risk to very low levels as quickly as possible. Accordingly, SCE's forecast for covered conductor is constrained by the amount of work SCE can feasibly execute through 2023 given available resources, and is informed by and prioritized through several risk-based approaches.[25] SCE then multiplied the forecast scope by a cost-per-circuit-mile to arrive at the total forecast expenditure amount. Table II-6 summarizes SCE's request compared to Cal Advocates' and TURN's positions.

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[23] *See* Exhibit TURN-02, pp. 26-27.

[24] The WCCP also includes the removal of tree attachments and poles replacements. Tree attachments are an outdated practice of physically attaching wires to trees instead of utility poles, with attendant increased wildfire risk. Installing covered conductor also in some cases necessitates pole replacements when the heavier wires cause the existing pole to fail wind loading requirements.

[25] *See* Exhibit SCE-04, Vol. 05A, p. 25-28.

Table II-6
Wildfire Covered Conductor Program Capital Expenditures
2019 Recorded/2020-2023 Forecast
Summary of SCE, Cal Advocates,[26] and TURN Positions
(Nominal $000)

Line No.	GRC Activity	SCE Rebuttal Position 2019 Recorded	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast	Total 2021-2023	
1	Wildfire Covered Conductor Program	$ 249,288	$ 507,445	$ 733,024	$ 861,973	$1,053,035	$ 2,648,033	
Line No.	GRC Activity	Cal Advocates' Position 2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast	Total 2021-2023	Variance From SCE 2021-2023
1	Wildfire Covered Conductor Program	$ 156,337	$ 507,445	$ 507,445	$ 507,445	$ 507,445	$ 1,522,336	$ (1,125,697)
Line No.	GRC Activity	TURN's Position 2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast	Total 2021-2023	Variance From SCE 2021-2023
1	Wildfire Covered Conductor Program	N/A	N/A	$ 208,197	$ 214,219	$ 220,380	$ 642,796	$ (2,005,237)

As explained in detail below, while Cal Advocates' and TURN's proposals would retain material risk that would result from an incomplete roll-out of WCCP, the Commission should not ignore the potentially serious consequences of unmitigated wildfire risks. Just as the State of California, amidst an unprecedented pandemic crisis, is proposing to double down on investing resources into mitigating wildfires, so should SCE with the Commission's support.[27] Tom Porter, Cal FIRE Director, remarked at the CPUC Sponsored Wildfire Technology Innovation Summit, that reducing fire starts [reducing ignitions] is one of the most important things we can do to mitigate the risk – *i.e.*, prevent the

[26] Cal Advocates stated, "For the purposes of the 2021 forecast, the Public Advocates recommends that the WCC[P] forecast be the same as the 2020 forecast." Cal Advocates confirmed in DR SCE-PubAdv-009 (attached hereto as Appendix A, pp. A3-A4) that it replaced SCE's 2020 forecast amount with SCE's 2021 forecast amount for WCCP, without adjusting for escalation. While SCE strongly believes that the Commission should not adopt Cal Advocates' proposal of 1,000 circuit miles in 2021, it needs to be noted that, in the case the Commission did adopt this recommendation, it should ensure that the appropriate 2021 escalation is used.

[27] *See* 2020-2021 May Revision to the Governor's Budget http://www.ebudget.ca.gov/2020-21/pdf/Revised/BudgetSummary/SavingLivesandEmergencyResponse.pdf, pp. 23-24.

ignitions from taking place to begin with.[28] The greatest benefit SCE can provide the State and its firefighting resources is avoided ignitions – and that is what SCE's WCCP request in this GRC is designed to do.

As discussed in Mr. Payne's rebuttal testimony, SCE vigorously disagrees with TURN's proposal to stop covered conductor installation at 2,500 circuit miles, which TURN unilaterally deems will provide an acceptable level of remaining public safety risk. In TURN's view, because there is a diminishing marginal level of risk reduction per-mile as more miles are completed in the highest relative risk areas, SCE should stop installing covered conductor at a point earlier on the "risk buydown curve." In our view, TURN's limited interpretation of the risk buydown curve is incorrect. The curve is a mathematical model that should only be used to *prioritize* the deployment of the right covered conductor circuit segments and should not be used to determine the right amount of covered conductor final *scope*. In other words, the risk model demonstrates where covered conductor installation should start due to the non-uniform nature of the risk distribution throughout the CPUC's Tier 3 and Tier 2 areas, not the appropriate place to stop.

This testimony addresses in detail the many problematic issues inherent in TURN's argument. SCE lists and further summarizes these issues below:

1) The Commission undertook significant effort to identify the areas of ***extreme*** and ***elevated*** **wildfire risk** in its **CPUC Fire-Threat Map** which defined the locational scope of fire mitigation work we need to undertake over time – SCE's initial risk modeling helped determine the appropriate mitigation measures and the advancement of SCE's risk modelling capabilities helps ensure that we **are prioritizing covered conductor deployment** within the CPUC Fire-Threat Map to **mitigate wildfire risk as quickly as possible**
2) The risk buydown curve shows relative risk reduction and should **only be used to prioritize** the deployment of covered conductor, and not to set overall scope
3) **Absolute risk reduction** (as opposed to relative risk reduction) should be the **primary consideration when determining the scope** of covered conductor

[28] *See* https://www.youtube.com/watch?v=yG_ypwDIFQA&list=PLsgixh8pRZUBuk0O7MeqpyfD1zhvjutCc&index=2&t=0s at ~1:33:00 time marker

4) Historical experience has demonstrated **ignitions past TURN's 2,500** circuit mile proposal can turn into **catastrophic wildfires**

5) Covered conductor **prevents ignitions** that propagate into large wildfires due to **factors outside of SCE's control** (e.g. wildland-urban interface, climate change, fire suppression capability)

6) Significant numbers of homes and businesses, **critical care customers**, and **critical infrastructure** will be **exposed to significant wildfire risk** past TURN's 2,500 circuit mile proposal

7) **Operational realities** must also be considered in determining the actual amount of deployment scope (**20% additional circuit miles** for spans adjacent to those determined to be high risk)

These points are expounded upon in more detail below:

(1) The Commission has defined levels of risk in its development of the CPUC Fire-Threat Map after careful consideration and analysis.[29] This map identifies areas designated as Tier 3 – areas with *extreme* wildfire risk; and Tier 2 – areas with *elevated* wildfire risk. SCE's risk analysis helped determine the assets that posed the highest risks (overhead conductors) and the most cost-effective solution at an enterprise level (covered conductor). SCE's WCCP request is for deploying covered conductor almost exclusively within these "extreme" and "elevated" risk areas.[30] In other words, the Commission has already decided that the areas SCE will protect with covered conductor are *inherently risky*. SCE's proposed scope of 6,200 circuit miles is a subset of the miles of overhead conductor in HFTD and based on resource and operational constraints. SCE's "risk buydown curve" and associated risk modelling is used to help prioritize risk mitigation efforts within the proposed scope to mitigate the riskiest portions of circuits first, instead of treating all segments within a circuit the same. While Cal Advocates' and TURN's proposals retain the material risk that would remain from an

29 *See* D.17-12-024.

30 In August 2019, SCE filed a Petition for Modification (PFM) of D.17-12-024, in which SCE proposed to officially add approximately 1% of SCE's non-CPUC-designated high fire risk area (HFRA) to the CPUC High Fire Threat District (HFTD) map. This area was considered to have a relatively higher potential for a fire to propagate than other non-CPUC HFRA. SCE's amended testimony, Exhibit SCE-04, Vol. 05A (submitted on November 22, 2019), reflected the areas that SCE filed in its PFM. *See also* July 5, 2019 AL 4030-E. *See* Section II.B.1.c)(3) for operational realities that may also require covered conductor outside of SCE's HFRA.

incomplete roll-out of WCCP, the Commission should not tolerate such risk. SCE's proposed plan can mitigate these avoidable risks and the potentially serious consequences associated with them.

(2) TURN argues that areas further down the risk buydown curve are less risky and therefore it is less cost-effective to install covered conductor in those areas as compared to earlier areas.[31] That more relative risk is "bought down" on earlier-installed circuit miles as compared to later-installed miles is both expected and positive, as that was the intended purpose of developing this risk buydown curve. It helps SCE determine *relative risk* and the prioritization of covered conductor installation to reduce risk as efficiently as feasible. Scope of deployment on the other hand should be determined not based on relative risk or relative cost-effectiveness among circuit segments, but the cost-effectiveness of reducing the absolute risk for any given circuit segment or circuit mile.

(3) The risk buydown curve is measuring *relative* risk reduction, not *absolute* risk reduction – destructive wildfires recently have occurred in SCE's service territory on circuit miles located in areas on the risk buydown curve that TURN would leave uncovered. The importance of considering absolute risk – the impacts to structures, public safety, and land – is discussed in further detail in Section (c)(1).

(4) Large wildfires have recently occurred from ignition points much further down the risk buydown curve than TURN's proposal. The risk of a relatively small fire becoming a catastrophic fire is largely driven by exogeneous factors (most importantly weather and fire-fighting response) that are not only outside of SCE's reasonable control but are also not yet sufficiently captured in the risk modelling. The risk buydown curve is based on a mathematical model that simulates the estimated effects of a wildfire that burns for only six hours. Experience has shown that extremely dangerous and destructive fires can last for days, not hours. Thus, the consequence captured in our risk model is not reflective of the worst-case scenario. It is critical to keep in mind that many potential ignitions – given the wrong conditions – could turn into the next catastrophic wildfire event. And it is these types of ignitions (i.e., contact from object, wire-to-wire contact, and wire-related equipment failure) that can occur during high wind events, that covered conductor is particularly effective at mitigating, which happen to be the same kinds of weather conditions that can lead to catastrophic wildfires if an ignition does occur. This is discussed in further detail in Section (c)(1).

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[31] *See* Exhibit TURN-02, pp. 14-20.

(5) The risk curve modelling was completed at a fixed point in time based on historical data. California's population continues to expand into the wildland-urban interface[32] and that the climate continues to warm.[33] Unfortunately, both factors make future catastrophic wildfires more likely. SCE cannot control either of those factors, but it can substantially reduce the number of ignitions associated with our equipment. As discussed in Sections (c)(4) and (c)(6) of this testimony, covered conductor is the most effective way to do so in SCE's service territory.[34]

(6) There are a significant number of homes and businesses that could be impacted by potential wildfires starting much further down the risk curve as compared to areas that TURN would propose covering. The risk curve assumptions TURN uses present an incomplete view of the world in another way: the model is heavily weighted towards acres burned instead of structures impacted by a potential wildfire. Focusing on the latter instead, as demonstrated in Section (c)(1) of this testimony, the curve appears much "flatter." Even more important than structures affected by a potential wildfire, are the hundreds of thousands of people living in SCE's HFRA in areas that would be excluded from the protection of WCCP. As explained in more detail in Section (c)(1) of this testimony, that population includes hundreds of critical care customers and thousands of critical infrastructure facilities. In SCE's view, despite the natural mathematical effect of diminishing relative risk reduction that results from installing covered conductor in a risk-prioritized fashion, it remains important to consider the people and communities that would be left out if one only focuses on that single measure.

(7) Even if the Commission were to determine that based on the risk buy-down curve there is an "acceptable" amount of risk to leave unmitigated by authorizing a lower number of total circuit miles "target" as compared to SCE's forecast, it is important to note that the installation of additional miles will still be necessary to efficiently achieve that lower target. That is because the risk buydown curve is based on a circuit segment basis, not a complete circuit basis. Accordingly, in order to install covered conductor on the riskiest circuit segments, SCE will need to install additional miles of

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32 *See* http://tejonranch.com/los-angeles-county-board-of-supervisors-finalizes-approval-of-centennial-at-tejon-ranch/

33 *See* https://www.gov.ca.gov/wp-content/uploads/2019/06/Strike-Force-Progress-Report-6-21-19.pdf

34 In its response to Data Request WSD-SCE-002, Q33, SCE showed its covered conductor has a ~62% mitigation effectiveness at the sub-driver level (summarized and attached hereto as Appendix A, p. A5).

covered conductor immediately adjacent to those segments for operational efficiency and other practical reasons. SCE further details this concept of an "operational installation buffer" in Section (c)(3).

Due to these points and those made in the testimony that follow, we urge the Commission to authorize our request and accordingly empower us to help continue to meaningfully address the wildfire crisis.

b) TURN

(1) TURN's Position

TURN recommends that SCE install a mere 2,500 cumulative circuit miles from 2019-2023 versus SCE's 6,272 circuit-mile forecast for the 2019-2023 period.[35] This assertion is based on inappropriately using SCE's risk *prioritization* curve for *scoping* purposes. TURN also does not fully take into account the risk exposure faced by the communities within SCE's service area. TURN incorrectly states that "SCE's risk analyses demonstrate significantly diminishing safety returns…"[36] TURN also believes that "SCE is unlikely to complete its forecasted level of covered conductor deployment."[37]

For the tree attachment program, TURN states, "[t]hough TURN does not oppose SCE's proposal to eliminate tree attachments as it installs covered conductor, TURN's reduction to SCE's covered conductor deployment necessarily reduces the number of tree attachments to be remediated over the forecast year. TURN assumes the number of tree attachments is reduced proportionally to the percentage reduction in covered conductor miles recommended by TURN in each year from 2021-2023."[38]

In addition to a reduced scope of covered conductor deployment and tree attachment remediations, TURN proposes reductions in both scope and unit cost to the pole replacements under the WCCP, which results in a total reduction of $2,143 million from SCE's

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[35] *See* Exhibit TURN-02, p. 25. SCE proposes using 2019 recorded number of circuit miles in place of SCE's 2019 scope forecast. *See* pp. 11-14 where TURN asserts that "[t]he scope of SCE's covered conductor proposal is not justified," and further stated that "SCE's …proposal does not target its scope based on cost-effectiveness or affordability constraints."

[36] *Id.*, pp. 14-20.

[37] *Id.*, pp. 20-21.

[38] *See* Exhibit TURN-02, pp. 25-26.

proposed $2,786 million for the WCCP in the 2021-2023 period.[39] First, TURN reduces the pole replacement scope in proportion to the covered conductor scope. Second, TURN assumes that SCE can utilize fire resistant wraps on wood poles, which has an incremental cost of approximately $1,600 per pole, on 75% of its pole replacements. For the remaining pole replacements, TURN assumes SCE can utilize composite poles, which have an incremental cost of approximately $5,100 per pole. TURN uses an average unit cost of approximately $2,500, weighted on the proportion of fire-resistant wraps and composite poles.

c) <u>SCE's Rebuttal to TURN's Position</u>

At a time when the State, this Commission, and many public agencies are doing everything in their reasonable power to reduce the public safety risks of wildfires, TURN is suggesting that SCE do dramatically less than what we have proposed. Adopting TURN's request would subject California, and SCE's service area and the customers who live and work there, to more wildfire safety risks. For example, in this testimony, SCE details how there is there is substantial absolute risk up to and beyond 7,000 miles on the risk buydown curve. SCE further illustrates that recent large fires (> 5,000 acres) have occurred up through 4,500 miles of the risk buydown curve. These fires could have grown much larger under the wrong conditions.

SCE's WCCP request in this GRC will move California significantly closer to the goal of no catastrophic utility-related wildfires. WCCP is the single most effective measure at expeditiously reducing near and long-term wildfire risk on SCE's electric system. SCE's current risk analysis[40] demonstrates that wildfire risk associated with overhead distribution-level facilities can be reduced by over 60% through its proposed deployment of covered conductor. While this deployment alone cannot eliminate all potential catastrophic wildfires, it will provide significant risk reduction in relatively short order through risk-prioritized deployment. As SCE details further in this testimony, there are no effective substitutes to the WCCP that will provide the corresponding amount of risk reduction, in the time it can be provided, without cost-prohibitive customer impacts.

As discussed in SCE's 2021 GRC Application and subsequently in its 2020-2022 WMP, SCE's wildfire risk modeling capabilities continue to evolve. As an example, in its 2021 GRC Application, SCE presented the "risk buydown curve" which illustrated the modelled wildfire risk per

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[39] *Id.,* pp. 24-25.

[40] *See* Appendix A, p. A5.

mile in HFRA, which conveyed the decrease of relative risk reduction as the deployment of covered conductor increased.[41] This risk buydown curve demonstrated how SCE planned to evolve its risk-*prioritized* deployment of covered conductor. Subsequent to the development of that illustrative figure, SCE has developed greater fidelity in its wildfire risk modeling capabilities, to transition from circuit level covered conductor risk buydown prioritization to an actual risk buydown curve that enables circuit segment level prioritization. In addition, SCE has revised its probability of ignition calculations from the aggregate circuit level to the circuit segment level. The wildfire risk at each circuit segment is developed using a machine learning algorithm built with historical data using over 100 variables related to conductor incidents to determine a probability of ignition, which is then combined with a circuit segment wildfire consequence score.[42] SCE has provided TURN an extensive amount of additional information on this topic, including a prioritization list that has the circuit name, circuit segment ID and miles, probability of ignition, consequence score, and risk score, among other variables like region, and Tiers 2 and 3.[43], [44], [45]

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[41] *Id*.

[42] The consequence module of the Wildfire Risk Model is based on the analysis performed by REAX Engineering. These calculations involve an input of high-resolution hourly gridded fields of relative humidity, temperature, dead fuel moisture, and wind speed/direction into Monte Carlo simulations that include an analysis of hundreds of thousands of ignition locations. Consequence is estimated as the product of the number of structures burned within a modeled fire perimeter and the fire volume (acres burned) associated with that fire perimeter. To limit the order of magnitude of consequence scores, these scores are scaled by a factor of 1,000. The formula is as follows: fire volume x impacted structures x 0.001. A description of the REAX methodology is available within the REAX supporting workpaper for 2021 GRC Exhibit SCE-01, Vol. 02.

[43] *See* TURN-SCE-042 Q4h (attached hereto as Appendix A, p. A6). SCE states, "The data, as well as the underlying calculations are extensive. In addition, the data does not reside in Excel format and was not intended to be used in an Excel-based application. Based on the compressed requested time frame to provide this information, and given that calculations reside in another software tool, in lieu of providing this information SCE respectfully offers to provide a telephonic demo of the data and the tool used to develop this data."

[44] *See* SCE 2020-2022 WMP, pp. 5-8. "Deployed in 2019, the asset-level Wildfire Risk Model (WRM) estimates probability and consequence of ignition using advanced analytics. The WRM's probability module uses machine learning capability to estimate the probability of an ignition from inherent equipment failure, current asset characteristics, or contact from a foreign object. The WRM's consequence module uses a fire propagation model that incorporates weather and fuel conditions along with other factors such as topography and housing and population density. The resulting ignition risk scores for each asset or circuit-segment location are used to target WCCP deployment, prioritize remediation of inspection findings, and guide our vegetation clearing activities."

TURN's argument pivots around what they consider to be less cost-effective. *Less* cost effective should not be confused with *not* cost effective. TURN's proposal is based on a faulty analysis of cost-effectiveness that compares relative risk reduction from any particular mile of covered conductor replacement to the risk reduction from the previous priority mile. But the relevant cost-effectiveness test should compare the cost of installing a mile of covered conductor to the absolute risk mitigated from that mile of covered conductor. In addition, as explained to TURN in a data request response:

> It is also important to recognize that [Risk-Spend Efficiencies] (RSEs) are not and should not be the only factor used to develop a risk mitigation plan. The RSE metric does not take into account certain operational realities, resource constraints, and other factors that SCE must consider in developing its plan. … Accordingly, SCE developed a comprehensive and balanced mitigation plan with activities that will collectively reduce the greatest amount of risk in the shortest amount of time, considering RSE as well as various regulatory, operational, resource, and cost constraints. It would be inappropriate to implement a comprehensive wildfire risk mitigation plan based solely on RSEs, which would likely lead to significant parts of the system and potentially significant risk issues left unaddressed.[46]

SCE addresses TURN's limited interpretation of the risk buydown curve and resulting inappropriate proposed reduction in scope for SCE's WCCP request in the testimony that follows.

(1) Adopting TURN's Proposal Would Leave Significant Risks Unaddressed

TURN argues that a majority of wildfire risk is concentrated in a portion of the total circuit miles in SCE's HFRA.[47] Because TURN believes SCE could mitigate a substantial portion of modelled relative risk by only deploying covered conductor on 2,500 circuit miles, TURN

Continued from the previous page

[45] SCE provided TURN the data supporting the new modeling capability. *See* TURN-SCE-013 Q1.c (attached hereto as Appendix A, p. A7). SCE stated, "Please see column 'covered' in attached Excel file 'TURN-SCE-013 – 01.a-3_Prioritization_List.csv.' Due to the method of capturing what has been scoped at circuit level and translating that to segment level, some segments that have scoped may be mapped to more than one segment from the prioritization list. As a result, the completed segment list may show more segments and miles than what has been actually scoped."

[46] *See* TURN-SCE-005, Q4 (attached as Appendix A, p. A8-A10).

[47] *Id.*, pp. 12-13.

suggests dramatically fewer circuit miles for WCCP. SCE agrees that the installation of covered conductor in the first few years of the WCCP program will likely capture greater per-mile risk reduction than the miles of conductor covered in the later years of the program. This is a simple product of the effective risk-informed deployment strategy that SCE employs.[48] However, TURN's proposal would leave substantial risk on the system.

While current models show relative risk reduction declining as deployment increases (which is expected), substantial risks would remain under TURN's proposal. The risk buydown curve is measuring *relative* risk reduction, not *absolute* risk reduction. It is important to understand the relative magnitude of wildfire risk (which could be mitigated by covered conductor) remaining along the curve. While it may appear that risk approaches a small amount towards the right-hand side of the curve, this is largely due to the wide-ranging scale of REAX wildfire consequence scores (from 0 to over 100,000), and the extremely high modeled risk associated with some areas of the risk curve. In other words, the curve appears steep because certain circuit segments have extraordinarily high risk values.

The illustrative risk curve shown in SCE's direct testimony conveys risk in relative terms.[49] While this can be informative, making decisions purely on relative risk curves is not adequate. It is important to also review the absolute risk associated with points on the risk curve, to fully understand the tangible consequences associated with that risk. While ignitions associated with points along the far right-hand side of the risk curve have not led to large catastrophic wildfires in recent years, it does not mean that they will not in the future. These potential ignitions pose real risks to adjacent communities and the outcome of the ignitions can depend greatly on weather conditions and third-party fire-fighting abilities to effectively contain resulting wildfires. There are no guarantees that weather factors will be favorable in the event of future ignitions. In Table II-7 below, SCE illustrates the consequence portion of the wildfire risk associated with various points on the risk curve, in natural units of measure (i.e., absolute risk). For example, this table shows that for the cost of deploying one mile of

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[48] *See* TURN-SCE-013 Q1.e (attached hereto as Appendix A, p. A7). SCE stated, "SCE generally seeks to deploy covered conductor from the highest to lowest risk segment. However, SCE considers many factors, including, but not limited to, design/engineering, permitting requirements, work management scheduling (e.g., bundling of work), existing remediation and maintenance activities, weather, and environmental constraints that could alter the order in which segments are selected for covered conductor deployment."

[49] *See* Exhibit SCE-04, Vol. 05A, p. 27, Figure II-9.

covered conductor (~$421,000 (2018 constant $)) along some point on SCE's system between 5,001 and 6,250 cumulative miles on the risk curve, on average, 23 structures and 1,597 acres could be prevented from destruction. This is further illustrated in Figure II-1. Due to the limitations of REAX fire propagation modeling (i.e., 6 hours) the average potential wildfire consequence per mile in the Table II-7 below is a conservative value (i.e., in a real-world fire, the damages or "consequence" could very well be much greater).

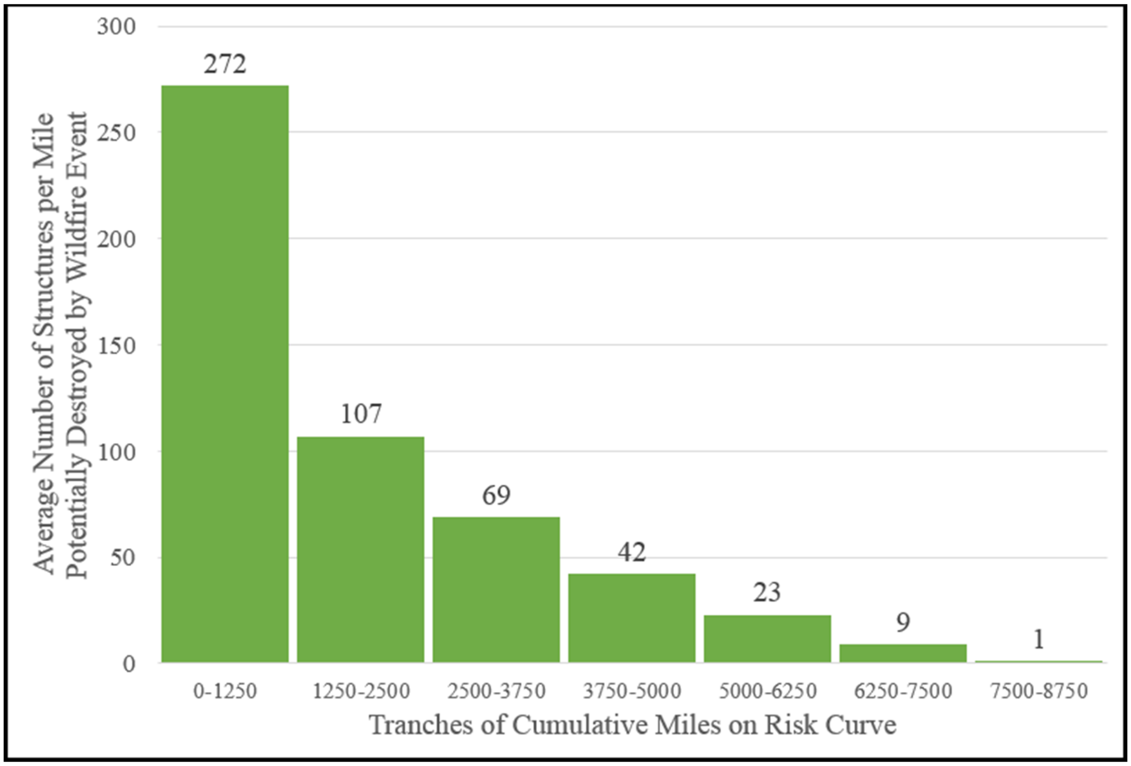
Table II-7
Average Wildfire Consequence Along the Relative Risk Buydown Curve

Tranches of Cumulative Miles on Risk Curve	Average Reax Score for Tranche[50]	Average Wildfire Consequence per Mile for Tranche[51]
0-1,250	6,849	272 structures and 33,036 acres
1,251-2,500	1,291	107 structures and 16,830 acres
2,501-3,750	371	69 structures and 8,617 acres
3,751-5,000	104	42 structures and 4,102 acres
5,001-6,250	24	23 structures and 1,597 acres
6,251-7,500	3	9 structures and 334 acres
7,501+	0	1 structure and 23 acres

[50] Rounded to nearest whole number. REAX values are derived from current DOTS 2.0 risk-prioritization model.

[51] Rounded to nearest whole numbers. Consequence data from original methodology used to populate illustrative risk buydown curve shown in SCE's direct testimony and TURN testimony. SCE has also "mapped" the consequence data to current DOTS 2.0 model.

Figure II-1
Histogram of the Average Absolute Risks Displayed in Table II-7

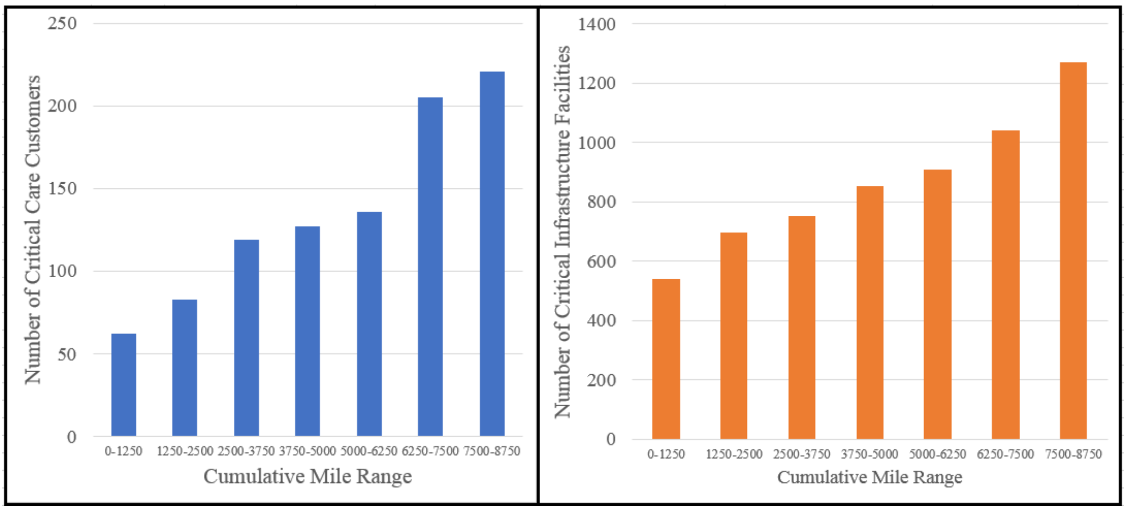


Further, it is important to understand the impacts to some of SCE's most vulnerable residential customers and essential services facilities in areas throughout the risk curve.[52] It is important to understand the limitations of TURN's proposal as it relates to the ability for covered

[52] These residential customers are classified as critical care customers, which means they depend on the use of life-supporting medical devices for their survival and cannot tolerate loss of electricity sources for two or more hours. In accordance with the interim definition adopted in D.19-05-042, those facilities and infrastructure that are essential to the public safety and that require additional assistance and advance planning to ensure resiliency during de-energization events, namely emergency services sector (police stations, fire stations, emergency operations centers), government facilities sector (schools, jails, prisons), healthcare and public health sector (public health departments, medical facilities, including hospitals, skilled nursing facilities, nursing home, blood banks, healthcare facilities, dialysis centers and hospice facilities), energy sector (public and private utility facilities vital to maintaining or restoring normal service, including, but not limited to, interconnected publicly owned utilities and electric cooperatives), water and wastewater systems sector (facilities associated with the provision of drinking water or processing of wastewater including facilities used to pump, divert, transport, store, treat and deliver waste or wastewater), communications sector (communication carrier infrastructure including selective routers, central offices, head ends, cellular switches, remote terminals and cellular sites), and chemical sector (facilities associated with the provision of manufacturing, maintaining, or distributing hazardous materials and chemicals).

conductor to lessen the potential for wildfires to affect critical care customers, medical baseline customers, income qualified customers, critical facilities, etc., and mitigate other impacts including PSPS for those customers. Figure II-2 shows the counts of some of these types of customers and facilities by cumulative circuit miles on the risk curve. Adopting TURN's proposal would leave out more than eight hundred critical care customers and approximately 5,000 critical infrastructure facilities.

Figure II-2
Histograms of the Number of Critical Care Customers (Left) and Critical Infrastructures Facilities (Right) Along the Relative Risk Buydown Curve



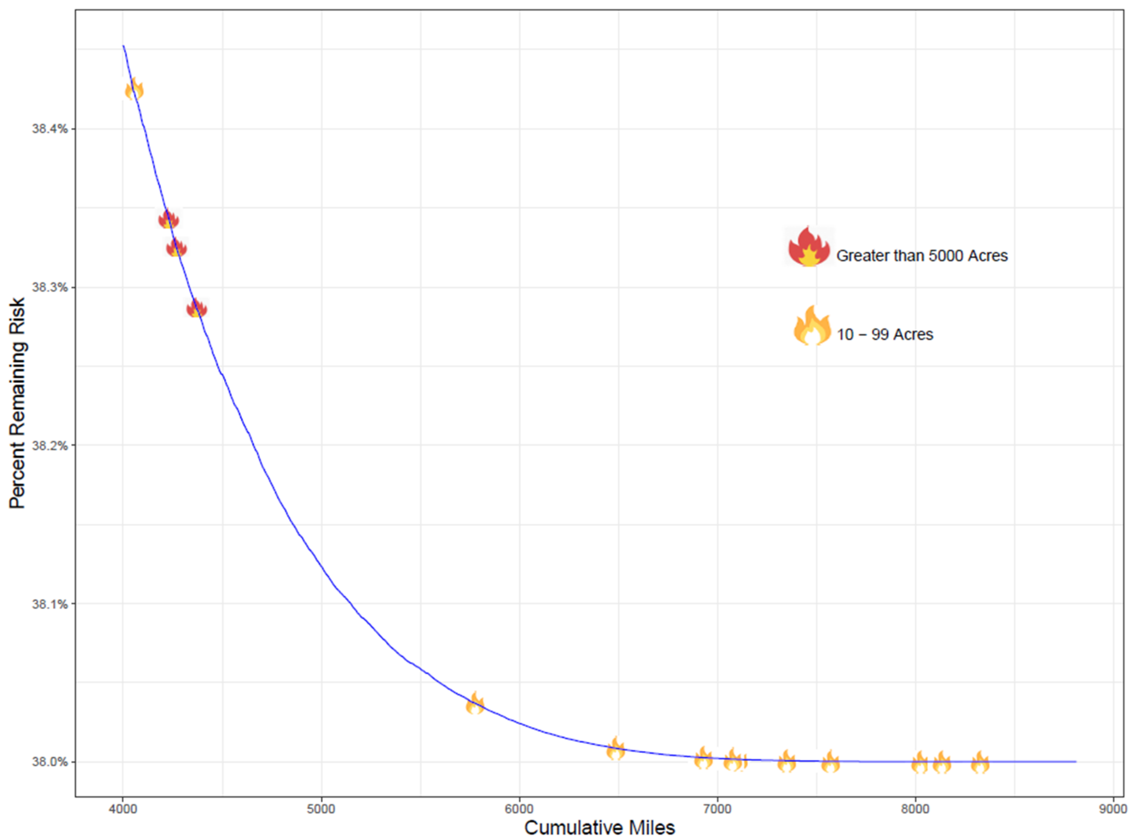
Adopting TURN's proposal would leave the vast majority of the elevated and extreme wildfire risks areas – *as determined by the Commission* -- unmitigated by covered conductor. SCE has approximately 9,600 circuit miles of overhead circuit miles located in the Commission's designated Tier 3 and Tier 2 HFTD areas; TURN proposes that SCE cover only 2,500 of those miles. Many customers who live in these high wildfire risk areas are also the constituencies that the Commission and SCE are proactively trying to assist with various customer programs. SCE believes it is prudent to continue its grid hardening efforts in areas beyond the very highest risk areas to protect these communities, including their vulnerable customers and critical infrastructure facilities.

(2) <u>TURN's Proposal Would Leave Parts of the System Completely Uncovered Where Some Of The Largest Fires Have Occurred</u>

SCE's portfolio of wildfire mitigation activities is designed to protect public safety, and SCE's WCCP is the primary mitigation to quickly and comprehensively buy down public safety risk associated with wildfires. TURN's proposal would leave significant parts of the system completely uncovered, including locations where large fires have occurred in recent years.

To illustrate this, SCE has overlaid large historical reportable ignitions which have occurred since 2014 on the updated risk curve presented previously. As can be seen in Figure II-3 below, there have been three recent ignitions greater than 5,000 acres which occurred up to the 4,500 mile-mark. In other words, while the relative modeled risk reduction does decrease beyond 2,500 miles, there is substantial risk – not just modeled risk – proven to have occurred beyond 2,500 miles.

Figure II-3
Overlay of Historical Large Fire Events
on SCE's Relative Risk Buydown Curve



SCE has presented a solution – its WCCP program – to dramatically reduce the potential for ignitions that have the potential to lead to catastrophic wildfires. It is clear from this figure that TURN's proposal could prove to be insufficient in preventing ignitions from occurring and turning into large wildfires of the same size and scale that California has seen in recent years.

(3) TURN's Proposal Does Not Account For The Operational Realities Of Deploying Covered Conductor Or The State's Objective of "Significant Reduction and Eventual Elimination" Of PSPS Activations[53]

There are operational factors that SCE must account for when deploying covered conductor. These can include planning and execution lead time, construction methods, work management efficiencies, and compliance requirements. These factors can affect the actual scope of covered conductor deployment relative to the scope initially identified based on risk analysis.[54] Based on SCE's experience with covered conductor scoping and deployment, these operational realities result in the necessary deployment of additional miles of covered conductor, much of which are not contiguous on the risk curve to the circuit segments identified for original scoping.

Therefore, it is not practical or efficient to exactly align the circuit segments (and associated miles) of deployment of covered conductor to the risk buydown curve. In its testimony, TURN signals understanding of certain operational realities.[55] However, TURN's proposal of 2,500 cumulative miles is solely based on the risk buydown curve, which is merely a mathematical model to help SCE prioritize deployment of covered conductor, and does not, nor was it intended to, capture these kinds of operational realities.

Accounting for operational realities of deploying covered conductor and capturing PSPS benefits for customers necessarily increases the scope of covered conductor as compared to the number of miles that would be covered strictly pursuant to the risk analysis by more

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53 *See* May 7, 2020 Wildfire Safety Division Draft Resolution WSD-004, p. 4.

54 *See* TURN-SCE-005, Q38 Revised (attached hereto as Appendix A, p. A11). SCE states, "The prioritization is driven by risk which is the product of probability and consequence. Due to dynamic improvements to the prioritization model, engineering design, planning, and operational execution, many factors are considered that may alter the order that these segments are selected for covered conductor deployment. Therefore, the deployment over the GRC cycle of the covered conductor in the HFRA is unlikely to be identical to the designated risk priority."

55 *See* Exhibit TURN-02, p. 23. "TURN recognizes SCE's position that it cannot deploy covered conductor in the exact order (highest to lowest risk) prescribed by its GRC analysis."

than an estimated 20%.[56] The two sections below discuss the operational realities and PSPS benefits related to the deployment of covered conductor in more detail.

(a) <u>Operational Realities Of Deploying Covered Conductor At The Circuit Segment Level Requires Installation Of Additional Circuit Miles</u>

In the field, when SCE installs covered conductor, it necessarily does not solely cover the particular circuit segment explicitly identified by the wildfire risk analysis. Instead, SCE prudently extends that covered conductor installation to the next contiguous structure with equipment or the next structure that is a dead-end, even if those structures are outside of the range of the initial scoping predicted by the risk model.

Other operational considerations come into play as well: For example, pole loading is another important operational consideration when installing covered conductor. The extra weight and the associated wind loading of covered conductor becomes a concern where it meets with a bare conductor. The imbalance of pull on a pole requires guying.[57] In many cases, guying can be challenging if there is a lack of locations for the guying, easement requirements, etc. Often, it is most operationally feasible to extend the installation of covered conductor to a point where there is sufficient space for a guy wire or to extend to a location where a guy wire is not needed.

As another example, installation of covered conductor where there are multiple circuits on the same structures also poses operational considerations. In these cases, the two circuits may be on different points of the risk curve. This occurs when circuits have different probabilities of ignition, but the same wildfire consequence. It is often more cost-effective and makes more operational sense out in the field to cover the circuit segments of all circuits along the same path. As an additional benefit, this also lessens the impact to the surrounding customers, who would otherwise experience a second set of outages if SCE were to come back for the adjacent circuit segment later.

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[56] SCE estimates that accounting for operational realities for covered conductor deployment requires an additional ~20% circuit miles. *See* Appendix A, p. A12. Further, to capture PSPS benefits, SCE would require some additional amount of circuit miles.

[57] Guying is a process of attaching a pole to a stabilizing structure, such as the ground.

SCE conducted an analysis for 2021 forecast covered conductor scope that demonstrates that on average this "operational buffer" equates to approximately 20% additional circuit miles in addition to those miles explicitly scoped based on risk analysis.[58]

(b) Covered Conductor Has PSPS Benefits, But Requires Additional Circuit Miles To Be Covered To Achieve These Benefits

Covered conductor also has additional benefits beyond reducing wildfire risk– if deployed effectively, it can reduce the activation of PSPS events. SCE understands the impact PSPS has on its customers and is focused on reducing that impact. Furthermore, in the Wildfire Safety Division's Draft Resolution to SCE's 2020-2022 Wildfire Mitigation Plan, it states "…The result should be that each passing year California is safer from wildfire threats, with a significant reduction and eventual elimination of the need to use Public Safety Power Shutoffs (PSPS) as a mitigation action."[59] Covered conductor can help achieve this shared objective.

Deployment of covered conductor provides protection from contact from object blow-in risk, wire-to-wire contact and equipment failure. The deployment of covered conductor not only replaces the existing conductor but also resolves any outstanding remediations, verifies pole loading of all structures and restores the circuit segments to as-built condition with the most recent high fire risk area standards (e.g., fire-resistant poles, composite cross-arms, etc.). Having circuits that are at current high fire risk area construction standards, with covered conductor installed, will increase the threshold for that circuit's de-energization criteria and reduce the need and impact of PSPS. However, for these covered circuit segments to benefit from the increased de-energization threshold, a similar operational issue as previously discussed must be considered. A circuit segment that has covered conductor deployed cannot meaningfully reduce PSPS impacts if SCE is not able to electrically isolate that circuit segment from its contiguous circuit segments that still have bare conductor. Thus, SCE must install covered conductor to the next structure that will allow SCE to isolate the covered portion of the circuit from the bare portion of the circuit. In order to achieve this PSPS benefit for any isolatable portion of a circuit, additional circuit miles will be required. These circuit

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[58] *See* Appendix A, p. A12.

[59] *See* May 7, 2020 Wildfire Safety Division Draft Resolution WSD-004, p. 4.

miles will be determined on a case-by-case basis during scoping & design based on the feasibility to operationalize this benefit.

Any level of covered conductor scope adopted by the Commission should consider the incremental circuit miles required to account for these operational realities and PSPS benefits.

(4) <u>The Practical Alternatives To Covered Conductor Are (1) Repeated And Increasing Use Of PSPS Or (2) Widespread Undergrounding – The Former Is Not A Viable Long-Term Strategy; The Latter Is Financially Prohibitive And Practically Infeasible.</u>

Over the last five years, the ignition frequency from Contact from Object (CFO)[60] and Wire-to-Wire contact have averaged ~58%[61] of the total overall ignitions in SCE's HFRA service territory. There are only three mitigation programs within SCE's suite of wildfire mitigations that span and mitigate, at least partially, each one of those CFO and Wire-to-Wire contact risk drivers: covered conductor, repeated and increasing use of PSPS, and widespread undergrounding.

SCE recognizes the burden that PSPS places on our communities and understands that it is a mitigation of "last resort" and not a long-term, sustainable solution. Through grid hardening mitigation programs, SCE expects to reduce the frequency and impact of PSPS de-energization as covered conductor is installed, but it does have to remain an available tool during severe and extreme weather events.

Undergrounding, as a program, does mitigate most risk drivers, however, it is financially prohibitive and practically infeasible from a widespread deployment perspective – SCE has over 9,600 circuit miles in its HFRA, and many of these miles are in areas with terrain prohibitive to undergrounding. In addition, SCE's risk-spend efficiency (RSE)[62] calculation shows that undergrounding has five times lower RSE than that of covered conductor.

Covered conductor can be deployed much faster and more cost-effectively than undergrounding circuits, has much longer useful life (~45 years) than PSPS, and provides continuous risk mitigation benefits over its life. And because circuits that receive covered conductor

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[60] Contact from Object risk sub-drivers: Animal, Balloons, Vegetation, Vehicle, and Unspecified.

[61] Calculation based from SCE 2020-2022 Wildfire Mitigation Plan, Table 18A.

[62] Based on SCE's 2020-2022 Wildfire Mitigation Plan.

treatment also get brought up to current standards for related equipment, the benefits of covered conductor deployment extend beyond just mitigating CFO and Wire-to-Wire contact risk drivers, and also include mitigating additional equipment failure ignition drivers (e.g., conductor, crossarm, insulator, splice/clamp/connectors). The ability for covered conductor to mitigate such a broad spectrum of wildfire risks versus other alternatives is why it is the foundational mitigation program in SCE's portfolio.

(5) <u>TURN Mischaracterizes SCE's Execution Capabilities – SCE Can Execute The Volume Of Scope Requested</u>

Here, SCE addresses TURN's arguments related to SCE's execution capabilities; in addition, SCE further addresses this concept in our rebuttal to Cal Advocates' arguments later in this testimony. TURN's assertion that "SCE is unlikely to complete its forecasted level of covered conductor deployment" is unreasonable.[63] In its testimony, TURN displays a graph showing SCE's year-over-year scope of Overhead Conductor Program (OCP) work from 2015-2018, and covered conductor work in 2019, 2021, 2022, and 2023, in an attempt to illustrate that SCE's proposed WCCP ramp-up is too steep.[64] But TURN's graph omits vital information that is important to understand when evaluating the full capabilities of SCE's deployment capabilities. First, OCP and WCCP are concurrent programs, so it is inappropriate to stop showing the OCP program in 2019 and beyond. Also, the title of TURN's plot states "Recorded OCP and Covered Conductor Deployment…," yet its plot did not show 2019 recorded OCP numbers. Most importantly, however, TURN's analysis fails to take into account that OCP and WCCP are very different programs. While sharing some similarities in terms of operational deployment, SCE never intended to deploy OCP at the scale and to the extent which it intends to deploy covered conductor. OCP was a relatively narrow, focused program, primarily used in urban areas to proactively and reactively replace small wires that were in danger of falling down. It is an important program, but merely one of many tools in SCE's infrastructure replacement toolbox. WCCP, on the other hand, is a comprehensive, territory-wide (in HRFA) large-scale program that is SCE's primary wildfire mitigation initiative and is designed to aggressively buy down risk to safeguard the public from the existential threat of catastrophic wildfires. OCP was not resource-constrained; rather SCE's relatively limited OCP rollout was a function of regulatory constraints (including those driven by

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[63] *See* Exhibit TURN-02, p. 20.

[64] *Id.*, p. 21, Figure 6.

opposition from parties like TURN in the 2018 GRC) and competing priorities. Although OCP and WCCP use the same types of crews, it is not reasonable to directly compare the two programs when developing future scope.

SCE also takes issue with TURN's illustration of SCE's covered conductor mile forecasts. Notably absent from TURN's graph is the 2020 year. It is not clear why 2020 is omitted, but its omission has the effect of skewing the graph and portraying a misleadingly steep growth rate between 2019 and 2021. Finally, SCE made significant reductions to Distribution Infrastructure Replacement to re-prioritize resources to focus on WCCP.[65]

(6) TURN Inappropriately Ignores The Rigorous Testing, Engineering Evaluations, And Benchmarking[66] Efforts Performed On Covered Conductor

TURN's claim that "the actual performance of covered conductor for reducing ignitions in high-risk wildfire conditions has not been validated in the field" is incorrect. As SCE explained in its direct testimony, SCE has carefully researched, evaluated, and vetted the use of covered conductor to mitigate wildfire risk. These evaluations include examples of actual field deployment of covered conductor. Included in the extensive materials provided to TURN, SCE demonstrated that covered conductor prevents faults from occurring and avoids ignitions at the site of the fault and potential failure of upstream conductor. Compared to alternatives that also have significant risk reduction benefits, specifically undergrounding and PSPS, covered conductor has proven to be more cost-effective (versus the former) and has less societal impacts (versus the latter). As part of its GRC submission, SCE provided a Covered Conductor Compendium as part of its workpapers.[67] This document describes, in detail, the testing, evaluation and benchmarking that SCE conducted to arrive at the decision to pursue covered conductor to the extent it is as part of its wildfire mitigation efforts. Specifically, this document explains the technical details of covered conductor, why SCE is pursuing it

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[65] *See* Exhibit SCE-02, Volume 1, Part 1.

[66] SCE has benchmarked with the following utilities regarding covered conductor: S. Korea (Korea Electric Power Company – KEPCO), Australia (Ausnet), Massachusetts (National Grid, Groveland Light, Holyoke, Middleton), New Hampshire (Eversource, Liberty Utilities), New York (Con Edison, Orange and Rockland Utilities), Washington (Seattle City Light, Puget Sound Energy), and Colorado (United Power). *See* R.18-10-007 Data Request MGRA-SCE-003 (attached hereto as Appendix A, p. A13).

[67] *See* Exhibit WPSCE04Vol05APt01, pp. 3-246 (attached hereto as Appendix A, pp. A14-A256).

as the cornerstone of its wildfire mitigation efforts, what the expected service life of covered conductor is, industry and benchmarking performed to validate its benefits, and construction standards and guidelines for use of covered conductor. Among the bases for SCE's decision to use covered conductor was the success of its deployment in other countries. For example, as a result of devastating bushfires in Australia, the 2009 Victorian Bushfires Royal Commission issued a report listing a variety of recommendations, among which were installing covered conductor and removing trees outside of the clearance zone but could come into contact with an electrical power line.[68] The implementation of such multiple mitigations has resulted in marked improvements in bushfire risk performance.[69] SCE made the decision to pursue covered conductor only after extensive evaluation and deliberation with technical experts. As TURN recently acknowledged, "if targeted properly, covered conductor can be an important and extremely effective wildfire risk mitigation tool."[70]

Beyond the research, evaluation and analysis conducted by SCE before deciding to pursue covered conductor as a key cornerstone to its wildfire mitigation portfolio, SCE has also begun analyzing early data associated with its rollout. To date, no ignitions on SCE's system resulting from contact from object or wires down have been reported on lines that have had bare conductor replaced with covered conductor. SCE will continue to evaluate the effectiveness of covered conductor, but given its extensive evaluation before deployment, and that early in-the-field results are confirming the previous pre-deployment analysis, it is appropriate to continue its deployment strategy. While SCE will continue to evaluate relevant effectiveness data moving forward, all information available today supports SCE's planned covered conductor deployment strategy for addressing wildfire risk.

(7) Accepting TURN's Reduced Scope for Tree Attachments Would Put Customers and Communities At Risk

Tree attachments are instances where the overhead conductor is supported by trees instead of utility poles. With significant and destructive wildfires being the new normal in California, and the deteriorated condition of these trees increasing due to the effects of a changing

[68] *See* http://royalcommission.vic.gov.au/finaldocuments/summary/PF/VBRC_Summary_PF.pdf at p. 29.

[69] *See, e.g.,* Bryant, Phil, Ausnet Services, "Meeting our bushfire safety obligations" dated June 15, 2018, p. 36, available at https://www.ausnetservices.com.au/-/media/Files/AusNet/About-Us/Determining-Revenues/Distribution-Network/Customer-Forum/Weeks-3-and-4/Bushfire-safety-obligations.ashx?la=en.

[70] *See* Exhibit TURN-02, p. 8 in A.18-09-002, the GSRP proceeding.

climate, SCE proposes the removal of existing conductor from trees in HFRA. Though TURN does not oppose SCE's proposal to eliminate the tree attachments, TURN reduces SCE's tree attachment program by 70% in the forecast amount.[71]

SCE's tree attachment program started over 40 years ago. The program was established on the premise that it would be far easier, from both an operational and construction perspective, to install utility equipment directly to living trees rather than to set new poles in difficult terrain. Live trees in the forest have good insulation and contain certain chemicals that make them impervious to termites. This was a common practice at that time, but many of the trees were killed by bark beetles and have dried up, presenting increased wildfire risk. SCE now proposes the removal of all tree attachments in its HFRA.

In its GRC forecast, SCE assumed that a rollout of tree attachment scope would generally follow that of covered conductor. The primary reason for this approach was operational. There are operational efficiencies gained by replacing tree attachments together with covered conductor deployment, rather than scoping each program separately, given the similarity in construction and design. This does not mean, however, that a reduction to covered conductor scope should result in a subsequent reduction in tree attachments. If any reduction to SCE's WCCP request were adopted by the Commission, SCE still believes it is prudent to remove all tree attachments in its service territory. A lot has changed since SCE relied on construction standards that included these tree attachments, including changes to the state's climate and wildfire risk profile. The trees with these attachments have been subjected to continually drier conditions and continue to be at risk of becoming diseased or dying. By their nature, these assets pose a unique wildfire risk. They are assets, in vegetative areas, attached to trees that are subject to conditions that are worsening. Regardless of the Commission's decision on SCE's covered conductor scope, SCE believes that our forecast for tree attachment removals should be adopted.

(8) <u>TURN's Proposal For The Use Of Fire-Resistant Pole Wraps Has Merit, But The Ratio Between Pole Wraps And Composite Poles Requires Modification</u>

When SCE filed its 2021 GRC application, SCE assumed that 100% of the pole replacements performed through WCCP would be fire-resistant composite poles. SCE has

[71] *See* Exhibit TURN-02, pp. 24-26.

continued to evaluate the engineering principles and mitigation strategies regarding fire-resistant pole technologies and agrees with TURN that a combination of both fire-resistant pole wraps and composite poles is appropriate for use within SCE's HFRA. As stated in its Off-Ramp Report and 2020-2022 WMP, through fire testing and technical evaluations in 2019, SCE understands that a fire-resistant wrap is capable of withstanding temperatures exceeding 2,100 degrees Fahrenheit.[72] Applying a protective layer to new wood poles has proven to be an effective measure to protect from the typical conditions a wood pole may be subjected to during a passing wildfire (after an ignition has occurred). Additionally, fire-resistant wraps have an incremental cost of approximately $1,600 per pole, whereas composite poles have an incremental cost of approximately $5,100 per pole. SCE agrees with TURN that this fire-resistant pole-wrapping technology is a cost-effective alternative to installing fire-resistant composite poles. However, while TURN proposes a ratio of 75% and 25% for fire-resistant wraps and composite poles, respectively, a more appropriate ratio would be a ratio of 60% and 40%, respectively. TURN has subsequently confirmed that its 75/25 percentage split was arbitrary and unsupported.[73] SCE's proposal of a 60/40 percentage split is based on a decision tree logic[74] that SCE uses to determine which fire-resistant material is appropriate to deploy, and is consistent with SCE's 2020-2022 WMP.[75]

Installing fire-resistant wrapped poles is not always feasible or appropriate. For example, at locations with pole-top electrical equipment, risers, or known woodpecker problem areas, SCE will continue to deploy composite poles. This logic is based on preventing pole-top ignitions from equipment sparks and ensuring pole structure integrity from woodpecker damage. Generally, in most other applications, SCE plans to use fire-resistant wrapped wood poles, however, there are times when terrain, access and operational realities will necessitate the use of fire-resistant composite poles.

For either pole type there is also a dependency on material availability. SCE will also continue to evaluate its decision tree logic based on results from deployment of covered conductor and fire-resistant poles. It is important that SCE evaluates the type of fire-resistant pole

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72 *See* SCE Advice 4120-E, p. 17 and SCE 2020-2022 Wildfire Mitigation Plan.

73 *See* SCE-TURN-012 (attached hereto as Appendix A, pp. A257-A258).

74 *See* Workpaper – Decision Tree Logic in Appendix A, p. A259.

75 *See* SCE 2020-2022 WMP, pp. 5-4, 5-156 for discussion related to fire-resistant pole wraps and composite poles.

required for each installation on a case-by-case basis. This is one of many reasons why a two-way balancing account for wildfire management costs is reasonable and would help ensure that the best solutions are provided in each situation to maximize wildfire risk mitigation and resiliency.

SCE's modification of using a 60/40 ratio results in a reduction of $138 million from SCE's original forecast for the 2021-2023 period.[76] This is based on full adoption of SCE's WCCP circuit mile forecast. As the volume of pole replacements is based on the volume of WCCP miles, a proportional adjustment to the pole replacement forecast is required relative to the eventual adopted WCCP circuit mile forecast.

d) Cal Advocates

(1) Cal Advocates' Position[77]

Cal Advocates did not oppose SCE's 2019[78] and 2020 capital forecasts; however, Cal Advocates proposed a Test Year scope of 1,000 circuit miles, which is a 400 circuit mile reduction from SCE's forecast of 1,400 miles. Cal Advocates claims that "this is a reasonable compromise between the three-year average for 2019-2021 of about 900 circuit miles per year versus the five-year average for 2019-2023 of about 1,200 circuit miles per year."[79] Cal Advocates stated that it "expects that the rate of expansion of circuit miles installed will be slower than SCE's forecast."[80] Cal Advocates proposed Test Year funding equal to $625.8 million, a $237.3 million reduction from SCE's forecast.[81]

e) SCE's Rebuttal to Cal Advocates' Position

(1) Cal Advocates' Assertion that the Rate of Installation in the Test Year will be Slower than SCE's Forecast is Unfounded and Inconsistent with the Current Pace of Deployment

Cal Advocates' conjecture of a slower expansion rate of circuit miles installed has no basis and should be rejected. SCE continues its commitment to aggressively reduce

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[76] *See* Workpaper – FR Wrap vs. Composite Poles Calculations in Appendix A, pp. A260-A261.

[77] *See* Exhibit PAO-09, pp. 12-15.

[78] *Id.*, p. 14. "The Public Advocates Office recommends that this forecast should be used until the 2019 recorded costs can be audited and reviewed with the wildfire memorandum accounts in later phases of this GRC."

[79] *Id.*, pp. 14-15.

[80] *Id.*, p. 14, lines 23-24.

[81] *Id.*, p. 15, lines 4-6. Cal Advocates used SCE's WCCP forecast amount in 2020 for the test year 2021.

wildfire risk and install covered conductor on 1,400 circuit miles in 2021 as originally forecasted. There have been no specific changes to our capital request in terms of planning. SCE continues to design and engineer work scope for 2021 and beyond. As discussed throughout SCE's Application, mitigating wildfire risks is a primary objective of SCE's overall request. To effectively and aggressively mitigate this risk, SCE has taken significant measures to help ensure we have the resources available to perform critical wildfire mitigation work over this GRC period. To accomplish this, SCE has significantly reduced its forecast for many activities, including infrastructure replacement programs, so that the resources – the planners, engineers, field crews, project support personnel, etc. – can shift their focus to supporting the aggressive ramp-up and deployment of wildfire mitigation measures, including and especially, the installation of covered conductor.[82] SCE is increasing crews and building up design/engineering capabilities to handle increased mileage each year.[83] SCE is also working with suppliers to help ensure materials are available as required.

Separately, SCE has proven that it can effectively and expeditiously ramp up new programs, including for its overhead conductor program (OCP) and covered conductor itself. In 2019 SCE greatly exceeded its 2019 WMP goal (96 miles) and GRC forecast (291 miles) for covered conductor.[84] Thus far, SCE is ahead of its internal monthly plan to deploy 1,000 circuit miles in 2020. SCE expounds on this argument in its rebuttal to TURN in section (c)(5).

(2) <u>It Is Inappropriate To Use 2019 To Set The Volume Of Work Authorized In The Test Year</u>

Cal Advocates used 2019 in its three-year and five-year averages calculations in proposing 1,000 circuit miles for TY2021. But 2019 was the first full year of WCCP and it would be inappropriate to include the initiation year as part of a three- or five-year average for forecasting purposes. Installation rates for these types of program (e.g., OCP, WCCP) deployment is typically lower in the initiation year. The lower execution rate for new programs in these early years is due to the time required to scope and design projects that will be ultimately constructed in the field. SCE did not put forth the covered conductor circuit mile forecast without purpose. In fact, the reason why SCE included a significant ramp-up over the years, going from 291 miles in 2019, to 1,000 miles in

[82] *See* Exhibit SCE-02, Vol. 1 Pt. 1, p. 14, lines 4-17.

[83] *See* Data Request CUE-SCE-001 Q1 (attached hereto as Appendix A, pp. A262-A263).

[84] *See* Exhibit SCE-04, Vol. 06, p. 2.

2020, 1,400 miles in 2021, 1,600 miles in 2022 and 1,900 miles in 2023, is largely due to the fact that production capabilities will need to be built gradually over time. While the use of historical averages is often appropriate for long-standing historical programs, using an average to determine a level of work does not make sense when looking at a new program with significant efforts being undertaken to ramp-up capacity and reprioritize work to quickly address wildfire risks.

(3) <u>Cal Advocates' Proposal To Reduce SCE's WCCP Forecast To 1,000 Circuit Miles In 2021 Has Cumulative Implications</u>

The effect of Cal Advocates' proposal to reduce SCE's forecast to 1,000 circuit miles in 2021 would not be limited to 2021 – although Cal Advocates' testimony is silent about its proposal for 2022 and 2023 scope, its Results of Operations model makes clear that they would extend their proposed cuts to those future years (i.e., 1,000 miles in each of the three years). This would affect the overall execution capability of the program. As mentioned above, SCE's covered conductor program is new and has been forecasted with a year-over-year ramp-up to allow for the needed increase in production capacity, as described above.

Cal Advocates' proposal of 1,000 circuit miles in 2021 would not only delay 400 circuit miles of risk-reduction in 2021, but would also likely have the cumulative effect of delaying an additional 1,500 circuit miles of work in 2022-2023. Pushing a total of 1,900 circuit miles out of this rate case cycle would potentially subject thousands of customers to wildfire risk that could be mitigated with the installation of covered conductor as shown earlier in Table II-7.

C. <u>Distribution Fault Anticipation</u>

1. <u>Capital Expenditures</u>

a) <u>SCE Application</u>

Distribution Fault Anticipation (DFA) is a technology that provides three primary functions that help minimize potential fire ignition risks and increase circuit reliability: 1) alerts SCE to where future faults ("Incipient Faults") may occur and thus allow for proactive remediation, which will minimize potential fire ignition risks and increase circuit reliability; 2) facilitates the analysis of fault data, improving SCE's ability to pinpoint the source of a fault and make appropriate mitigations and/or repairs; and 3) monitors the operation of capacitor banks. Further details on DFA are provided below that explain these technology features which DFA provides in greater detail.

<u>Incipient Fault Detection:</u> DFA utilizes intelligent electronic devices with a detection algorithm that monitors electrical system measurements to recognize current and voltage signatures indicative of potential incipient equipment failures. Texas A&M and Electric Power Research Institute (EPRI)-sponsored research and development created a library of event signatures and developed the algorithm to detect events on the electric system. The detection algorithm identifies significant events from the large amount of data collected by the fault recorder and provides alerts in anticipation of an undesirable condition, which are further analyzed by SCE to determine where future faults may occur ("Incipient Faults"). DFA thus allows SCE to recognize the initial stage of an undesirable condition on the electric system and to take action before the condition progresses to a severe level.

Fault Recorder with Remote Access: DFA provides remote access and data retention for grid events. Distribution circuit fault records today are captured, where available, by microprocessor relays which require local interrogation involving a site visit by SCE personnel. The remote access and algorithm enable SCE to collect and analyze large amounts of fault data for potential repairs and/or mitigations using far less manpower than would otherwise be required with conventional methods. There is a population of fault events that occur on the distribution system for which conventional circuit patrols are unable to locate the location or cause. SCE estimates that it experiences around 650 annual outages across the HFRA circuits where a cause is not identified and therefore damage, such as arcing damage to conductor, cannot be immediately repaired and conditions that caused the event cannot be rapidly mitigated. For example, a momentary fault from wind-blown conductors may result in minimal damage and thus be difficult for a circuit patrol to identify its location. However, this type of fault may repeat itself in the future, potentially resulting in a more damaging event. Fault record data that DFA provides can be used to pinpoint some of these fault locations for SCE to proactively repair and remediate and thus minimize and eliminate occurrences of some of these otherwise unidentified fault events.

Equipment Operation Monitoring: The DFA system also allows SCE to closely monitor the operation of distribution capacitor banks, and provides alerts when issues are detected. Distribution capacitor banks are devices on the distribution system which can create large reactive power imbalances, and it is otherwise more difficult to detect potential problems with these capacitor banks. Rapid reactive power imbalances can indicate a distribution capacitor bank component replacement is needed.

The above capabilities enable the repair of damages following faults that might otherwise have gone unidentified; the identification of conditions that may lead to repeated and/or future fault events; and the monitoring of the operation of capacitor banks. As of January 2020, SCE has installed 60 DFA devices at 7 substations and is studying their performance. In 2020, SCE will continue to operate the 60 pilot installations and determine how to best deploy the targeted installations of DFA for 2021 to minimize in-service failures of equipment and potential ignitions. Table II-8 shows for 2021 – 2023, SCE requested funding of $32.446 million to install 750 DFA devices.

DFA installations will focus on circuits maximizing the HFRA circuit mileage in high consequence regions from SCE risk-informed REAX studies. This circuit and substation ranking aim to capitalize on detection of incipient conditions. Additional prioritization criteria will be applied for circuits with historical trends where outage causes were not identified. To the extent these causes reoccur DFA data can be used to help locate the potential fault locations and aid in mitigation and repair actions.

Table II-8
Distribution Fault Anticipation Capital Expenditures
2019 Recorded/2020-2023 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(Nominal $000)

		SCE Rebuttal Position						
Line No.	**GRC Activity**	**2019 Recorded**	**2020 Forecast**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**Total 2021-2023**	
1	Distribution Fault Anticipation	$ 3,445	$ -	$ 6,270	$ 12,903	$ 13,274	$ 32,446	
		Cal Advocates' Position						
Line No.	**GRC Activity**	**2019 Forecast**	**2020 Forecast**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**Total 2021-2023**	**Variance From SCE 2021-2023**
1	Distribution Fault Anticipation	$ 2,340	$ -	$ 6,270	$ 6,270	$ 6,270	$ 18,810	$ (13,636)
		TURN's Position						
Line No.	**GRC Activity**	**2019 Forecast**	**2020 Forecast**	**2021 Forecast**	**2022 Forecast**	**2023 Forecast**	**Total 2021-2023**	**Variance From SCE 2021-2023**
1	Distribution Fault Anticipation	N/A	N/A	$ -	$ -	$ -	$ -	$ (32,446)

b) **TURN**

(1) **TURN's Position**

TURN does not oppose SCE's request for the 2019 – 2020 Distribution Fault Anticipation (DFA) pilot.[85] However, for 2021 – 2023, TURN recommends zero funding to SCE's capital expenditure request stating, "[while] the technology sounds promising in theory, SCE is currently conducting a pilot, the results of which have not been analyzed. SCE does not know whether the technology will work as expected, nor whether the massive amount of data collected will lead to a trustworthy 'predictive algorithm' that can pre-emptively identify failing equipment."[86] In sum, TURN's position to oppose the 2021 – 2023 forecast is primarily a result of TURN believing that the technology may not prove useful.[87] Additionally, TURN recommends that the results of DFA should be analyzed and reviewed by the Commission and all parties before full deployment be approved.[88]

c) **SCE's Rebuttal To TURN's Position**

SCE's pilot program is intended to learn about how best to scale up a particular device or technology most efficiently and productively across SCE's service territory. SCE does not just cavalierly apply an unknown device on its system given the safety and reliability implications. TURN has misunderstood the intent of the pilot program and associates it with the premature conclusion that this device has not proven to be useful when there have already been numerous industry publications that demonstrated the value of this technology. TURN minimizes the DFA technology capabilities SCE expects to gain in responding to electric system events, remediation of system degradation, and fault or ignition avoidances. SCE addresses each argument from TURN's proposal to remove all funding in SCE's forecast for DFA.

(1) **SCE Completed Its DFA Pilot Deployment In Q1 2020 And Is Confident With The Preliminary Results**

Contrary to TURN's assertion, SCE believes, based on available data from its pilot as well as other utilities' installations, that DFA is effective. As stated in its 2020-2022 WMP, SCE commissioned 60 DFA units monitoring HFRA circuits as part of a pilot program. By January 31,

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85 *See* Exhibit TURN-02, p. 8.

86 *Id.*, p. 9.

87 *Id*.

88 *Id*.

2020, all 60 units were fully installed and collecting data. The pilot focus was to confirm the expectations that DFA does not produce an abundance of nuisance incipient fault alarms. The pilot also provided experience with the product to refine anticipated application expenses and operational hands on training with utilizing the product. SCE's experience with DFA, as well as others', have demonstrated we are not likely to receive a significant number of false alarms and that this technology can facilitate the collection and management of available data to improve fault avoidance in the system. SCE arrived at this conclusion based not only on the data provided by its 60 deployed units, but also the data collected by Texas A&M from approximately 190 other units installed by other utilities. This population of DFA-equipped circuits collected data from 10,000 conventional faults events for slightly less than 17 months (Jan 2019 to May 2020) and found the following significant events:

- 26 faults related to Fault Induced Conductor Motion (FICM)
- 29 series arcing events were classified
- 5 events from capacitor bank arcing were indicated
- 700 situations for re-occurring faults were classified, with 575 occurring following an excess of 24 hours from the first instance (*i.e.*, over 24-hours between each fault)

Each of these identified significant events represent an opportunity for the utility to mitigate and repair parts of its system to avoid future faults and thus minimize the risk of ignition events. It is important to reiterate that DFA software identified the above events automatically and did not require manpower-intensive processes, as further detailed below.

Specific to SCE's installation across 60 circuits, two events were identified where proactive remediations were executed for the system to prevent future faults and possible ignition occurrences. Both situations involved fault events that likely would not have been identified without the DFA. One situation was a fault event created by FICM, and another fault involved wind-blown conductors.[89] The results thus far from SCE's pilot program, as well as the other

[89] The DFA pilot also helped identify an early failure of a distribution transformer, where SCE was not aware of the failure and internal damage.

installations of DFA, demonstrate the wildfire benefits DFA can have if deployed across circuits within SCE's HFRA.[90]

(2) Data Collected By DFA Will Not Lead To Wasted Resources

TURN argues that DFA will generate large amounts of data that will require extensive resources to analyze and may produce false positives, leading to a waste of those resources.[91] TURN supports its argument by quoting EPRI, but omits critical information from the quote in its testimony which appropriately identifies the intended purpose and benefits of DFA. SCE highlights the omitted portion of TURN's quotation of EPRI below:

"*Ubiquitous digital devices can provide data to supply the underpinnings for better awareness and, therefore, operation of power systems. However, the sensitive monitoring required for detecting subtle failure precursors produces too much data to be analyzed with manpower-intensive processes.* ***This [DFA] project has put significant focus on the automation of data capture, retrieval, analysis, management, and presentation processes.***"[92] (emphasis added)

Indeed, one of the primary long-term benefits of DFA is to conserve resources, not waste them. As EPRI notes, DFA is focused on automating and simplifying the data analysis process. As summarized above, the Incipient Fault Signature Recognition capabilities of DFA allow SCE to focus on the DFA-identified significant events caused by undesired system conditions, without manually analyzing large volumes of data. The review of fault records and other data for every event on the distribution system is a labor-intensive process. That is precisely why SCE is pursuing DFA, because it enables SCE to specifically target certain conditions for further analysis and allows remote access to fault records, which will more efficiently utilize, not waste, valuable manpower resources.

(3) The DFA Algorithm Is Already Operational

TURN states, "while TURN understands SCE hopes to build a predictive algorithm to process the massive amount of data produced by DFA, the utility has not yet demonstrated the technology is operational, nor that it can be scaled to the level of deployment requested in this

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[90] As part of the pilot, SCE is also exploring how DFA can improve system operation decisions, such as identifying locations of underground equipment failures to help improve public safety related to significant manhole events where explosions can create hazards.

[91] *See* TURN-02, p. 9.

[92] *See* Distribution Fault Anticipation Phase III: System Integration and Library Enhancement, Final report, Electric Power Research Institute, EPRI report #1016036, 2009, p. v.

GRC."[93] This is incorrect. The predictive algorithm is already operational and in use with the DFA installations on SCE's system. SCE is not developing the predictive algorithm, and as such we are able to pull from the experiences of other utilities who have paved the development path for this technology (as highlighted earlier by the preliminary results described in section (1)). SCE also expects that continued and further use of the DFA technology by SCE and the utility industry will also yield additional product improvements over time.

(4) <u>TURN's Proposal Would Inhibit SCE From Deploying The DFA Technology If The Pilot Results Transpire As Favorable</u>

TURN's recommendations of providing zero funding for the DFA deployment and pushing for a one-way balancing account would inhibit SCE from implementing a technology that is promising.[94] As SCE stated above, the preliminary results from the pilot program strongly indicate the technology will be effective. If, for currently unforeseen reasons, this technology does not perform as intended, then a two-way balancing account would appropriately allow customers to be refunded. However, if the technology continues to produce risk-reduction benefits as SCE expects it to do, TURN's proposal would inappropriately deny funding to deploy the technology during this rate case period. Time is of the essence, so SCE recommends that the Commission reject TURN's proposal and adopt SCE's DFA technology.

In sum, there are clear benefits for DFA to remotely detect incipient fault conditions, facilitate the proactive repair of otherwise undetected damaged equipment (e.g., conductors, load-carrying connectors, switch contacts), and identify locations of fault events. By installing DFA on the 750 circuits in this GRC cycle, SCE is strategically targeting the DFA technology to most of the SCE HFRA circuits (on a prioritized basis) to gain these benefits. TURN's recommendation to not authorize funding for DFA technology is short-sighted. SCE recommends continued scaled execution of the technology in HFRA to aid in situational awareness and increased fault avoidance. Technology continues to evolve and offer innovative ways to further maintain our electric system. SCE must continue to incorporate these innovations into our electric system planning and operations to help maintain a safe and reliable grid, especially in SCE's HFRA.

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[93] *See* TURN-02, p. 9.

[94] *See* Exhibit TURN-02, pp. 28-30.

2. O&M Expenses

a) SCE Application

SCE anticipates managing the large quantity of data that will be collected from DFA devices during the pilot period from 2019 – 2021. As such, Texas A&M will provide SCE with data storage, software to remotely access data and software to automatically interpret DFA data to support the pilot programs transition to broad implementation. For these needed activities, SCE is forecasting O&M of $68 thousand for 2021 as seen in Table II-9.

Table II-9
Distribution Fault Anticipation O&M Expenses
2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	GRC Activity	SCE Recorded	2021 Forecast			Variance from SCE		SCE Rebuttal Position
		2018	SCE	Cal Advocates	TURN	Cal Advocates	TURN	
1	Distribution Fault Anticipation	$ -	$ 68	$ 68	$ -	$ -	$ (68)	$ 68

b) TURN

(1) TURN's Position

TURN does not oppose SCE's DFA O&M forecast for the pilot being conducted in 2019-2020, however TURN opposes SCE's O&M forecast of $68 thousand for 2021. TURN asserts "SCE is currently conducting a pilot, the results of which have not been analyzed. SCE does not know whether the technology will work as expected, nor whether the massive amount of data collected will lead to a trustworthy 'predictive algorithm' that can pre-emptively identify failing equipment."[95]

c) SCE's Rebuttal To TURN's Position

See discussion above in Section (1.c).

95 *See* Exhibit TURN-02, p 9.

D. Organizational Support

1. O&M Expenses

a) SCE Application

Organizational Support is an Organizational Change Management (OCM) program that focuses on managing the effect of necessary changes to business processes, systems and tools, job roles, policies and procedures, and other areas that may have a corresponding impact to resources. For SCE's wildfire mitigation efforts, the OCM program is needed to facilitate internal and external awareness, understanding, and knowledge of the many and varied changes resulting from the increased hardening and resiliency of our grid and the safety of our employees, customers, and communities. Since these wildfire mitigation efforts were introduced in late 2018, the OCM funding request for wildfire management was not included in SCE's 2018 GRC, and therefore, SCE is requesting $3.354 million in the 2021 GRC as seen in Table II-10 below. This program is new and incremental to the change management functions performed by traditional OCM programs. This program is a targeted effort needed to help drive essential changes in planning, engineering, operational practices, communications, etc. to ensure wildfire mitigation targets can be successfully met.

Table II-10
Organizational Support O&M Expenses
2014-2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	Organizational Support	SCE Recorded	2021 Forecast			Variance from SCE		SCE Rebuttal Position
		2014-2018	SCE	Cal Advocates	TURN	Cal Advocates	TURN	
1	Labor	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	Non-Labor	$ -	$ 3,354	$ -	$ 3,354	$ (3,354)	$ -	$ 3,354
3	Other	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total	-	$ 3,354	$ -	$ 3,354	$ (3,354)	$ -	$ 3,354

b) Cal Advocates

(1) Cal Advocates' Position

Cal Advocates states that "SCE Organizational Change Management program is newly reorganized but its proposed activities are not new…"[96] and recommends "SCE's request for additional funding in the TY of $3.354 million should be denied."[97] Cal Advocates believes that "[t]his management program is essentially duplicative to the type of other change management functions… and embedded in historical expenses."[98]

c) SCE's Rebuttal To Cal Advocates' Position

(1) Wildfire Management OCM Is New, Not Duplicative, And Not Simply A Reorganization

Cal Advocates' position that the OCM is not new, is duplicative and simply a reorganization is without merit. OCM is a new program that specifically targets SCE's wildfire mitigation efforts. The OCM is not the result of any reorganization of SCE's OCM work and while OCM activities can be similar across programs, the activities in SCE's forecast are new activities specific to wildfire workstreams.

The wildfire mitigation programs require many changes to the type and scope of work, business processes, and technology systems. The program also introduces new work

96 *See* Exhibit PAO-06, pp. 55-56.

97 *Id.*, p. 56.

98 *Id.*, p. 55.

practices and material. The program is further complicated by the increase in work volume and work complexities, such as more cross-organizational coordination than implementing more traditional programs. Not only are a large number of field and office personnel reassigned from traditional programs to new wildfire mitigation activities, many contract workers have been onboarded to complete the work expediently. This requires dedicated and targeted OCM efforts[99] to help ensure a shared understanding of objectives, safety, and quality.

Once the OCM scope was determined, SCE evaluated the capacity of existing OCM resources to perform the OCM activities. SCE determined that existing OCM resources would not be able to perform the OCM activities. SCE's forecast is bottoms-up, based on the incremental contract and SCE resources required to perform the necessary OCM to support the successful implementation of the Wildfire Management Program.[100] This demonstrates that the OCM is new and does not have costs "embedded in historical expenses"[101] as claimed by Cal Advocates. In addition, Cal Advocates' proposal to "reallocate funding from the other areas that are currently performing these organizational changes and redirect the funding to its newly established Organizational Change Management"[102] would disrupt SCE's existing business functions to the detriment of those operations. Table II-11 below shows all OCM projects across the organization. This table demonstrates the need for OCM for other programs, and each program justifies the request for OCM resources on its own merits. As shown in the table below, redirecting resources from these other areas for wildfire OCM as suggested by Cal Advocates would directly impact SCE's ability to perform those business functions, many of which are focused on safety. Therefore, the Commission should adopt SCE's OCM Test Year request of $3.354 million.

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[99] OCM activities include: (1) identifying impacted personnel, (2) developing materials about the objectives and importance of the program, the expected roles and responsibilities and the need for changing responsibilities and a plan of action, (3) supporting message delivery, (4) assessing readiness of the impacted employees to perform the required functions and provide additional information as needed, (5) developing training materials, (6) supporting training delivery, (7) monitoring ability of new teams to perform their functions and support teams as needed, and (8) analyzing what could be improved for future efforts.

[100] Exhibit WPSCE04Vol05APt01 shows SCE's bottoms-up forecast for the wildfire OCM. In reply to Cal Advocates' question in PubAdv-SCE-070-TLG Q1.d1-3 (attached hereto as Appendix A, pp. A264-A265), SCE stated that SCE "did not request funding during 2014-2018 for the same or similar OCM activities…"

[101] *See* Exhibit PAO-06, p. 55, lines 21-22.

[102] *Id.*, p. 56, lines 17-20.

Table II-11
OCM Projects in SCE's 2021 GRC Funding Requests

Exhibit	OCM Projects	GRC Activities that OCM Supports	Cal Advocates' Proposal
SCE-04, Vol. 05A, pp. 52-53 (Wildfire Management OCM)	• Develop and implement changes to the Wildfire Management activities, including and not limited to: o Train reassigned field and office employees, as well as contract workers, to perform wildfire mitigation activities, e.g. train Qualified Electrical Workers (QEWs) to perform EOI o Support message delivery relating to PSPS programs	Wildfire Management	Opposed[103]
SCE-02, Vol. 04, Pt. 1, pp. 21-24 (T&D Deployment Readiness)	• OCM Consultants to develop and implement changes to Grid Mod Plan • Value of Service (VOS) Study: a study to evaluate how much SCE's customers value a Customer Minute of Interruption (CMI) from a financial perspective	Grid Modernization	Not Opposed[104]
SCE-03, Vol. 03, pp. 27-38 (CS&RP OCM). Note that SCE removed this funding from Track 1.[105]	• Design and develop training material, develop project communications, and manage the business readiness framework to prepare the organizations for the transition to the new SAP based solution	Customer Service Replatform	N/A
SCE-06, Vol. 01, Pt. 1A, pp. 17-22 (Technology Delivery OCM)	• Develop and implement operational unit (OU) capitalized software projects (excluding Grid Mod, CSRP and Cybersecurity)	Enterprise Technology	Not Opposed[106]
SCE-06, Vol. 03, Pt. 1, pp. 10-16 (Organizational Effectiveness OCM)	• Use tools, assessments and workshops that focus on team and leader effectiveness and organizational health	Employee Benefits, Training & Support	Not Opposed[107]
SCE-06, Vol. 04, pp. 66-70 (Safety Culture Transformation OCM)	• Develop strategy to ensure leaders use dashboard to make more informed safety decisions	Safety Programs	Not Opposed[108]

103 *See* Exhibit PAO-06, p. 56, lines 20-21.

104 *See* Exhibit PAO-07, p. 10, lines 19-20.

105 *See* Exhibit SCE-03, Vol. 03A.

106 *See* Exhibit PAO-10, pp. 5-6.

107 *See* Exhibit PAO-11, pp. 3-5.

108 *See* Exhibit PAO-12, p. 4, lines 11-12.

(2) There Is No "Embedded" Funding For OCM

Cal Advocates presents a flawed concept of embedded funding by claiming that SCE can take previous GRC authorized funding amounts and reallocate these amounts to other 2021 GRC programs because the funds are already "embedded" in rates. Because SCE has demonstrated that this program is incremental, the concept of "embedded" funding is irrelevant.

(3) There Is Commission Precedence For Authorizing OCM funding For Major Transformational Activities

The Commission has largely recognized the need for change management activities to support the effective implementation of new programs and projects. There are numerous large projects that required the use of OCM that SCE has filed in previous rate cases, and which the Commission has adopted. For example, the Commission approved Organizational Readiness funding for the implementation of SAP in 2008-2010.[109] A more recent example is from SCE's 2018 GRC, where the Commission approved SCE's request for OCM activities in support of SCE's Grid Modernization program.[110] The Commission should continue to recognize the importance of such work and approve SCE's 2021 OCM request of $3.354 million supporting the successful integration and implementation of wildfire mitigation activities.

E. Vertical Switches

1. Capital Expenditures

a) SCE Application

Vertical switch replacement is an activity in SCE's portfolio of wildfire mitigation measures intended to improve the switching performance on distribution circuits. The "vertical switch" term is describing a subset of gang operated overhead pole switches that are installed generally with vertical line construction.[111] Wood crossarms can twist, shrink, and warp, impacting the switch bell crank system and may lead to performance issues for these switches. SCE proposes replacement of these switches with a design which can be mounted to composite crossarms that remove

[109] *See* D.09-03-025, pp. 233-234.

[110] *See* D.19-05-020, pp. 117-118.

[111] The vertical switches function as switching points on circuits. The switching points include capabilities for sectionalizing, paralleling, and isolating circuits or circuit segments. Vertical switch designs have three bell crank operating systems which must remain in sync for consistent operation and to provide the intended performance rating and capabilities of the switch.

issues created by the wood crossarm application. Beyond simply enhancing grid reliability, proactively replacing aging vertical switches in HFRA reduces ignition risks caused by arcing and spark shower events. SCE has identified 210 vertical switches for replacement in its HFRA for the 2021-2023 period with a total forecast amount of $5.708 million as shown in Table II-12.

Table II-12
Vertical Switches Capital Expenditures
2019 Recorded[112]/2020-2023 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(Nominal $000)

		SCE Rebuttal Position						
Line No.	GRC Activity	2019 Recorded	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast	Total 2021-2023	
1	Vertical Switches	See Note in Title	$ 1,558	$ 2,813	$ 2,895	$ -	$ 5,708	
		Cal Advocates' Position						
Line No.	GRC Activity	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast	Total 2021-2023	Variance From SCE 2021-2023
1	Vertical Switches	$ 750	$ 1,558	$ 2,813	$ 2,895	$ -	$ 5,708	$ -
		TURN's Position						
Line No.	GRC Activity	2019 Forecast	2020 Forecast	2021 Forecast	2022 Forecast	2023 Forecast	Total 2021-2023	Variance From SCE 2021-2023
1	Vertical Switches	N/A	N/A	$ -	$ -	$ -	$ -	$ (5,708)

b) <u>TURN</u>

(1) <u>TURN's Position</u>

TURN opposed the replacement of vertical switches in SCE's HFRA and recommended $0 funding, stating that "SCE has not demonstrated that this program will have any benefit for the prevention of ignitions that cause wildfires."[113] TURN continued, "SCE is not aware of a single ignition that has been caused by the failure of a vertical switch, and there is no engineering basis for finding that replacement of vertical switches provides an ignition reduction benefit."[114] TURN added

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[112] The 2019 recorded amount for Vertical Switches was included in the Enhanced Overhead Inspections and Remediations GRC Activity.

[113] *See* Exhibit TURN-02, p. 10.

[114] *Id*.

that "[w]hile TURN does not object to replacement of these assets as they fail, premature replacement results in a stranded asset costs and a higher than necessary forecast with no corresponding benefit to wildfire risk mitigation."[115]

c) SCE's Rebuttal To TURN's Position

(1) There Are Wildfire Reduction Benefits To Vertical Switches

TURN's conclusion that the replacement of vertical switches in SCE's HFRA likely provides no wildfire risk reduction should be rejected.[116] SCE is improving its ability to investigate and track the source of ignitions. The fact that SCE currently does not have conclusive evidence that a vertical switch caused an ignition does not mean vertical switch failures have not caused ignitions. More importantly, it does not mean that it will not happen in the future.

The mounting hardware for these vertical switches clamps to the wood crossarms. The wood crossarms change dimensions over time as the wood dries out, causing the mounting hardware to become loose and correspondingly causing the vertical switches to be out of alignment. This misalignment can lead to failures either when they are being operated or even just being idle. The concern with vertical switch failures is the production of sparks with the contacts becoming misaligned. When a vertical switch fails, the electricity current arcs at the top of the pole and showers down sparks at whatever is situated below – whether it be a tree, vegetation, an SCE asset or a customer's home. Although SCE cannot definitively state that there has been an ignition based on a failed vertical switch, SCE has had historical ignition events associated with arcing and showers of sparks. For example, in 2020 SCE observed that a vertical KPF switch was misaligned due to the top crossarm of the structure to be "scissored" which likely resulted in misalignment of the KPF switch contacts on the top phase position. Thru fault current that resulted from a downstream cable failure likely caused the contacts of the KPF switch to burn up and result in an arcing connection dropping incandescent particles.

The replacement of vertical switches in SCE's HFRA would reduce the number of arcing and spark shower events, and therefore reduce the risk of ignitions that can lead to wildfires. Ultimately, TURN's recommendation is shortsightedly based on a limited view of historical events, instead of appropriately considering proactive measures to avoid future ignitions.

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115 *Id.*

116 *Id.*, p. 6.

(2) TURN's Recommendation Puts Customers' Safety At Risk

TURN's recommendation should be rejected because it encourages a run-to-failure approach for vertical switches that is not appropriate within HFRA. TURN has previously suggested similar run-to-failure approaches, such as its previous proposal for OCP.[117] In 2019 alone, SCE identified 31 vertical switches out of a population of 252 in HFRA that presented ignition risk concerns surrounding the mounting hardware and alignment of the switch blade connections. The redesigned vertical switch utilizing composite crossarms resolves the issue created with the wood crossarm design to mitigate the ignition concerns present with these existing vertical switches. Replacement of this switch population is recommended over the coming years aligning priorities of replacements with our REAX risk model, capitalizing on opportunity replacements (such as replacing these switches where work aligns with covered conductor efforts), and incorporating other factors such as results from the 2019 inspection efforts. Given that a significant proportion of the existing vertical switches were identified in a single year as needing repair, simply waiting for the vertical switches in HFRA to create a risk of ignition would not be prudent utility management. The Commission should approve SCE's proactive mitigation measures, and not accept TURN's run-to-failure model, especially in HFRA where sparks caused by vertical switches could ignite a wildfire.

F. EOI And Remediations

1. O&M Expenses

a) SCE Application

In response to emerging climate and wildfire threats facing the communities we serve, SCE made the decision in 2018 to inspect ***all*** distribution and transmission structures in SCE's HFRA as quickly as feasible with the specific intent of finding asset conditions that could potentially cause a spark or ignition. SCE also conducted aerial inspections of a significant number of its structures in HFRA. These inspections, along with associated findings and corresponding remediations, make up SCE's 2019 EOI and Remediations program. Starting in 2020, on an ongoing basis, SCE performs these enhanced inspections on overhead structures located in HFRA based on risk profiles of each structure to ensure that any deterioration is promptly identified for timely remediation. The EOI initiative is being implemented in addition to – not in lieu of – SCE's regular compliance- and safety-based inspections as

[117] In SCE's 2018 GRC, TURN recommended 120 circuit miles per year, a reduction of 180 circuit miles from SCE's forecast for OCP. TURN's recommendation was based on the number of miles that SCE scoped for, what TURN called, "Reactive" projects in 2016. *See* 2018 GRC Exhibit TURN-04, pp. 14-28.

an added measure to further strengthen the safety and reliability of SCE assets. EOI was not designed to replace SCE's legacy compliance inspection programs, since EOI was primarily built on a risk-based approach and not designed to identify the full spectrum of potential compliance issues. Through its Inspection Redesign initiative, beginning in 2020, SCE launched the High Fire Risk Informed Inspection (HFRI) Program to perform risk-informed inspections in HFRA that meet the requirements for both wildfire-focused inspections (formerly known as EOI), distribution Overhead Detail Inspections (ODI), transmission inspections, and generation inspections.[118] Further, in its May 7, 2020 Draft Resolution on SCE's 2020-2022 WMP, the Commission's Wildfire Safety Division (WSD) states, in reference to SCE's changes to its inspections and maintenance programs in HFRA, that "[t]his inspection effort represents a strength of the WMP."[119] SCE agrees. Collectively, the five EOI sub-activities, which are summarized below, will enable SCE to move to a risk-informed inspection and maintenance program in SCE's HFRA. Without the full funding requested in this GRC for these activities, SCE will not be able to perform this transition.

- **EOI Inspections - D**, which constitutes SCE's inspection of distribution-level overhead facilities in HFRA. Importantly, this sub-activity focuses on high-risk assets within the HFRA that are not due for a compliance-based inspection and therefore does not duplicate those efforts.
- **Aerial Inspections - D**, which constitutes inspections at the distribution level conducted with either a helicopter or a drone that provides a top-down view of an asset, and is not performed as part of the compliance requirements with an overhead detail inspection.
- **EOI Repairs - T**, which constitute repairs from either a transmission EOI inspection or an aerial inspection; therefore, it is different from normal preventive and breakdown maintenance.
- **EOI Repairs - D**, which constitutes repairs from either a distribution EOI inspection or an aerial inspection; therefore, it is different from normal preventive and breakdown maintenance.

[118] In this rebuttal testimony, references to "EOI" in future years are meant to refer to HFRI, which is its analogous replacement.

[119] May 7, 2020, Wildfire Safety Division Draft Resolution WSD-004, p. 33.

- **EOI PMO**, which is composed of various IT activities necessary to enable the implementation of EOI.

Table II-13 provides SCE's forecast for each sub-activity, as well as those recommended by Cal Advocates and TURN.

Table II-13
EOI and Remediations O&M Expenses
2018 Recorded[120]/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	GRC Activity	SCE Recorded	2021 Forecast			Variance from SCE		SCE Rebuttal Position
		2018	SCE	Cal Advocates	TURN	Cal Advocates	TURN	
1	EOI Inspections - D	$ 4,394	$ 9,626	$ -	$ 9,626	$ (9,626)	$ -	$ 9,626
2	Aerial Inspections - D	$ -	$ 12,691	$ 4,230	$ 12,691	$ (8,461)	$ -	$ 12,691
3	EOI Repairs - T	$ -	$ 6,647	$ -	$ 6,647	$ (6,647)	$ -	$ 6,647
4	EOI Repairs - D	$ -	$ 14,553	$ -	$ 14,553	$ (14,553)	$ -	$ 14,553
5	EOI PMO	$ -	$ 10,714	$ 5,132	$ 10,714	$ (5,582)	$ -	$ 10,714
6	Cal Advocates' Proposal using 2018 Recorded			$ 4,863				
7	**EOI and Remediations (O&M) Total**	**$ 4,863**	**$ 54,232**	**$ 14,225**	**$ 54,232**	**$ (40,007)**	**$ -**	**$ 54,232**

b) <u>Cal Advocates</u>

(1) <u>Cal Advocates' Position</u>[121]

Cal Advocates proposes Test Year funding of $14.225 million, a $40.007 million reduction from SCE's request; i.e., a 74% reduction. Cal Advocates' forecast is comprised of three elements: 1) using 2018 recorded costs, 2) authorizing partial funding for Aerial Inspections and the EOI PMO, and 3) authorizing no funding for the inspections or repairs on the distribution or transmission system. "The Public Advocates Office utilized SCE's 2018 recorded adjusted expenses as a basis and normalized SCE's TY forecast."[122] Cal Advocates groups Aerial Inspections and the EOI Project Management Office together, and "normalizes" the forecast for each activity (i.e., "normalize" in this context means to divide by three). Cal Advocates argues that the reduction in Test Year expenses it

[120] 2018 recorded amount of $4,863 includes EOI Inspections – T, which is not listed in Table II-12 since SCE does not have this activity for the forecast year of 2021.

[121] *See* Exhibit PAO-06, pp. 62-67.

[122] *Id.*, p. 63, lines 7-9.

has proposed is to "account for similar activities that have costs included in rates."[123] Cal Advocates also argues that the Aerial Inspections "lack supporting detail" and there are "no historical data to review and analyze." Similarly, according to Cal Advocates, the EOI PMO forecasts are comprised of projects "that lack a detailed breakdown of calculation of the individual line items," that "rates include costs incurred for IT projects that have been completed, closed or eliminated," and those costs are available to fund efforts in the 2021 GRC cycle.[124]

Cal Advocates recommends no Test Year funding for Transmission EOI repairs, Distribution EOI inspections, and Distribution EOI repairs. Cal Advocates argues that its proposal accepts SCE's alternative proposal for Distribution Inspections, which SCE offered in the event that its proposals for EOI were rejected. "The Public Advocates Office enhanced SCE's request in Distribution Overhead Detailed Inspections from $4.945 million to $6.551 million as SCE required/proposed,"[125] and therefore sets Distribution Inspection activity within EOI at zero dollars.[126] Cal Advocates argues that maintenance activities are an ongoing activity and expense. "SCE's historical expenses (2014-2018) for its Distribution Preventive and Breakdown O&M maintenance and its Distribution Overhead Detailed Inspections organizations have costs embedded in rates for performing the same inspection and maintenance activities as proposed by SCE's newly organized Wildfire Management program."[127] Cal Advocates also observes that both "groups recorded expenses in 2018 incurred for performing EOI", and that Cal Advocates has included the 2018 recorded costs for the Wildfire Management program into their forecast.[128] Cal Advocates also objects to SCE's requested funding because "Duplicate funding for activities already included in rates for the establishment of another organization within SCE to perform the same activities….is not necessary and is burdensome to ratepayers."[129] Based on this reasoning, Cal Advocates proposes zero funding for EOI repairs, both distribution and transmission.

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[123] *Id.*, p. 63, lines 10-14.

[124] *See* Exhibit PAO-06, p. 63, lines 16-21.

[125] *Id.*, p. 64, lines 17-19.

[126] *Id.*, p. 64, lines 1-4.

[127] *Id.*, pp. 64-65.

[128] *Id.*, p. 65, lines 3-6.

[129] *Id.*, p. 65, lines 7-13.

c) **<u>SCE's Rebuttal To Cal Advocates' Position</u>**

In sections (1) and (2), SCE rebuts statements made by Cal Advocates applicable to all sub-activities. Then, in sections (3) through (7), SCE addresses Cal Advocates' recommendations specific to each sub-activity.

(1) **<u>SCE's EOI And Remediations Program, Including All Five Sub-Activities, Are New And Were Not Requested Or Authorized In SCE's 2018 GRC.</u>**

SCE agrees with Cal Advocates that it has always performed routine maintenance and inspection (M&I) work in the entire service territory, including the HFRA. However, none of the components requested in this EOI activity were authorized in the 2018 GRC. In light of what has been called "the new normal" wildfire climate in California, SCE is conducting additional, enhanced inspections of its infrastructure in HFRA. The EOI initiative is being implemented in *addition* to SCE's routine M&I work to identify and rectify immediate and/or probable wildfire risk – including an emphasis on SCE historical ignition data to help ensure the EOI criteria identifies a wide range of potential ignition risk.

In its Test Year forecast for its routine Overhead Detailed Inspection program (ODI), SCE removed any historical costs for those routine M&I activities in the HFRA,[130] so there is no double counting. Cal Advocates' assertion that SCE has "costs already included in rates for similar activities"[131] mischaracterizes SCE's careful forecast development of this EOI activity. Since enhanced inspections and repairs are new and different from traditional maintenance & inspection programs, Cal Advocates' stance that 2018 be used as the basis for the Test Year forecast for EOI funding does not make sense. The recorded costs from 2018 includes only one month of EOI ground activities that were performed, and no costs for aerial inspections that are now an integral part of EOI. Thus, using 2018 recorded data is an inherently flawed barometer upon which to base a 2021 forecast for EOI activities.

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130 For Distribution ODI, SCE used 2018 recorded costs as a basis for its test year forecast. SCE reduced $1.476 million from it test year forecast due to one-time infrared inspections performed in 2018. *See* Exhibit SCE-02, Vol. 02A, pp. 11-12. For Distribution Preventive and Breakdown O&M Maintenance, SCE reduced its test year forecast by $27.807 million (normalized) to account for EOI Repairs performed in its place. *See* Exhibit SCE-02, Vol. 02A, p. 20, Table II-6.

131 *See* Exhibit PAO-06, p. 67.

SCE has demonstrated that these activities were not previously authorized by the Commission through its GRC Track 2 testimony as well,[132] which seeks cost recovery for wildfire mitigation costs that are incremental to authorized funds. SCE's GRC Track 2 testimony requests cost recovery for EOI activities for 2019, as illustrated in Table II-14 below. Further, the fact that these are new and incremental is demonstrated by the independent audit of SCE Track 2 testimony.[133] In particular the Audit Report validates SCE's assertion that "[t]he costs are incremental (i.e., in addition to and separate from) amounts previously authorized by the CPUC in the decision resolving SCE's 2018 General Rate Case (GRC), Decision (D.) 19-05-020."

Table II-14
Mapping of EOI Sub-Activities to Track 2 Activities

EOI Sub-Activity	Track 2 Activity	Citation
Distribution EOI Inspection	EOI Inspections	Exhibit SCE Tr. 2-01, Vol. 01, pp. 13-17.
Aerial Distribution Inspection	EOI Inspections	Exhibit SCE Tr. 2-01, Vol. 01, pp. 13-17.
Distribution EOI Repair	EOI Remediations	Exhibit SCE Tr. 2-01, Vol. 01, pp. 18-23.
Transmission EOI Repair	EOI Remediations	Exhibit SCE Tr. 2-01, Vol. 01, pp. 23-24.
EOI PMO	EOI PMO	Exhibit SCE Tr. 2-01, Vol. 01, pp. 25-28.

(2) Cal Advocates' Recommendation For SCE's EOI And Remediations Program, Including All Five Sub-Activities, Runs Counter To The Objectives Of SCE's 2020-2022 Wildfire Mitigation Plan

Cal Advocates recommends zero funding for any expense in the Test Year for inspection and remediation activities and partial funding of Distribution Aerial Inspection and PMO activities. As shown in Table II-15 below, all of these activities were included in SCE's 2020-2022 WMP. SCE notes the direct parallel between the wildfire risk mitigation activities included in SCE's 2020-2022 WMP to the requests for cost recovery of those activities in this GRC.

[132] *See* Exhibit SCE Tr.2-01, Vol. 01. SCE provided Cal Advocates a copy of Track 2 testimony in a supplemental data request response to PubAdv-SCE-014-TLG Q3 Supplemental (attached hereto as Appendix A, pp. A266-A267). SCE also issued DR SCE-PubAdv-010 Q4 (attached hereto as Appendix A, pp. A268-A270) to Cal Advocates to ask if Cal Advocates had reviewed that material and how it influenced its recommendations. Cal Advocates' May 5, 2020 response to this data request contained a list of items that it reviewed, and Exhibit SCE Tr.2-01, Vol. 01 was not on that list.

[133] *See* A.19-08-013 2021 GRC Track 2 Audit Report.

Table II-15
Mapping of EOI Sub-Activities to 2020 WMP Activities

GRC EOI Sub-Activity	2020-2022 WMP Activity	Citations to GRC and WMP
Distribution EOI Inspection	Distribution High Fire Risk Informed Inspections in HFRA (IN-1.1)	GRC: SCE-04, Vol. 06; WMP: pp. 5-85 to 5-86.
Distribution Aerial Inspection	Distribution Aerial Inspection (IN-6.1)	GRC: SCE-04, Vol. 06; WMP: pp. 5-87 to 5-88.
Distribution EOI Repair	Distribution Remediation (SH-12.1)	GRC: SCE-04, Vol. 06; WMP: pp. 5-72 to 5-73.
Transmission EOI Repair	Transmission Remediation (SH-12.2)	GRC: SCE-04, Vol. 06; WMP: pp. 5-73 to 5-74.
EOI PMO	PMO	GRC: SCE-04, Vol. 06; WMP: p. 5-133.

(3) <u>Transmission EOI Repairs</u>

(a) <u>There Is No Overlap or Duplication In The Funding Request For Transmission EOI Repairs With Any Other Request In SCE's 2021 GRC</u>

Cal Advocates proposed to altogether remove SCE's forecast for Transmission EOI Repairs of $6.647[134] million, and footnoted that "SCE's Transmission Line Patrols with a TY forecast of $7.233 million and its Transmission O&M Maintenance with a TY forecast of $21.064 million perform inspection and maintenance of SCE's overhead transmission lines and includes a TY proposal for Aerial Inspections, which are the same activities proposed by SCE's Wildfire Management Program."[135] Cal Advocates' claim is without basis and should be rejected. Transmission EOI Repairs are not the same as the Transmission O&M Maintenance activities requested in Exhibit SCE-02, Vol. 02A. The Transmission EOI repairs address findings or notifications resulting from Transmission EOI Inspections, including Transmission Aerial Inspections performed in HFRA. The Transmission O&M Maintenance, on the other hand, address notifications identified during regular compliance inspections, such as Transmission Line Patrols and Aerial Inspections in non-HFRA, or

[134] Cal Advocates stated $6.648 million in Exhibit PAO-06, p. 62, but SCE stated $6.647 million in Exhibit WPSCE04Vol05Apt01, p. 378.

[135] *See* Exhibit PAO-06, p. 64.

reactive maintenance due to unplanned events.[136] SCE draws a clear delineation between Transmission EOI Repairs and Transmission O&M Maintenance in Table II-16 below. As Table II-16 clearly demonstrates, SCE has not duplicated its forecast for Transmission EOI Repairs, and there is no overlap in its forecast across this GRC.

Table II-16
Distinction between Transmission EOI Repairs and Transmission O&M Maintenance

Transmission O&M	Transmission Grid Volume (Exhibit SCE-02, Vol. 02A)	Wildfire Management Volume (Exhibit SCE-04, Vol. 05A)
Maintenance from regular compliance inspections	**Transmission O&M Maintenance** addresses notifications from Line Patrols in HFRA and non-HFRA. If notifications are found by Line Patrols, the remediation will record under Transmission O&M Maintenance. Otherwise, it will not record under Transmission O&M Maintenance.	N/A
Maintenance from EOI inspections	N/A	**Transmission EOI Repairs** addresses findings from EOI ground inspections in HFRA.
Maintenance from Aerial Inspections	**Transmission O&M Maintenance** addresses notifications from aerial inspections for non-HFRA.	**Transmission EOI Repairs** address notifications from aerial inspections for HFRA.

(4) <u>Distribution EOI Inspections</u>

(a) <u>There Is No Overlap In The Funding Requests For Distribution EOI And Distribution ODI</u>

Regular inspection of all overhead facilities is necessary to maintain a safe and reliable electric distribution system. SCE performs this work through its distribution Overhead Detailed Inspection (ODI) program. However, due to the catastrophic risks posed by wildfires, SCE modified its inspection practices within its HFRA to more robustly and frequently inspect its overhead distribution system. Accordingly, in 2018 and 2019, SCE developed its EOI program to perform inspections that are risk-based and go above and beyond the routine compliance-based ODI inspections.

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136 *See* Exhibit SCE-02, Vol. 02, pp. 15-20.

In its GRC Application, SCE presented two separate and distinct forecasts related to distribution inspection programs: (1) ODI, which performs inspections of overhead equipment in non-HFRA, and (2) EOI, which performs enhanced inspections of overhead equipment in HFRA. Accordingly, SCE's request for ODI included funding for routine compliance-based inspection work in non-HFRA only; and correspondingly, SCE's request for EOI included funding for enhanced overhead inspections work in HFRA only. Collectively, these two programs represented the totality of SCE's requested funding for distribution overhead inspections in this GRC.

As previously discussed, in 2020 SCE launched the High Fire Risk Informed Inspection (HFRI) Program to perform risk-informed inspections in HFRA that meet the requirements for both wildfire risk reduction-focused inspections (formerly known as EOI) and the routine compliance-based inspections (ODI). Whereas in our Application SCE presented two distribution inspection programs which cover SCE's entire service area, in this rebuttal testimony (as well as in SCE's 2020-2022 WMP),[137] SCE presents the components of the new HFRI program, which has resulted in an improved inspection model consisting of three inspection programs: (1) "HFRA Risk," which performs EOI-style inspections on areas of heightened risk within SCE's HFRA; (2) "HFRA Compliance," which performs ODI-style inspections on areas of reduced risk within SCE's HFRA; and, (3) "Non-HFRA Compliance," which performs ODI-style inspections on all areas outside of SCE's HFRA. Table II-17 illustrates how the direct testimony Distribution EOI and Distribution ODI activities align to these new inspection categories. Collectively, these three programs constitute the totality of SCE's planned distribution overhead inspection programs going forward.

Table II-17
Distinction Between Distribution EOI Inspections and Distribution ODI in terms of HFRI Program

	EOI HFRA		ODI Non-HFRA
SCE Application and Amended Testimony	**EOI Risk**		**ODI Compliance**
SCE Rebuttal Testimony	**HFRA Risk**	**HFRA Compliance**	**Non-HFRA Compliance**

The manner in which SCE forecasted distribution inspection programs in its Application used the best available information at the time and it is still prudent to

[137] *See* Exhibit SCE-04, Vol. 06, pp. 5-79-5-82.

determine authorized funding amounts for distribution overhead inspection programs based on that structure. Cal Advocates' proposal would eliminate the "HFRA Risk" inspection category of HFRI, which would have the effect of authorizing funding sufficient for SCE to conduct inspections at 2015-2017 levels and would constitute a repudiation of the Commission's focus on heightened measures to address wildfire risks.

(b) Distribution EOI Inspections Are Different Than SCE's Traditional ODI Program, And SCE Has Clearly Articulated These Differences In Its Testimony, Responses To Data Requests, And Related Regulatory Filings

Cal Advocates fails to account for the differences between the work performed by SCE's Enhanced Overhead Inspections and its traditional Overhead Detail Inspection work. As stated in data requests to intervenors and advice letters to the Commission,[138] this work is not duplicative of ODI. There are specific differences between the two activities, and those

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[138] SCE provided a compendium of data requests and advice letters in which SCE explained the difference between EOI and traditional programs: **(1) PubAdv-SCE-091 Q1a** (attached hereto as Appendix A, p. A271) "For years 2019-2023, SCE-02, Vol. 1, Pt. 2 includes the forecast costs for Distribution Overhead Detailed Inspections, Distribution Preventive & Breakdown O&M Maintenance, and Distribution Preventive & Breakdown Capital Maintenance. These forecasts include only the costs to perform these activities in non-HFRAs. The Enhanced Overhead Inspection (EOI) SCE performed at the end of 2018, which required the redeployment of resources away from Distribution Preventive & Breakdown (capital and O&M) Maintenance, was a one-time effort. SCE continues to perform Wildfire mitigation and has presented the costs to perform this work in SCE-04, Vol. 5A – Wildfire Management, and therefore, EOI financial impacts in SCE-02, Vol. 1, Pt. 2 have been removed from the forecast"; **(2) TURN-SCE-002 Q9** (attached hereto as Appendix A, p. A272) "The inspections ordered by General Orders (GO) 95 and 165 differ from those performed as part of the Enhanced Overhead Inspection (EOI) program primarily by the following: The GO Inspections only documented conditions needing repair; whereas EOI documented conditions needing repairs and collected data; EOI focused on fire mitigation efforts; whereas GO inspections focused on compliance matters. *See also* SCE's Advice 4031-E filing (attached) that describes SCE's EOI and clarifies the differences from SCE's existing inspection programs"; **(3) TURN-SCE-003 Q8** (attached hereto as Appendix A, p. A273) "Overhead equipment located in either a Tier 2 or Tier 3, will be inspected through its EOI program (or future high fire inspection program). High fire structures will be removed from the non-high fire grid-based ODIs. Overhead equipment located in Tier 2/3 areas will instead be inspected under SCE's proposed EOI program […]"; **(4) Advice Letter 4031-E** dated July 5, 2019 p. 2 (attached hereto as Appendix A, pp. A274-A285) "The distribution EOI initiative was designed to identify and rectify immediate and/or probable wildfire risk on the distribution system – including an emphasis on SCE historical ignition data to ensure the EOI criteria identified a wide range of potential ignition risk. However, for the 2019 WMP cycle, the EOI initiate was not designed to identify or replace SCE's legacy compliance inspection programs; EOI was primarily designed for a risk-based approach and not designed to identify the full spectrum of distribution compliance infractions." *See also* A.19-08-013 2021 GRC Track 2 Audit Report.

differences have been made readily apparent throughout the pendency of this GRC proceeding. In essence, ODI is a prescriptive interval-based regulatory compliance inspection program. In contrast, EOI is a risk-informed inspection and remediation program that is targeting different risks that go beyond those addressed in ODI (which is grounded in GO 165). Asset conditions can change after an inspection for several reasons, many outside of a utility's control, and thus it was deemed prudent and necessary to perform the EOI efforts in light of wildfire risks facing California.

(5) Distribution Aerial Inspections

(a) Contrary To Cal Advocates' Assertion, SCE Has Provided Sufficient Detail And Justification For The Commission To Adopt Its Distribution Aerial Inspection Forecast

Cal Advocates asserts that "SCE's Aerial Inspections Program lacks supporting detail, its TY estimates cannot be verified, and there are also no historical data to review and analyze."[139] SCE disagrees and points to evidence on the record to address Cal Advocates' stated concern. For example, as SCE stated in its testimony, "Aerial inspections employ high resolution photographs to identify problems that are not visible from the ground."[140] SCE further stated, "Due to the rapidly evolving wildfire risks, SCE continues to review and assess its inspection and maintenance programs to get ahead of the evolving wildfire threat."[141] SCE also discussed Aerial Inspections in its Track 2 Testimony, "To further improve and augment these enhanced ground-based inspections and minimize potential ignition risks, SCE launched a comprehensive aerial inspection program on both Distribution and Transmission structures as part of EOI in June 2019. Whereas the ground-based enhanced inspections are effective in detecting issues with SCE's infrastructure that are visible to Qualified Electrical Workers (QEWs) on foot, the aerial inspections provide 360-degree visuals of overhead infrastructure, such as pole tops, from above, that may not be easily visible from the ground. Aerial inspections are performed by helicopters and/or drones taking high-definition digital photographs of each HFRA distribution overhead structure. Subsequently, each photograph is examined by a team of qualified resources (e.g., journeyman linemen or distribution engineers) and the results are documented. As with ground inspections, remediation notifications prioritized by the severity of the findings are

139 *See* Exhibit PAO-06, p. 63.

140 *See* Exhibit SCE-04, Vol. 05A, p. 56, lines 4-5.

141 *Id.*, p. 56, lines 22-23.

submitted for issues identified during these aerial inspections. The aerial inspections are generally in addition to — not in lieu of — the ground-based inspections."[142] As detailed above, SCE relies on necessary imaging capture and processing technology and associated infrastructure, and trained personnel to deploy this new program. SCE's forecast, which is based on the costs associated with data capture and processing and labor costs for a QEW Review Team, is well substantiated and reasonable.[143]

(b) Cal Advocates' Use Of The Word 'Normalization' Is Not An Accurate Characterization Of Its Forecast Methodology

SCE uses normalization to adjust the Test Year O&M forecasts when the estimated funding for an activity fluctuates among the Test Year and Post Test Years. In these cases, SCE normalizes the Test Year forecast by taking the average of the total estimates for the Test Year and Post Test Years. Normalization is used to ensure SCE's forecast does not build in an unjustified over- or under—collection bias over the GRC cycle. Cal Advocates' proposal, on the other hand, is not "normalization." Instead, Cal Advocates simply divided SCE's Test Year forecast by three, and therefore reduces the funding for this activity by two-thirds for 2021-2023. The Commission should not adopt Cal Advocates' forecasts based on this unjustified reduction.

(6) Distribution EOI Repairs

(a) Cal Advocates' Assumption That Distribution EOI Repair Is The Same As Distribution Preventive And Breakdown O&M Maintenance Is Incorrect[144]

Cal Advocates' assumption that Distribution EOI Repair is the same as Distribution Preventive and Breakdown (P&B) O&M Maintenance is incorrect and should be rejected. Distribution EOI Repairs address findings from Distribution EOI Inspections, whereas Distribution Preventive and Breakdown O&M Maintenance address findings from Overhead Distribution Inspections and reactive repairs. SCE went to great lengths to ensure no duplication in funding request exists by reducing the Distribution P&B O&M Maintenance forecast for work that will

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[142] *See* Exhibit SCE Tr.2-01, Vol. 01, p. 14.

[143] *See* Exhibit WPSCE04Vol05APt01, Aerial Inspections - Distribution (attached hereto as Appendix A, pp. A286-A288).

[144] *See* Exhibit PAO-06, p. 65.

be performed under the EOI program.[145] Cal Advocates' proposal would return SCE to only doing preventive repairs on a five-year cycle of inspections, not the annual inspection cycle using the risk-based evaluations. The volume and cadence of repairs is much higher under EOI than the historical levels that could be funded by Cal Advocates' proposal, and mitigate wildfire risk much more than the level of maintenance that could be funded by Cal Advocates' proposal.

(7) EOI PMO – IT Projects

The EOI PMO – IT Projects sub-activity is composed of various IT activities necessary to enable the implementation of EOI inspections and repairs. As an example of the kind of projects that are being developed under this umbrella of PMO project, SCE is working to develop a machine learning program that is "cloud" based that can scan images taken from aerial inspections in real time and quickly assess the health of its assets. SCE forecasts an O&M funding level of $10.714 for Test Year 2021 to support all projects shown in SCE's workpapers.[146] These EOI O&M components run parallel with EOI capital projects, which Cal Advocates do not oppose. Cal Advocates does not contend that these IT projects are unnecessary to support wildfire mitigation efforts. However, Cal Advocates reduced SCE's forecast by two-thirds, based on two assertions: (1) SCE's forecast lacks a detailed breakdown, and (2) SCE's rates include costs incurred for IT projects that have been completed, closed or eliminated, and funding for those projects can be reallocated in the TY for proposed IT activities.[147] SCE addresses each of these points below.

(a) Contrary To Cal Advocates' Assertion, SCE Has Provided Sufficient Detail And Justification For The Commission To Adopt Its EOI PMO forecast

In its testimony SCE stated that EOI PMO costs are composed of project forecasts for various IT activities needed to support EOI implementation.[148] In SCE's workpapers, SCE provided a description of each IT item, e.g. Remote Sensing Aerial Survey Inspection, iPad Deployment & Support, etc. along with a forecast amount for years 2019-2023.[149] For Remote

[145] *See* Exhibit SCE-02, Vol. 1, Pt. 2A, p. 19, lines 15-16.

[146] *See* Exhibit WPSCE04Vol05APt01E, EOI PMO IT Projects (attached hereto as Appendix A, p. A289).

[147] *See* Exhibit PAO-06, p. 63.

[148] *See* Exhibit SCE-04, Vol. 05A, p. 57, lines 23-24.

[149] *See* Exhibit WPSCE04Vol05APt01E, EOI PMO IT Projects (attached hereto as Appendix A, p. A289).

Sensing Aerial Survey Inspection, the O&M expense is for the cloud services, such as cloud subscription, commercial-off-the-shelf licensing, and data storage. The iPad Deployment O&M expenses include device management, mobile data plan, AppleCare, and training for the field deployment. The remaining IT items are based on a ratio of 10% of the capital requirement, which include business process analysis and redesign, organizational change management specific to software development, hardware/software support services, and technical consulting. SCE determines that the 10% is a reasonable allocation due to the complexities of the changes in business processes and technology solution and require on-going software application support. In its 2021 GRC Track 2 testimony, SCE further substantiated the need for EOI IT solutions.[150] Finally, SCE discussed the need for these information technologies, such as Remote Sensing, throughout its 2020-2022 WMP.[151]

(b) Cal Advocates' Assertion that SCE's Rates Include Costs Incurred for IT Projects that Have Been Completed, Closed and Eliminated and Funding for those Projects Can Be Reallocated Is Unsubstantiated

It was unclear to SCE what Cal Advocates was referring to when it asserted that SCE's rates include costs incurred for IT projects that have been completed, closed and eliminated. SCE issued a data request asking Cal Advocates to "provide what specific projects that Cal Advocates is referring to for completed projects, closed projects, and eliminated projects."[152] Cal Advocates responded, "[t]he projects … are associated with Information Technology projects for revisions, upgrades and enhancements SCE requested funding for in its 2012, 2015 and 2018 GRCs and have costs embedded in rates (*i.e.*, Distribution Control Management System/Distribution Management System, Business Process and Technology Integration, Information Technology and Business Integration, Market Redesign and Technology Upgrade."[153] Cal Advocates assertions are incorrect, as the projects it identifies do not have any relation to those requested in this GRC for EOI enablement. SCE illustrates this in Table II-18 below:

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[150] *See* Exhibit SCE Tr.2-01, Vol. 01, pp. 26-28.

[151] *See* Exhibit SCE-04, Vol. 06.

[152] *See* SCE-PubAdv-010, Q3 (attached hereto as Appendix A, pp. A268-A270). SCE also stated, "Please also identify the years the projects were completed, closed, or eliminated."

[153] *Id*.

Table II-18
Illustration that the "Projects" Identified by Cal Advocates
Are Unrelated to EOI IT Request

"Project" Identified by Cal Advocates	**Description of "Project"**	**Related to EOI PMO IT Costs?**
Distribution Control Management System/ Distribution Management System (DMS)	The DMS is the distribution grid control system that is used by SCE to gather real time data from various distribution automation field services and facilitate automated operation and perform supervisory control of the distribution system. The DMS was deployed in multiple phases between 2012 and 2016.	**No.** The DMS project predates SCE's Wildfire Resiliency efforts under EOI Incident Management Team (IMT). Capabilities and the associated costs for development under the EOI IMT are outside of the core capabilities that were developed under DMS.
Business Process and Technology Integration (BP&TI)	BP&TI was an operational unit (OU) within T&D and not a project. However, some resources within BP&TI were responsible for managing multiple projects to support T&D operations and was not focused on Wildfire Resiliency effort. BP&TI operations included Project Management, Systems Support & Help Desk, Software/Application Maintenance and Enhancements, Process Design and Management, Organizational Change Management, Financial Support, and Management and Administration. A re-organization for BP&TI moved some parts to IT, while other parts remained in T&D.	**No.** BP&TI and the re-organization of BP&TI into different departments within IT and T&D, significantly predates SCE's Wildfire Resiliency efforts under the EOI IMT. While the old BP&TI organization did manage projects, the scope of those projects did not include the development and delivery of specific capabilities currently being pursued under the EOI IMT.
Information Technology and Business Integration (IT&BI)	IT&BI was an OU within SCE that predates SCE's current IT organization and not a project. However, some resources within IT&BI had the responsibility for managing the hardware and software development of multiple projects that supported all of SCE's large OUs (e.g., Customer Service, T&D, and Energy Procurement). IT&BI operations included Application Services, Technology and Risk Management, Infrastructure Operations, and Business and Operations Management. A re-organization merged some segments of BP&TI and IT&BI into a new IT organization, which is now the Technology Delivery function in SCE's 2021 GRC within Exhibit SCE-06, Vol. 01.	**No.** IT&BI organization and subsequent re-organization of BP&TI and IT&BI into the current IT significantly predates SCE's Wildfire Resiliency efforts under the EOI IMT. While the old IT&BI organization did manage the hardware and software development of many projects, the scope of those projects did not include the development and delivery of specific capabilities currently being pursued under the EOI IMT.
Market Redesign and Technology Upgrade (MRTU)	The MRTU project enabled SCE to implement the changes to the California Independent System Operator (CAISO) energy market that were put in place by CAISO in 2009. MRTU replaced many of the systems and business processes in the SCE power procurement organization.	**No.** The focus of the MRTU project was to implement changes to the SCE power procurement process to handle the energy market changes put in place by CAISO. The MRTU project focused on the energy market, not the physical grid. MRTU operates outside of, and not specific to, the EOI PMO IT development.

Further, Cal Advocates presents a flawed concept of "embedded funding" when it asserts that SCE can take previous GRC-authorized funding amounts and reallocate these amounts to 2021 GRC programs because the funds are already "embedded" in rates. SCE has not asked for funding for this activity in any previous GRC, so there is no "embedded" funding in rates. For example, the Commission's Decision for SCE's 2018 GRC, D.19-05-020, authorized a revenue requirement for the years 2018-2020, while SCE's 2021 GRC, A.19-08-013, requests a revenue requirement for the years 2021-2023. SCE's request for the 2021 GRC includes the costs for activities that are necessary for the utility to perform during the period 2021-2023, including for new activities such as EOI PMO IT project costs. All other IT costs requested in SCE's 2021 GRC support other specific non-wildfire SCE needs and are not duplicative to the Wildfire IT projects.[154]

(c) Cal Advocates' Proposed Reduction In EOI PMO O&M IT Projects Runs Counter To Cal Advocates' Not Opposing The EOI Capital Expenditures

Cal Advocates' proposal to eliminate all O&M funding for EOI PMO IT projects should be rejected as it is inconsistent with Cal Advocates' acceptance of SCE's associated EOI capital expenditures.[155] Capital projects have an O&M component necessary for successful implementation. The Commission has adopted capital-related O&M expenses in each of SCE's prior two GRCs; this is a well-accepted concept that has numerous precedents.[156] The O&M requested here is required to implement the technology platforms that will advance how SCE inspects, analyzes, and remediates assets in HFRA to decrease potential ignition risks. Because many of these requested expenses are necessary to realize the value of our capital technology investments, eliminating the associated O&M expense would render the capability inoperable; for example, cloud subscriptions, or the capability and data quality would be at risk of significant degradation without the corresponding operations & maintenance work. SCE's O&M request is necessary to support IT capital solutions supporting SCE Wildfire Management program and should be adopted.

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[154] *See* Exhibit SCE-06, Vol. 01A.

[155] *See* Exhibit PAO-9, pp. 14-15.

[156] *See* D.19-05-020, pp. 146-149 and D.15-11-021, pp. 220-221.

G. Public Safety Power Shutoff (PSPS)

1. PSPS Execution

SCE employs guidelines to proactively de-energize circuits within HFRA if data sources indicate that elevated local weather conditions pose an imminent and significant threat to public safety. SCE's protocol is the Public Safety Power Shut-off (PSPS) and consists of a set of criteria and guidelines with a wide variety of factors to be considered for appropriate use.

No parties have opposed any of the proposed expenses or capital expenditures.

Table II-19
PSPS Execution Capital Expenditures
2014-2019 Recorded/2020-2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(Nominal $000)

		SCE Rebuttal Position					Cal Advocates				
Line No.	GRC Activity	2014-2018 Recorded	2019 Recorded	2020 Forecast	2021 Forecast	Total 2019-2021	2019	2020	2021	Total 2020-2021	Variance from SCE 2020-2021
1	PSPS Execution	-	1,766	1,212	738	3,716	1,766	1,212	738	1,950	-

Table II-20
PSPS Execution O&M Expenses
2014-2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

		SCE Recorded		2021 Forecast			Variance from SCE		SCE
Line No.	GRC Activity	2014-2017	2018	SCE	Cal Advocates	TURN	Cal Advocates	TURN	Rebuttal Position
1	PSPS Execution	-	169	13,922	13,922	13,922	-	-	13,922

2. PSPS Customer Support

SCE's PSPS Customer Support strategy will leverage an integrated mix of communications channels that deliver the right message and in the right moment to stand out in an environment that can be extremely "noisy." Our plan relies both on leveraging existing processes as well as building new platforms and campaigns that will bring awareness to our customers.

No parties have opposed any of the proposed expenses.

Table II-21
PSPS Customer Support Functions O&M Expenses
2014-2018 Recorded/2021 Forecast
(2018 Constant $000)

Line No.	GRC Activity	2018 Recorded	2021 Forecast SCE	2021 Forecast Cal Advocates	2021 Forecast TURN	Variance from SCE Cal Advocates	Variance from SCE TURN	SCE Rebuttal Position
1	PSPS Customer Support	$ 852	$ 13,311	$ 13,311	-	$ -	-	$ 13,311

H. Community Resiliency Equipment Incentive Program

1. O&M Expenses

a) SCE Application

The Community Resiliency Equipment Incentive program will support specific customers that provide a community benefit by providing an incentive for microgrid controls technology to enable self-supply of power from the customer's behind-the-meter generation plus storage system. The incentive will allow the customers to develop micro-grids on their facilities that will be able to provide support for customers during both PSPS events and disasters which have interrupted energy service in the area. The program will target customers capable of enhancing resiliency services to the communities they serve, consistent with the extent of the services that can be provided. A portion of the funding is reserved for low income and underserved communities.

For example, a school in Hesperia that has on-site solar and storage facility that can power the school gymnasium would agree to stay open in the event of a wildfire in the Angeles National Forest, with the benefit of a microgrid controls system to enable islanding during an extended outage. Another might be a new fire station being built in Goleta that wants to support a county goal for providing clean on-site resilience, by opting to back up with a cleaner alternative than a large on-site diesel generator. Given the limited financial position of these customers, the Community Resiliency Equipment Incentive Program is an effective mechanism to build community resiliency by helping to close the gap for enabling off-grid operation.

Cal Advocates proposed to reduce the funding by two-thirds, based on a perceived overlap with other programs. No other party opposed the Community Resiliency Equipment Incentive Program.

Table II-22
Community Resiliency Equipment Incentive Program O&M Expenses
2014-2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)[157]

Line #	Community Resiliency Equipment Incentive Program	SCE Recorded					2021 Forecast			Variance from SCE	
		2014	2015	2016	2017	2018	SCE Rebuttal Position	Cal Advocates	TURN	Cal Advocates	TURN
1	Labor	-	-	-	-	-	191	64	N/A	(127)	N/A
2	Non-Labor	-	-	-	-	-	3,259	1,086	N/A	(2,173)	N/A
3	Other									-	
	Total	-	-	-	-	-	**3,450**	**1,150**	**N/A**	**(2,300)**	**N/A**

b) <u>Cal Advocates</u>

(1) <u>Cal Advocates' Position</u>[158]

Cal Advocates proposes Test Year funding of $1.150 million, a reduction of $2.300 million from SCE's request. Cal Advocates methodology for developing the Test Year forecast is to take SCE's Test Year forecast and divide it by three. Cal Advocates state the reduction from SCE's request is to "account for similar activities that have costs included in rates", in particular their proposal reflects "the amount of funding it [SCE] already receives in rates for the administration of the Self-Generation Incentive Program". Cal Advocates also takes issue that "SCE does not acknowledge that its shareholders receive benefits when SCE's customers with behind-the-meter distributed generation and storage supplies (Sic) 'power during an outage from their on-site distributed generation and energy devices'. Cal Advocates also argues that SCE does not acknowledge that "its shareholders have provided funding in the past for various incentive programs and other projects in which they receive a benefit". Cal Advocates express concern with the lack of historical data: "There are no historical costs to review for the Community Resiliency Incentive Program and SCE did not provide any recorded costs from the Self-Generation Incentive Program for comparison, evaluation and analysis". Cal Advocates conclude that in the next GRC SCE "should be able to provide historical

[157] In its 2020 Wildfire Management Plan (WMP), SCE requested funding for 2020 as part of this program to promote the use of battery storage for islanding, when customers or locations will provide support during PSPS events. *See* page 5-112, 2020 WMP. The 2020 funding in the WMP is incremental to the rate case request for funding over 2021-2023.

[158] Exhibit (PAO-06) pp. 51-55.

expenses and more specific detail on the operation of its Community Resiliency Equipment Incentive program and the Self Generation Incentive program."[159]

c) SCE's Rebuttal To Cal Advocates' Position

Cal Advocates position and forecast methodology is without merit. The Cal Advocates' position rests on three points. First, Cal Advocates maintains that there is an overlap between the Community Resiliency Incentive Program and the Self Generation Incentive program. Second, in Cal Advocates' view, the lack of historical data undermines SCE's forecast credibility. Third, Cal Advocates claims shareholders should fund the program because they receive benefits from customer operations and because shareholders have previously funded similar programs. Each of these incorrect assertions is discussed below.

Cal Advocates' argument that there is an overlap between the SGIP and the Community Resiliency Equipment Incentive Program (CREIP) is without merit. The SGIP stands on its own and is a longstanding program the Commission has funded for the purposes of encouraging customers to add on-site generation. The CREIP is intended to be either a stand-alone incentive, or an adder onto, the incentives from the SGIP, for a targeted set of larger customers that will promote resiliency in a way that benefits the community. There is no requirement for a community benefit with the SGIP, while that is a paramount consideration for eligibility for CREIP. CREIP will support customers being able to operate during an outage of electric power on the distribution grid, by running as an islanded microgrid, and provide valuable support for their communities. The SGIP supports customer acquisition of on-site generation and storage, but not the control systems that are needed to turn those devices into a micro-grid capable of operating independently of the grid.

SCE acknowledges that the programs have certain similarities, with their focus on building customer resiliency with behind-the-meter solutions but they are targeted at different customers, in different situations, and with the intention of promoting different outcomes. The SGIP is designed to support individual customer resiliency and the CREIP is designed to support larger customers to build resiliency that is then shared as a resiliency resource with the wider community during fires, other natural disasters, or PSPS events, all of which can cause disruption for customers. The Commission funds a variety of similar incentive programs through its Energy Efficiency (EE) and Demand Side Management funding. The Commission has adopted these various programs that target

[159] Exhibit PAO-6, p. 55.

different customer groups, and that promote behavior or outcomes that the Commission is actively supporting, or that provide support for customers the Commission has deemed worthy of support. The Community Resiliency Equipment Incentive program should be seen in that context, i.e., as a new program with a specific and worthwhile objective of facilitating islanding capability for customers to provide community-targeted resiliency.

In D.19-09-027, the Commission adopted an additional payment available under the SGIP called the Equity Resiliency Incentive. The SGIP Equity Resiliency Incentive benefits will allow for a portion of costs to be provided to eligible customers. However, this incentive is unlikely to cover the cost of a microgrid controller necessary for islanding , especially for larger facilities that SCE is targeting with its Community Resiliency Equipment Incentive.[160] Moreover, the program is limited at the total system cost, including other benefits received – such as SGIP. The Community Resiliency Equipment Incentive program will aid SCE customers by lowering the net cost to enable resilience with a distributed generation and energy storage system for non-residential customers. Customers will receive rebates for a portion of the qualifying system cost associated with microgrid controls, transfer switches, and other equipment necessary to enable islanded operation, which may include engineering & design services, equipment, construction and installation, configuration, and commissioning. These additional costs and requirements will likely increase costs significantly for this type of installation and are not likely to be covered through the SGIP Equity Resiliency Incentive. This is where SCE’s Community Resiliency Incentive Program aids its customers who are interested in providing community resiliency offerings such as critical services, evacuation or resource centers during times of crisis. These are the customers who are targeted for the allocation within SCE’s Community Resiliency Incentive Program.

A key part of the Community Resiliency Equipment Incentive Program is also serving low income, critical care customers through costs within this program. This program will provide those customers who reside in a high fire risk area, who are of limited income and identified as Critical Care with a portable battery back-up solution that will aim to aid them in their resiliency during PSPS events or other emergencies. Cal Advocates does not include this component in their request to deny SCE’s funds for the Community Resiliency Incentive Program. At the time SCE filed its 2021

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[160] *See, e.g.,* Exhibit PAO-6, at page 52. Footnote 133 cites SCE’s response to a data request (PubAdv-SCE-073-TLG, q. 1-a.3). “Even though recent changes to the SGIP have ‘closed the gap’ for some customers to be able to fund the addition of an energy storage system with islanding capabilities, certain configurations will not be fully covered by the SGIP.”

Testimony this program concept was to provide a form of rebate to qualifying customers of a $500 rebate.

The table below reflects the planned allocation of annual benefits of the program for the qualifying customer segments within the program. Cal Advocates may have overlooked the detailed breakdown of the $3.450 million allocation.

Table II-23
Community Resiliency Equipment Incentives by Customer Segment

Customer Segment	Potencial Avaialable Rebate	Maximum Rebate per Customer	Minimal Annual Allocationof Funding
Community Resource Center	$0.15/Wh	$100,000	25%
Critical Services	0.10/Wh	$25,000	25%
Low Income Critical Care	$500	$500	10%

Cal Advocates' second argument that the lack of historical data justifies their arbitrary reduction in the proposed funding is also without merit.[161] It should come as no surprise that there are no historical costs. The CREIP cannot start until the Commission has adopted it, and the review by the Commission for the prudency of the program is part of this proceeding. This is true of any new program, and under Cal Advocates' logic, no program can be reasonably reviewed until it has been operating, and there are recorded costs available for review. Obviously, the Commission has been able to adopt new programs, based on the applications or requests that provide key details about the intent of the planned program, the scope, the costs, etc. SCE has provided a description of the program, a clear explanation of how this program works in concert with the SGIP, details on the target locations and planned incentives, a forecast of costs, and an explanation of the program benefits.[162]

[161] Cal Advocates conclude their discussion of the CREIP by stating that "In SCE's next GRC, it should be able to provide historical expenses and more specific detail about the operation of its Community Resiliency Equipment Incentive Program and demonstrate the comparisons in operations between this program and the Self Generation Incentive program". PAO-6, p. 55.

[162] It can also be noted that in this same volume of Cal Advocates' testimony, they accept SCE's proposal for Infrared Inspections even though there are no recorded costs. Please refer to Figure II-22, p. 62 SCE-04, Vol. 5A, and PAO-6, p. 51 at Table 6-15.

Cal Advocates' final argument for reducing the proposed Test Year funding for this program is its claim that SCE shareholders benefit, and that shareholders have "funded similar programs in the past."[163] The Commission should completely disregard this argument as irrelevant and unfounded. Cal Advocates explained that the shareholder benefits they were referring to were "avoidance of negative public relations associated with outages, the tangible benefits SCE's shareholders receive in the form of dividends and higher stock prices when SCE's operations are running efficiently and it is not receiving negative press associated with outages, and the possibility that SCE's shareholders could be responsible for payments and/or refunds for outages."[164] These claims are entirely unsubstantiated and unsupported by empirical evidence. Taking Cal Advocates' argument to its logical conclusion, shareholders should fund the entire GRC revenue requirement because all of SCE's requests are in some ways tied to maintaining a safe and reliable electric grid, which in Cal Advocates' view, produces "shareholder benefits." Instead, the Commission should evaluate SCE's Community Resiliency Incentive Program request for funding on its merits and consider whether the benefits and the costs of the program justify customer funding.

Cal Advocates' argument that shareholders have funded "similar programs in the past" is equally unavailing. In response to a data request, Cal Advocates cites two examples. First, Cal Advocates refers to "SCE's Long Term- Incentive Program (see SCE Exhibit SCE-6, Vol. 3, Part 1, p. 62) and its Short-Term Incentive Program (STIP)".[165] The Commission has evaluated the STIP and the LTIP in past rate cases, and is doing so in this case.[166] While the Commission has previously disallowed full customer funding for those programs (in SCE's view incorrectly), they are in no way analogous to the program at issue here, which has nothing to do with employee compensation or SCE company goals.

Like any program in a rate case, the CRIP should be evaluated on its merits, and the Commission should adopt it, revise it or reject the program, based on its merits.

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[163] Exhibit PAO-6, p. 53.

[164] Please refer to SCE-PubAdv-003, Q1a, attached as Appendix A, pp. A290-A291.

[165] Please refer to SCE-PubAdv-003, Q1b, as Appendix A, pp. A290-A291.

[166] Please refer to SCE-17, Vol. 3, Part 1.

I. Enhanced Situational Awareness

1. SCE Application

Comprehensive situational awareness is fundamental to SCE's operational decision-making, service delivery and all-hazards emergency response. Better understanding of the critical system operation, including granular weather conditions across the system, is crucial to understanding how real-time localized conditions affect the daily operation of the grid. To increase situational awareness, SCE has created The Situational Awareness Center (SA Center) which houses five meteorologists who provide weather forecasts, analytics, and hazard advisories. SCE has recently added a fire scientist, to expand and enhance existing wildfire mitigation capabilities. The SA Center is equipped with additional situational awareness tools, including access to high resolution weather and fire modeling products made possible through high-performance computing cluster (HPCC) technology. These tools increase the company's capacity to better forecast elevated weather conditions and potential wildfire activity to better inform decision-making during regular operations and emergencies. Our request in this case is for additional equipment to build out our capabilities in the SA Center.

SCEs request for Enhanced Situational Awareness funding has both an expense and a capital component. The capital expenditures are for additional weather stations to support improved modeling and forecasting as well as monitoring current weather conditions. The expense part of the request is for labor expenses to analyze and use the data provided by the weather stations and high definition cameras, and for various expenses associated with maintaining, repairing and replacing the equipment. Cal Advocates accept SCE's proposed capital expenditures but proposes a reduction to the Test Year O&M. No other party addressed Enhanced Situational Awareness.

Table II-24
Enhanced Situational Awareness Capital Expenditures
2014-2019 Recorded/2020-2021 Forecast
Summary of SCE, Cal Advocates, and Positions
(Nominal $000)

Line No.	GRC Activity	SCE Rebuttal Position						Cal Advocates				
		2014-2017 Recorded	2018 Recorded	2019 Recorded	2020 Forecast	2021 Forecast	Total 2019-2021	2019	2020	2021	Total 2020-2021	Variance from SCE 2020-2021
1	Enhanced Situational Awareness	-	2,997	5,252	4,159	-	9,411	5,252	4,159	-	4,159	-

Table II-25
Enhanced Situational Awareness O&M Expenses
2014-2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	GRC Activity	SCE Recorded 2014-2017	SCE Recorded 2018	2021 Forecast SCE	2021 Forecast Cal Advocates	2021 Forecast TURN	Variance from SCE Cal Advocates	Variance from SCE TURN	SCE Rebuttal Position
1	Enhanced Situational Awareness	-	169	3,594	3,060	3,594	(534)	-	3,594
2	Weather Stations	-	253	-	-	-	-	-	-
3	Total	-	422	3,594	3,060	3,594	(534)	-	3,594

a) <u>Cal Advocates</u>

(1) <u>Cal Advocates' Position</u>[167]

Cal Advocates propose a Test Year expense forecast of $3.060 million, a reduction from SCE's Test Year request of $0.534 million. Cal Advocates argues that SCE's request does not reflect "funding already included in rates for on-going and routine situational awareness activities[168]" that are duplicative of activities in its test year request. Cal Advocates proposes that the 2021 expense forecast should be equal to the recorded 2019 expenses.[169]

b) <u>SCE's Rebuttal To Cal Advocates' Position</u>

Cal Advocates' position is without merit. Their argument that SCE has not reflected the costs of ongoing activities is contradicted in their own testimony, and inconsistent with the facts. Cal Advocates have not identified any shortcomings, or defects, in the testimony and workpapers that support SCE's request, and their proposal to reduce the test year O&M is inconsistent with their acceptance of SCE's proposed capital expenditures for Enhanced Situational Awareness.

Citing to a data request response,[170] Cal Advocates asserts "SCE's responses above do demonstrate that although SCE does not show any recorded expenses for 2014-2017 for its Enhanced Situational Awareness program, it acknowledges that all TY activities are not new and have

[167] Exhibit (PAO-06) pp. 59-62.

[168] Exhibit PAO-6, p. 60.

[169] Ex. PAO-6, p. 61 "The Public Advocates Office utilized SCE's most recent 2019 recorded expenses as a basis to account for similar activities that have costs included in rates and to provide funding for additional TY activities."

[170] *See* SCE's response to data request PubAdv-SCE-073-TLG, Q1b.1-6, attached as Appendix A, pp. A292-A296.

been incurring costs that are embedded in rates for 2014-2017".[171] SCEs previously explained that "Prior to 2018, SCE relied on its expert meteorology, operational and emergency management staff to provide situational awareness."[172] The operational and emergency management staff are part of the Emergency Management organization, discussed in SCE-04, Volume 1. In 2018, a group of meteorologists was moved over from the Procurement group to the Business Resiliency department and formed the foundation for the Situational Awareness Center. The costs of that group are not included in this request, but are also included in the Emergency Management volume, SCE-04, Vol. 1.[173] Contrary to Cal Advocates' claim, there is no double counting of costs, and to the extent that meteorology, operational and emergency staff had recorded costs for 2014-2017 those are reflected in the Emergency Management volume, which also provides a justification for their respective test year forecasts.

The request here, for Enhanced Situational Awareness, is entirely incremental to those activities. Cal Advocates appears to have overlooked this aspect of SCE's response to its data request.

SCE has provided detailed workpapers supporting its request for Enhanced Situational Awareness.[174] These workpapers show the repair and maintenance costs for the HD cameras, a detailed derivation of the maintenance costs for the weather stations, and a bottoms-up staffing model for the SA Center. Cal Advocates has not challenged any of this evidence, or otherwise identified any shortcomings of our methodology or the data.

Cal Advocates' proposal is also short-sighted and inconsistent with its proposal to fund all of the capital expenditures for Enhanced Situational Awareness. Under the Cal Advocates' proposal, SCE would install weather stations and HD cameras, but not have the funding to maintain and replace them, or to utilize the data to improve our predictive and management responses to wildfires, and to improve the response time to wildfires.[175]

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[171] Ex. PAO-6, p. 62.

[172] *See* SCE's response to data request PubAdv-SCE-073-TLG, Q1b.1-6, attached as Appendix A, A292-A296.

[173] Please refer to SCE-04, Vol. 2, p. 18.

[174] *See* WP SCE-04, Vol. 5, Part 2, pp. 66-77, included here in Appendix A, A297-A308.

[175] *Id*.

J. Fire Science & Advanced Modeling

1. SCE Application

Fire Science is the broad term that involves the gathering and integration of science and technology to help with wildfire mitigation across the SCE service territory. The Fire Science Program provides overarching support for the advanced modeling efforts as well as the integration of the latest science and technology for wildfire mitigation strategies. Based on the continuous technological advances that are available, Fire Sciences will be enhancing much of the modeling applications and procedures that directly affect wildfire mitigation to include, the Fire Potential Index, Fuels Modeling, PSPS wind thresholds, fire season outlooks, and the migration to higher resolution model outputs. One of SCE's top priorities in the coming years will be to enhance our weather and fuel modeling capabilities.

The Fire Science and Advanced Modeling program requested both O&M and capital. The capital expenditures are for advanced computer hardware, models and analytical tools. The O&M expenses are for various software tools to be used on the hardware, acquiring advanced imagery of forest areas for modeling, and collecting data on surface fuel conditions.[176] As can be seen in the tables below, the majority of the capital expenditures occur in 2019 and 2020, and the expenses increase to the test year, to provide the tools, data and materials needed for the modeling efforts.

Cal Advocates accept SCE's proposed capital expenditures for Fire Science and Advanced Modeling but propose a 44% reduction in the test year expenses. No other party addressed Fire Science and Advanced Modeling.

Table II-26
Fire Science & Advanced Modeling Capital Expenditures
2014-2019 Recorded/2020-2021 Forecast
Summary of SCE, Cal Advocates, and Positions
(Nominal $000)

Line No.	GRC Activity		SCE Rebuttal Position 2014-2018 Recorded	2019 Recorded	2020 Forecast	2021 Forecast	Total 2019-2021	Cal Advocates 2019	2020	2021	Total 2020-2021	Variance from SCE 2020-2021
1	Fire Science & Advanced Modeling		-	6,487	5,685	1,102	13,274	6,487	5,685	1,102	6,787	-

[176] Please refer to WP SCE-04, Vol. 5 Part 2 pp. 85-92 for more details on SCE's expense forecast.

Table II-27
Fire Science & Advanced Modeling O&M Expenses
2014-2018 Recorded/2021 Forecast
Summary of SCE, Cal Advocates, and TURN Positions
(2018 Constant $000)

Line No.	GRC Activity	SCE Recorded 2014-2017	SCE Recorded 2018	2021 Forecast SCE	2021 Forecast Cal Advocates	2021 Forecast TURN	Variance from SCE Cal Advocates	Variance from SCE TURN	SCE Rebuttal Position
1	Fire Science & Advanced Modeling	-	1,873	3,948	2,204	3,948	(1,744)	-	3,948

a) <u>Cal Advocates</u>

(1) <u>Cal Advocates' Position On O&M</u>[177]

Cal Advocates propose a TY expense level of $2.204 million for SCE's Fire Science and Advanced Modeling O&M expenses, a reduction from SCE's proposal of $1.744 million. Cal Advocates asserts that "SCE's request for incremental funding of $2.075 million or 110.78% over 2018 expense levels of $1.873 million for Fire Science and Advanced Modeling is not adequately justified because SCE does not substantiate the significant increase."[178] Citing a response to a data request, "SCE acknowledges in its response that it was performing other activity to mitigate the risk of wildfires in 2014 – 2018", PAO concludes that "SCE failed to incorporate these similar historical costs in its TY calculations, and by not doing so creates unreliable forecasts."[179] Cal Advocates' TY forecast is set equal to SCE's 2019 recorded expenses.

b) <u>SCE's Rebuttal To Cal Advocates' Position</u>

Cal Advocates' position is without merit. Its argument that SCE has not reflected costs for programs in the past is incorrect. Its argument that SCE has not provided adequate justification for its test year operations is unsupported, and its reliance on a 2019 forecast would not provide adequate funding for the critical improvements this program will make to mitigating wildfire risk. It is also inconsistent with Cal Advocates' acceptance of the associated capital expenditures for the program.

Cal Advocates assert that SCE has not provided adequate justification for the program but does not identify deficiencies in any of the provided evidence. SCE has provided a detailed

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177 A1908013 Public Advocates Office Godfrey Transmission Distribution 1 Wildfire Management Expenses (PAO-06) pp. 56-59

178 PAO-06, pp. 56-57.

179 PAO-06, p. 59.

O&M forecast, showing specific line items and cost estimation methodology for the sub-activities that make up Fire Science & Advanced Modeling.

Cal Advocates' arguments about whether or not past costs have been included in the program are misdirected, and the argument that SCE has previously done work to mitigate wildfire risk is irrelevant. SCE has tried to mitigate fire risks in the past, but is now material expanding those efforts, as demonstrated throughout the direct testimony (SCE-04, Vol. 5A). Fire Science and Advanced Modeling are new programs which rely on evolving and emerging technology, new scientific methods, research, and practices. Some of these activities, namely, Advanced Modeling Computer Hardware and Advanced Weather Modeling Tool were included in the 2018 GS&RP filing (A18-09-002), and adopted as part of D.20-04-013, the GSRP Settlement. There was no Fire Science program in the past, and the methodologies that SCE will be using will be new science on new hardware, using newly collected data. It is important that SCE stay relevant in these areas so that it can keep up with industry demands and practices.

Cal Advocates have accepted SCEs proposed capital expenditures, but Cal Advocates' O&M proposals would have the hardware and tools purchased being significantly underutilized, and not providing the full benefits of wildfire risk mitigation that is possible. SCE is responding to new underlying threats and initiatives which requires Fire Sciences and Advanced Modeling to be dynamic and fluid in its response to how wildfire mitigation efforts are managed in the future. For example, multiple enhancements to our weather modeling is critical as it affects other downstream modeling, projects, and activities such as fuels modeling, fire spread modeling, and PSPS activations. In particular, more targeted approaches to proactive de-energization are dependent upon having more accurate and more precise weather and fuels forecasts. These enhancements are included as part of SCE's O&M request. Cal Advocates would fund the hardware, but not the data for improving it.

2. <u>Conclusion</u>

While SCE has been actively engaged in wildfire mitigation in the past, it has recently taken on a more aggressive strategy to ensure the safety of its employees, customers, and communities. In doing so, SCE has committed to leveraging and incorporating the latest science and technology in its effort to harden its grid against wildfires. This evolving effort has resulted in expenditures that exceed 2019 budget amounts. In order to protect customers from risks associated with wildfires, SCE needs to remain flexible on how various scientific and technical advancements are utilized within advanced modeling and fire sciences.

Appendix A

Select Data Request Responses and Workpapers

Index

Index

PUBLIC ADVOCATES OFFICE
DATA RESPONSE
Southern California Edison Company Test Year 2021 General Rate Case
A.19-08-013

Date: 4 May 2020

Origination Date: 27 April 2020

Response Due: **4 May 2020**

To: Martin Collette, Martin.collette@sce.com

cc: Douglas.Snow@sce.com
Russell.Archer@sce.com
scegrc@sce.com

From: Truman Burns, Project Coordinator
Public Advocates Office
505 Van Ness Avenue, Room 4104
San Francisco, CA 94102 txb@cpuc.ca.gov

Response by: Scott Logan
Phone: 415-703-1418
Email: scott.logan@cpuc.ca.gov

Data Request No: **SCE-PubAdv-009-MC**

SCE Question:

1. In Exhibit PAO-09, p. 13, Table 9-10, Cal Advocates footnoted that it used SCE's original testimony Exhibit SCE-04, Vol. 5, p. 5, Table I-2 as its source data. SCE submitted amended testimony Exhibit SCE-04, Vol. 5A, on November 22, 2019 to account for the reduction in work volume due to the removal of some non-CPUC High Fire Threat District (HFTD) High Fire Risk Areas (HFRA). Why did Cal Advocates use SCE's original testimony, and not the amended testimony?

Public Advocates Office Response:

1. The Public Advocates Office's corrections to its prepared testimony will reflect data from SCE's amended testimony.

SCE Question:

2. In Exhibit PAO-09, p. 15, lines 4-5, Cal Advocates stated, 'The Public Advocates Office recommends that the Commission adopt a wildfire management-related capital expenditure budget of $625.8 million' for SCE's 2021 forecast. Cal Advocates did not provide an explanation as to how Cal Advocates arrived at that amount. SCE believes Cal

Advocates replaced SCE's 2021 forecast amount for the WCCP with its 2020 nominal forecast of $533.803 million, to derive the amount of $625.803 million as illustrated in the table below.

a. Please confirm if this is the basis for Cal Advocates' recommendation.

Table 9-10
Wildfire Capital
2019 Recorded and 2019-2023 Forecast Expenditures
(In Nominal $000's)

	Recorded	Forecast			Cal Advocates' 2021 Proposal
GRC Activity	**2019**	**2019**	**2020**	**2021**	
Distribution Fault Anticipation	3,445	2,340	0	6,270	6,270
Enhanced Overhead Inspections and Remediations	300,592	152,331	155,741	56,174	56,174
Enhanced Situational Awareness	5,252	6,364	4,159	0	0
Fire Science and Advanced Modeling	6,487	12,953	5,685	1,102	1,102
Fusing Mitigation	70,298	50,173	11,885	0	0
HFRA Sectionalizing Devices	11,951	6,292	28,452	5,209	5,209
PSPS Execution	1,766	180	1,212	738	738
Undergrounding	0	0	0	22,507	22,507
Wildfire Covered Conductor Program	249,288	156,337	533,803	~~771,099~~	533,803
GRC Total	**649,079**	**386,970**	**740,937**	~~**863,099**~~	**625,803**

Source: Forecast data from Ex. SCE-4, Vol. 5, p. 5, Table I-2; recorded 2019 data from SCE response to Public Advocates Office data request PubAdv-SCE-056-TXB, Q.2 Supplemental.

b. If the answer to question 2a is no, please provide an explanation and/or formula used for Cal Advocates' methodology for its recommendation.

Public Advocates Office Response:

2.a. Yes.

2.b. N/A.

END OF RESPONSE

Summary of Covered Conductor Effectiveness
WSD-SCE-002, Q33

Drivers	Annual Frequency	Mitigation Effectiveness [%]	Mitigation Effectiveness Frequency
D1 - CFO	**19.60**		
D1a - Animal	4.40	99%	4.36
D1b - Balloons	4.60	99%	4.55
D1c - Unspecified	1.80	77%	1.39
D1d - Veg	5.00	60%	3.00
D1e - Vehicle	3.80	50%	1.90
D2 - EFF	**9.60**		
D2a - Cap. Bank	0.20	0%	0.00
D2b - Conductor	2.60	90%	2.34
D2c - Crossarm	0.20	50%	0.10
D2d - Fuse	0.20	0%	0.00
D2e - Insulator	1.20	90%	1.08
D2f - Splice/Clamp/Connector	2.60	90%	2.34
D2g - Transformer	1.00	0%	0.00
D2h - Unspecified	1.60	0%	0.00
D2i - Lightning arrestor	0.00	0%	0.00
D2j - Switch	0.00	0%	0.00
D3 - Wire to Wire / Contamination	1.20	99%	1.19
D4 - Unknown/Unspecified	5.40	0%	0.00
	Total	**35.80**	**22.24**

Mitigation Effectiveness	**62%**

Southern California Edison
A.19-08-013 – SCE 2021 GRC

DATA REQUEST SET T U R N - S C E - 0 4 2

To: TURN
Prepared by: Bryan Landry
Job Title: Senior Advisor
Received Date: 3/24/2020

Response Date: 3/30/2020

Question 04.h:
Regarding SCE-02, question 7, Excel Attachment "Risk Buydown Curve," which provides the data supporting Figure II-9, p. 26.

h. For the first 5 circuit segments of the "RIM" circuit, circuit IDs 1, 3, 12, 83, 142, please provide all inputs and calculations, where possible, that determine columns J through N (Fire Frequency, MARS Financial, MARS Injury, MARS Fatality, Total MARS. Please provide in Excel with an accompanying explanation of how each input is calculated or how it is derived.

Response to Question 04.h:
The data, as well as the underlying calculations associated with the data, in these columns are extensive. In addition, the data does not reside in Excel format and was not intended to be used in an Excel-based application. Based on the compressed requested time frame to provide this information, and given that calculations reside in another software tool, in lieu of providing this information SCE respectfully offers to provide a telephonic demo of the data and the tool used to develop this data.

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET T U R N - S C E - 0 1 3

To: TURN
Prepared by: Eric X Wang
Job Title: Sr. Advisor, Prdctve Anlytcs/Data Science
Received Date: 1/23/2020

Response Date: 2/6/2020

Question 01.a-e:
Re SCE's response to TURN-05, question 2h, Excel Attachment "DR prioritization_list:"
a. Please add a column to this spreadsheet that provides each segment's length (in miles).
b. Please add a column to this spreadsheet that indicates whether each segment is in Tier 2 or Tier 3 HFTD.
c. Please add a column that indicates whether the circuit segment already has covered conductor by adding the number 1 to the row for any segment with covered conductor.
d. Please add a column or another tab that indicates the "region" (Desert, North Coast, Rurals, San Jacinto, San Joaquin) each circuit or circuit segment is located in.
e. Please confirm that SCE will generally seek to deploy covered conductor from the highest to lowest risk circuit segment, as listed in the spreadsheet.

Response to Question 01.a-e:

a. Please see column "Miles" in attached Excel file "TURN-SCE-013 - 01.a-e_Prioritization_List.csv"
b. Please see column "High Fire Tier" in attached Excel file "TURN-SCE-013 - 01.a-e_Prioritization_List.csv"
c. Please see column "covered" in attached Excel file "TURN-SCE-013 - 01.a-e_Prioritization_List.csv". Due to the method of capturing what has been scoped at circuit level and translating that to segment level, some segments that have been scoped may be mapped to more than one segment from the prioritization list. As a result, the completed segment list may show more segments and miles than what has been actually scoped.
d. Please see column "Circuits_Region" in attached Excel file "TURN-SCE-013 - 01.a-e_Prioritization_List.csv"
e. SCE generally seeks to deploy covered conductor from the highest to lowest risk segment. However, SCE considers many factors, including, but not limited to, design/engineering, permitting requirements, work management scheduling (e.g., bundling of work), existing remediation and maintenance activities, weather, and environmental constraints that could alter the order in which segments are selected for covered conductor deployment.

DATA REQUEST SET T U R N - S C E - 0 0 5

To: TURN
Prepared by: Paul Joseph McGregor
Job Title: Principal Manager, Enterprise Risk Management
Received Date: 12/13/2019

Response Date: 1/6/2020

Question 04:
For proposed wildfire management expenditures, please explain and quantify how SCE incorporated the cost-effectiveness of various risk mitigations into its proposal.

Response to Question 04:
Risk Spend Efficiency (RSE) is a measure of risk reduction per dollar spent. It is a relative measure of cost-effectiveness for risk mitigation activities relating to a specific risk. RSE offers insights into how effective mitigations appear to be in reducing risk at a system, or portfolio level, while providing guidance on how effective new mitigations may be.

SCE quantified RSEs for most wildfire mitigations presented in Exhibit SCE-04, Volume 5A, and used RSE as a valuable contributing metric to inform the development of the overall wildfire mitigation plan presented in SCE-04, Volume 5A. These RSEs are discussed further in SCE-01, Volume 2 and calculated using the RAMP model methodology detailed in SCE's 2018 RAMP Report, for which the revised outputs for the GRC period are provided in WPSCE01V02, pp. 7-8.

The wildfire risk model presented in SCE-01, Volume 2, pp. 22-24 helps SCE to prioritize wildfire mitigation work. While the RAMP model calculates risk at a portfolio level, the wildfire model quantifies wildfire risk at a more granular level, i.e., down to specific circuits and circuit segments across the HFRA. The output of the model is a risk score that identifies potential high-risk circuits and segments where mitigation considerations, such as covered conductor, targeted undergrounding, equipment replacement, or other strategies may be considered.

It is important to note that the relative risk ranking of circuits can and probably will change over time as SCE continues to evolve its risk modeling capabilities. In general, SCE looks to first address those circuit segments and circuits which present the greatest risk. However, SCE will often bundle work related to multiple and/or contiguous circuit segments together to achieve operational efficiencies. For example, the risk associated with each circuit may not be uniform along its length. In other words, the risk can vary between a specific mile or segment within a circuit, especially if that circuit traverses various HFTD Tiers and is exposed to different probabilities of ignition by contact from objects, or varying topography and vegetation that can influence fire propagation and consequence. In some cases, it may be operationally efficient and prudent to remediate relatively lower risk segments of a circuit at the same time relatively higher risk segments of the same circuit are addressed, instead of sending multiple crews out at multiple different times, requiring the development of separate work scope packages.

It is also important to recognize that RSEs are not and should not be the only factor used to develop a risk mitigation plan. The RSE metric does not take into account certain operational realities, resource constraints, and other factors that SCE must consider in developing its plan. For example, while PSPS has a relatively high RSE, there are regulatory and practical limits to how much PSPS can be deployed. Indeed, the Commission prescribes that PSPS should be used "as a last resort" despite its relatively high RSE.

The same is true for other mitigations presented in this testimony. As another example, while undergrounding overhead power lines may present a relatively high risk-reduction opportunity, it requires considerably greater planning and lead time to implement than reconductoring using covered conductor. If SCE focused only on undergrounding its overhead system in HFRA, its ability to immediately reduce risk would be significantly delayed. In addition, for various operational and financial reasons, it is not practical to underground the entire transmission and distribution system in HFRA.

Accordingly, SCE developed a comprehensive and balanced mitigation plan with activities that will collectively reduce the greatest amount of risk in the shortest amount of time, considering RSE as well as various regulatory, operational, resource, and cost constraints. It would be inappropriate to implement a comprehensive wildfire risk mitigation plan based solely on RSEs, which would likely lead to significant parts of the system and potentially significant risk issues left unaddressed.

Indeed, the Commission's Safety and Enforcement Division (SED) agrees that focusing solely on RSEs in selecting mitigations could be "suboptimal from an aggregate risk portfolio standpoint."[1] This feedback is included in SED's comments regarding PG&E's 2017 RAMP Report (please refer to the footnoted citation). SED acknowledged that "mitigations are usually selected based on the highest risk spend efficiency score unless there may be some identified resource constraints, compliance constraints, or operational constraints that may favor another candidate measure with a lower RSE."[2]

SCE's proposed wildfire spending plan was also heavily impacted by resource availability and constraints. The same engineers, planners, and field crews who would perform much of the wildfire mitigation work have historically performed other important work on our system. As discussed in this GRC, SCE has reallocated a significant amount of these resources to address public safety risks associated with wildfires, while simultaneously maintaining similar resources to serve the

[1] California Public Utilities Commission, Risk and Safety Aspects of Risk Assessment and Mitigation Phase Report of Pacific Gas and Electric Company Investigation 17-11-003 (March 30, 2018) page 18.
[2] California Public Utilities Commission, Risk and Safety Aspects of Risk Assessment and Mitigation Phase Report of Pacific Gas and Electric Company Investigation 17-11-003 (March 30, 2018) page 18.

foundational needs of the electric system (e.g., restoration of service, storm, infrastructure replacement, new service connections, load growth, etc.), albeit at temporarily reduced levels. In the course of deciding to pursue this strategy, SCE performed a risk analysis to evaluate the public safety impacts of shifting resources from traditional infrastructure replacement programs to wildfire mitigation work. This analysis shows that the safety reduction gained through the enhanced portfolio of wildfire mitigations exceeds the safety reduction lost in other risk initiatives, specifically contact with overhead conductor and underground equipment failure risks (which are further described in SCE's 2018 RAMP report). The methodology and summary of results can be found in WP SCE-01, Vol. 02, Wildfire Tradeoff Risk Analysis, pp. 44-46).

Southern California Edison

A.19-08-013 – SCE 2021 GRC

DATA REQUEST SET T U R N - S C E - 0 0 5

To: TURN
Prepared by: Jamal Cherradi
Job Title: Principal Manager
Received Date: 1/7/2020

Response Date: 1/10/2020

Question Q.38 Revised:
If not previously provided, please provide a list of circuits and circuit segments, respectively, that SCE will use to prioritize covered conductor deployment (e.g. the order in which it is expected to be deployed). Please include a column with expected or actual year of deployment (e.g. 2018-2023 or later). Please provide in Excel with conductor ID (from "Risk Buydown Curve" attachment), Circuit Name, probability of failure, consequence score, egress score, and any other components that drive this prioritization.

Response to Question Q.38 Revised:
Attached in the Excel file titled "Q38_prioritization_list.xlsx" is the current prioritized list of all circuit segments based on highest risk with Circuit Name, ID, GE_FID, probability of failure, consequence score, risk, GESW_ID, COND_FID, High Fire Threat District, and Record ID are provided. The prioritization is driven by risk which is the product of probability and consequence. Due to dynamic improvements to the prioritization model, engineering design, planning, and operational execution, many factors are considered that may alter the order that these segments are selected for covered conductor deployment. Therefore, the deployment over the GRC cycle of the covered conductor in the HFRA is unlikely to be identical to the designated risk priority.

Due to the difference in data structure across two mapping systems (Map3D and GE Smallworld) the GESW_ID, COND_FID, High Fire Threat District, and Record ID columns will not always have a direct match across the datasets. "Risk Buydown Curve 7.23" utilizes data from Map3D whereas the list of prioritized risk segments comes from GE Smallworld segment data. Therefore, when matching there will be some records that do not have a Record ID match.

Workpaper

Operational Realities Requiring Additional Circuit Miles

Calculations

In the deployment of covered conductor (CC), generally SCE seeks to first address those circuits and circuit segments that present the highest risk. However, there are situations or operational realities where it is more efficient, and many times required, to replace additional spans. SCE performed an analysis on known 2021 covered conductor scope, and found that accounting for operational realities of deploying covered conductor would require 20% additional miles beyond the miles that would be covered strictly pursuant to the risk analysis.

Sum of Projected DOTS (circuit miles)	1,466
Sum of Scoped DOTS (circuit miles)	1,761
Number of additional miles	295
Percent of additional miles	**20%**

Notes

- DOTS = Distribution Overhead Targeted Scoping
- This analysis did not include Tree Attachment projects.
- Covered conductor scope may be further refined upon construction to account for local field conditions.

Southern California Edison

R.18-10-007 – Order Instituting Rulemaking to Implement Electric Utility Wildfire Mitigation Plans Pursuant to Senate Bill 901 (2018).

DATA REQUEST SET M G R A - S C E - 0 0 3

To: MGRA
Prepared by: Arianne Luy
Job Title: Engineer
Received Date: 9/27/2019

Response Date: 10/10/2019

Question 38:
Questions regarding SCE's September 17 WMP Progress Update
In its September 17th update, SCE states that it: "Held technical conferences with multiple covered conductor suppliers, performed benchmarking with other utilities and industry organizations, and contracted with multiple consultants to ensure design standards are industry best practices."

Which other utilities and industry organizations is SCE working with on covered conductor?

Response to Question 38:

SCE has benchmarked with the following utilities regarding covered conductor:

- Korea Electric Power Company - KEPCO (South Korea)
- Ausnet (Victoria, Australia)
- National Grid (Massachusetts)
- Eversource (New Hampshire)
- Con Edison (New York)
- Orange and Rockland Utilities (New York)
- Liberty Utilities (New Hampshire)
- Groveland Light (Massachusetts)
- Holyoke (Massachusetts)
- Middleton (Massachusetts)
- Seattle City Light (Washington)
- Puget Sound Energy (Washington)
- United Power (Colorado)

SCE has also worked with the following organizations regarding covered conductor:

- IEEE Insulated Conductors Committee
- Southwire Company
- Taihan Electric Wire
- Hendrix Aerial Cable Systems
- EA Technology
- Power Delivery Consultants

Workpaper Title:

Covered Conductor Compendium

Covered Conductor - Everything You Need To Know (Compendium)

August 6, 2019

Energy for What's Ahead[SM]

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Purpose

- There has been a vast amount of literature search, testing, calculation, benchmarking and standards development by T&D Engineering for the deployment of Covered Conductor
- As a result, multiple work documentation on various topics concerning Covered Conductor has been created for supporting the issuance of SCE specifications, design and construction standards for covered conductor
- These topics on Covered Conductor are summarized on the "Table of Contents" slide.
- The purpose of this slide deck is to consolidate and condense the key thoughts of these works into a single document, providing a comprehensive overview of covered conductor

Table of Contents

Chapter I
What is Covered Conductor?
Why Covered Conductor?

Energy for What's Ahead[SM]

1. The Evolution of Covered Conductor Design

This section introduces the high-level understanding of Covered Conductor and how it has evolved from a simple model in the early 1970s to a robust design today that mitigates contact issues and achieves long service life

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A Brief History

- Covered Conductor has been used by utilities since the 1970s in Europe and the U.S.
  - Key driver: reliability improvement in dense vegetation areas, such as forests in Scandinavia, the U.K., New England, etc.
- Other drivers expand the use of covered conductors:
  - Tokyo, Japan: public safety in dense population
  - Southeast Asia (Thailand, Malaysia): animal protection (snakes, monkeys, rodents), and dense vegetation, also public safety in downtown Bangkok
- Reduction of "bushfires" has become a key driver for replacing bare with covered conductor in Australia
- Over the years, significant development in the covered conductor design led to improved performance and extended life

Nomenclature of Covered Conductor

- Covered conductor is a widely accepted and used term for distinguished from bare conductor
- The term indicates a conductor being "covered" with insulating materials to provide incidental contact protection
- Covered conductor is used in the U.S. in lieu of "insulated conductor", which is reserved for grounded overhead cable
- Other parts in the world use the term "covered conductor", "insulated conductor", "coated conductor" interchangeably
- Covered conductor is a generic name for many sub-categories of conductor design and field construction arrangement
- Covered conductor in the U.S.:
  - Tree wire
    - Term was widely used in the U.S. in 1970's
    - Associated with simple one layer cover
    - Used to indicate cross-arm construction
  - Spacer cable
    - Associated with construction using trapezoidal insulated brackets for suspending covered conductor
  - Aerial bundled cable (ABC)
    - Installation of underground cable on poles with benefits of being grounded
- Covered Conductor in Europe:
  - SAX, PAS/BLX, BLX-T are some names for covered conductor used in Scandinavia for installations in forests
  - CC/CCT are covered conductor and covered conductor with extra thickness are used in Australia, the Far East
- Covered Conductor at SCE:
  - The term "Covered Conductor" was introduced to SCE standards in Q1, 2018, previously, the term "tree wire" was used
  - SCE is more familiar with "aerial cable" to indicate field-bundled underground cable (with or without jacket) prior to 2000's, and manufacturer "pre-bundled" underground cable on air (ABC) in the 2000's
  - Current SCE specified Covered Conductor is more robust than CCT with has better UV protection

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Single Layer Covered Conductor

- Characteristics:
  - Single Layer
  - Typically, Low Density Polyethylene (insulating material)
  - Covering Thickness ranges from 0.091 to 0.130 inches
- Lower impulse strength than the two or three layer design
- Provides some resistance to outages caused by tree and wildlife contact

Two Layer Covered Conductor

- Characteristics:
  - Two Layers
    - Layer A: Polyethylene (PE)
      - Insulating material
      - 0.080 inches
    - Layer B: High Density Polyethylene (HDPE)
      - Insulating Material
      - Tougher than layer A
        - Abrasion Resistant
      - 0.080 inches
- Higher impulse strength than the single layer design

Three Layer Covered Conductor

- Characteristics
  - Three Layers
    - Layer A: Conductor Shield
      - Semiconducting layer
      - Reduces Voltage Stress
    - Layer B: Polyethylene Layer
      - Insulating Layer
      - Can be crosslinked (XLPE)
    - Layer C: Polyethylene Layer
      - Insulating Layer
      - Can be high density and/or crosslinked

- Higher impulse strength than the single layer design and two layer design

SCE's Evolution

Single Layer

- 150 mils HDPE

3 Layer 75°C Rated

- 15 mils conductor shield
- 75 mils LDPE Inner Layer
- 75 mils HDPE Outer Layer

3 Layer 90°C Rated

- 15 mils conductor shield
- 75 mils XL-LDPE Inner Layer
- 75 mils XL-HDPE Outer Layer

Covered Conductor Installation Options

- Cross-arm Construction
  - (aka Tree Wire)

Most of SCE installations on Cross-arm (SCE uses grey to reduce the impact of sun light heating effect, thus increase ampacity)

- Compact Construction
  - (aka Spacer Cable)

Some installations will be spacer cable (e.g. replacement of tree attachments)

2. SCE Covered Conductor Design

This section provides more insights of SCE Covered Conductor Design – layer by layer and the functions of each layer (sheath)

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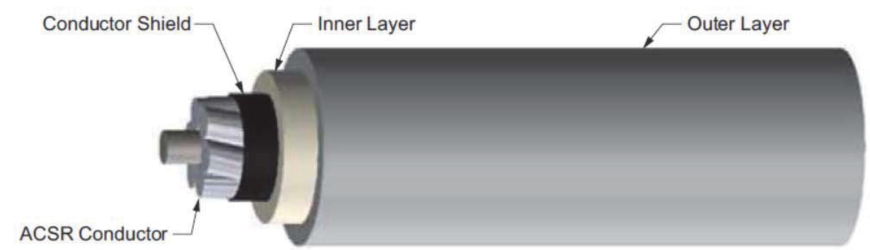
SCE Design

- Three Layer Covered Conductor
  - Conductor
    - Aluminum Conductor Steel-Reinforced (ACSR)
    - Hard Drawn Copper (HDCU)
  - Conductor Shield
    - Semiconducting Thermoset Polymer
  - Inner Layer
    - Crosslinked Low Density Polyethylene
  - Outer Layer
    - Crosslinked High Density Polyethylene



Conductor

- Aluminum Conductor Steel-Reinforced (ACSR)
  - Sizes
    - 1/0 AWG (6/1 Strand)
    - 336.4 AWG (18/1 Strand)
    - 653 AWG (18/3 Strand)
- Hard Drawn Copper (HDCU)
  - For use in coastal areas (within 1 mile of the coast)
    - Copper is more resistant to corrosion than Aluminum
  - Sizes
    - #2 AWG (7 Strand)
    - 2/0 AWG (7 Strand)
    - 4/0 AWG (7 strand)

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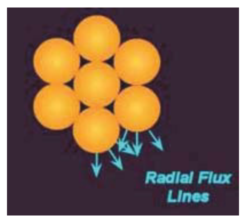
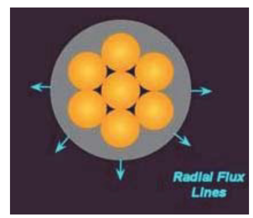
Conductor Shield

- Material: Semiconducting Thermoset Polymer
- Reduces stress concentrations caused by flux lines from individual conductor strands.
  - Transforms strands into a single uniform conducting cylinder



Flux lines without a conductor shield

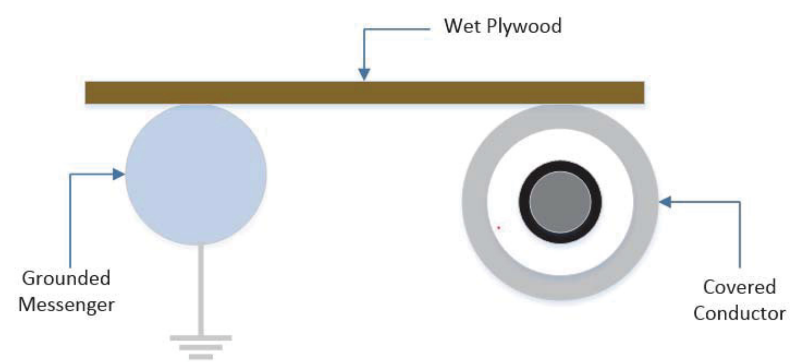


Flux lines with a conductor shield

- The reduction of electrical stress, especially if the covered conductor is in contact with another object, will help preserve the integrity of the insulation and lengthen the useful service life of the covered conductor.

Conductor Shield – Wet Wood Testing

- Subjected the covered conductor to higher-than-normal voltages for its typical use and design to accelerate the time it takes for the covered conductor to fail
- 35kV Covered Conductor subjected to 30 kV did not fail since it was exposed to voltage it was designed for
- Conclusion: Conductor shield allows the covered conductor to withstand contact for a longer period of time



Accelerated Testing - Days to Failure			
Voltage Applied	**15 kV CC - No Conductor Shield**	**15 kV CC - With Conductor Shield**	**35 kV CC - With Conductor Shield (Experiment Control)**
30 kV	21.3 Days	35.7 Days	Testing stopped without failure after 141.9 Days
40 kV	2.08 Days	9.2 Days	Not Tested
50 kV	0.02 Days	0.16 Days	Not Tested

Inner Layer

- Material: Crosslinked Low Density Polyethylene (XL-LDPE)
- Insulating Layer
  - Contributes to the high impulse strength of the covering, which will protect the conductor from phase-to-phase and phase-to-ground contact
- Crosslinking will allow the material to retain its strength and shape even when heated

Outer Layer

- Material: Crosslinked High Density Polyethylene (XL-HDPE)
- Insulating Layer
  - Contributes to the high impulse strength of the covering, which will protect the conductor from phase-to-phase and phase-to-ground contact
- Abrasion and Impact Resistant
- Environmental Stress-Crack Resistant
- Track Resistant
- UV Resistant
- Crosslinking (XL) will allow the material to retain its strength and shape even when heated
- HDPE uses Titanium Dioxide as the most effective UV inhibitor, and providing the best track resistant

Temperature Rating

- Normal Operation: 90ºC
- Emergency Operation: 130ºC
- Short Circuit Operation: 250ºC

Covered Conductor vs. Bare Comparison

- ACSR Covered Conductor

Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Overall Diameter (in)	Ampacity per Conductor/ (Amps)
1/0	ACSR (6x1)	XL-HDPE (165 mils)	0.277	0.728	271
336.4	ACSR (18x1)	XL-HDPE (165 mils)	0.564	1.014	550
653.9	ACSR (18x3)	XL-HDPE (180 mils)	0.973	1.313	835

- ACSR Bare

Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Overall Diameter (in)	Ampacity per Conductor/ (Amps)
1/0	ACSR (6x1)	N/A	0.146	0.398	280
336.4	ACSR (18x1)	N/A	0.365	0.684	605
653.9	ACSR (18x3)	N/A	0.677	0.953	920

Covered Conductor vs. Bare Comparison

- Copper Covered Conductor

Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Overall Diameter (in)	Ampacity per Conductor/ (Amps)
#2	HDCU (7)	XL-HDPE (165 mils)	0.316	0.622	240
2/0	HDCU (7)	XL-HDPE (165 mils)	0.569	0.744	367
4/0	HDCU (7)	XL-HDPE (165 mils)	0.845	0.852	488

- Copper Bare Conductor

Conductor Size (AWG)	Conductor Type (Stranding)	Cover Type	Weight (lb/ft)	Overall Diameter (in)	Ampacity per Conductor/ (Amps)
#2	HDCU (7)	N/A	0.205	0.292	260
2/0	HDCU (7)	N/A	0.411	0.414	405
4/0	HDCU (7)	N/A	0.653	0.522	540

3. Contact with Foreign Object

This section demonstrates how Covered Conduct reduces ignition risks during contact with foreign object or other conductor by performing a complex engineering analysis and testing impacts of contact on Covered Conductor

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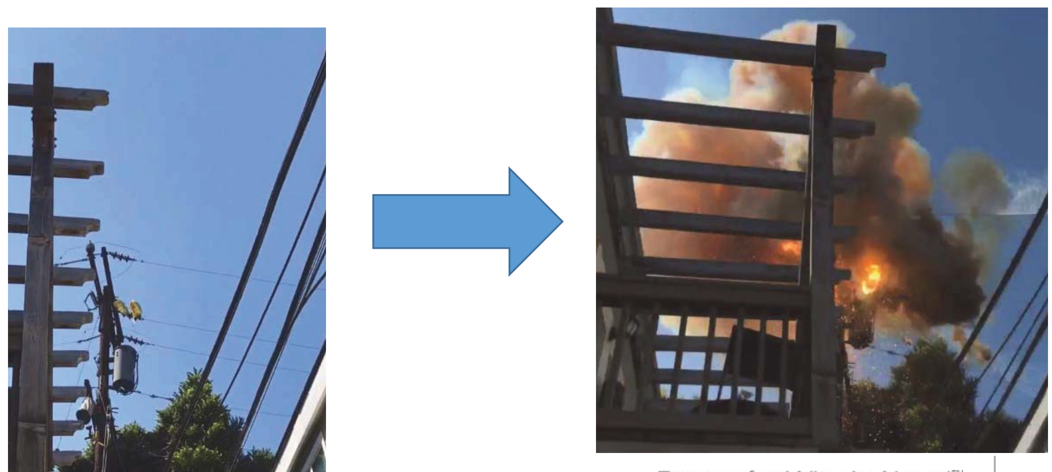
Contact from Objects with Bare Wire

Vegetation Contact
- Branches grow into line
- Wind blow trees around line
- Wind blows palm fronds into lines

Metallic Balloon Contact



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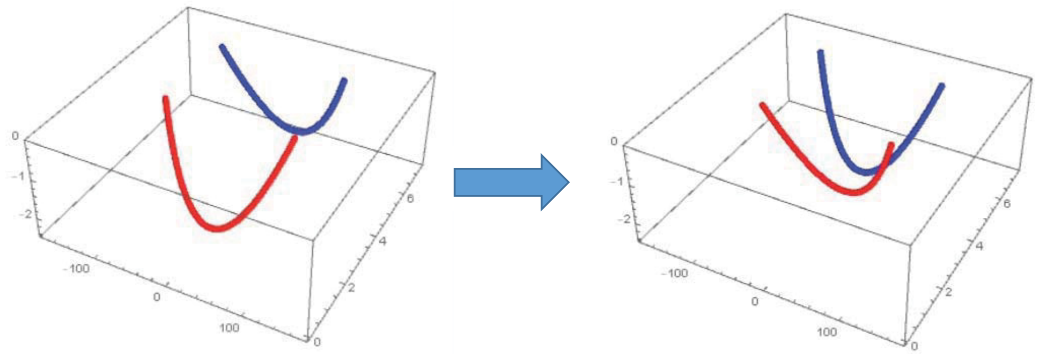
Contact from Objects with Bare Wire

Wildlife Contact



Conductor-to-Conductor Contact

Contact from Object

- Covered conductors will prevent incidental contacts that cause phase-to-phase and phase-to-ground faults caused by:
  - Vegetation/Palm fronds
  - Conductor slapping
  - Wildlife
  - Metallic Balloons
- Analysis of computer modeled scenarios and field testing supports that covered conductor will prevent faults caused by incidental contact.

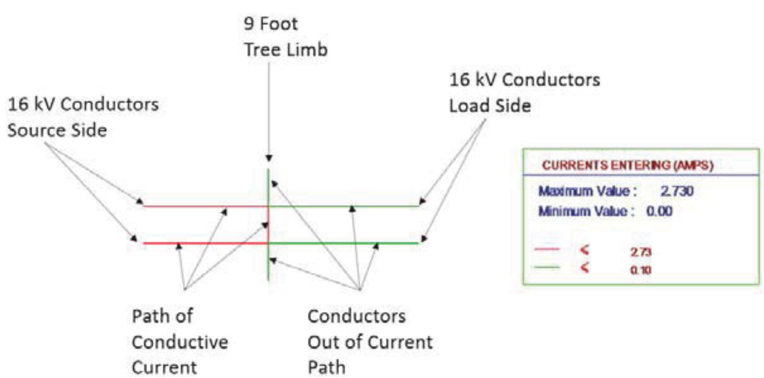
Contact with Foreign Object Using Computer Modeling & Simulation

- An SCE study analyzed the effectiveness of the covering in preventing phase-to-phase faults due to incidental contact
- The study also analyzed the energy absorbed by the foreign object when contact with two covered conductor is significant low and not sufficient to start a fire.
- Complex electric power engineering program tools used for computer modeling:
  - PSCAD (Power Systems Computer Aided Design)
  - CDEGS (Current Distribution, Electromagnetic Interference, Grounding and Soil Structure Analysis)
- Scenarios Modeled:
  - Tree/Vegetation phase-to-phase contact
  - Conductor Slapping
  - Wildlife phase-to-phase contact
  - Metallic Balloon phase-to-phase contact

Example of Computer Modeling & Simulation Results for Tree Contact (CDEGS)

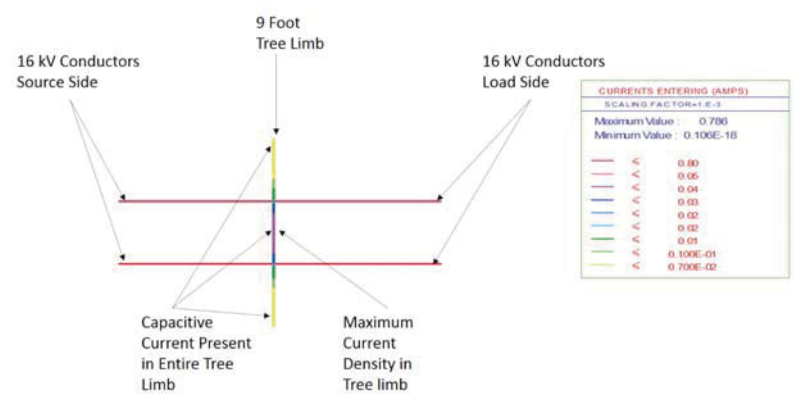
Case 1: Tree on Two Bare Conductors

Maximum Current through object: **2.7 A**



Case 2: Tree on Two Covered Conductors

Maximum Current through object **0.04 mA**



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Study Conclusion

- The analysis concluded that a foreign object contact with covered conductors will not cause a fault
- The results showed that covered conductors reduce the energy from tens of thousands of watts to well under one milliwatt.
- This reduction is expected to be sufficient to prevent ignition

Simulation Method	Conductor Type	Current in Branch	Resistance of Branch	Power into Branch
PSCAD	Bare Conductor	2800 mA	5800 Ω	45,472 W
	Covered Conductor	0.18 mA	5800 Ω	0.00019 W
CDEGS	Bare Conductor	2730 mA	5800 Ω	43,227 W
	Covered Conductor	0.04 mA	5800 Ω	0.00001 W

Field Testing

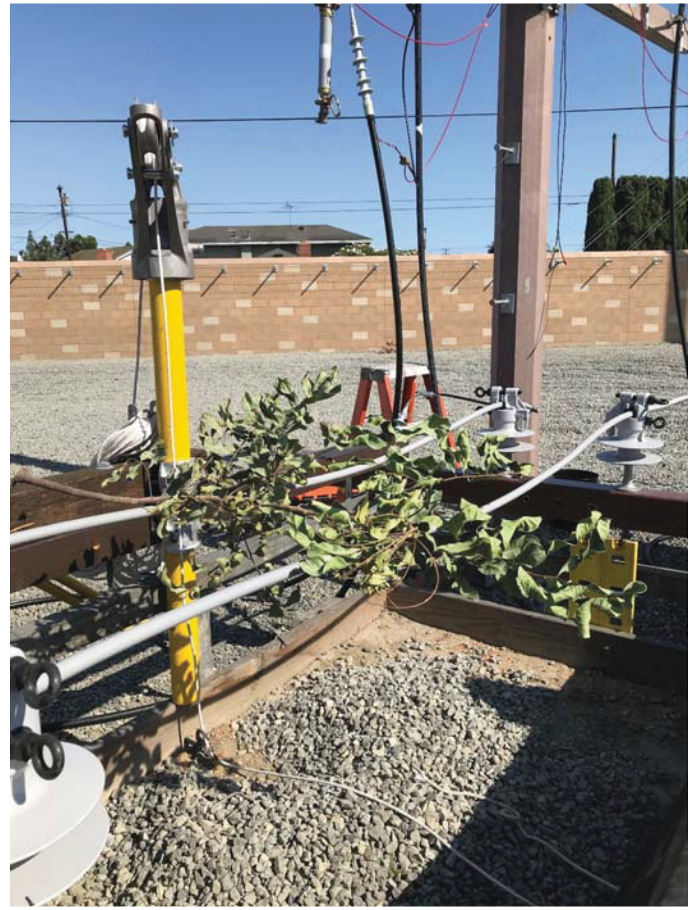
- Field testing was performed at SCE's EDEF Test Facility in Westminster to validate the computer model study
- Tests performed for contact with covered conductors only
- No tests performed for contact with bare conductors, because this information is well studied by the industry
- Scenarios tested:
  - Tree/Vegetation phase-to-phase contact
  - Conductor Slapping
  - Wildlife phase-to-phase contact
  - Metallic Balloon phase-to-phase contact

Palm Frond Contact

- Energized at 12 kV
- Observations
  - No arcing
  - No damage to the covered conductor
  - No damage to the palm frond

Tree Branch contact

- Energized at 12 kV
- Observations
  - No arcing
  - No damage to the covered conductor
  - No damage to the tree branch



Conductor Slapping

- Energized at 12 kV
- Observations
  - No arcing
  - No damage to both covered conductors

Wildlife Contact

- 700 Ω resistor simulated animal contact
- Energized at 12 kV
- Observations
  - No arcing
  - No damage to the covered conductor
  - No damage to resistor

Metallic Balloon Contact

- Energized at 12 kV
- Observations
  - No arcing
  - No damage to the covered conductor
  - No damage to the metallic balloon

Field Test Conclusion

- Field testing validated that covered conductor will prevent faults and reduce the chance of ignition due to incidental contact

Simulated/Test Subject	Current		Energy	
	Simulation Current with Test Subject (mA)	Empirical Current with Test Subject (mA)	Power -Simulation (Watts)	Power – Empirical Testing (Watts)
Palm Frond	0.005	0.001	0.00525	0.00021
Brown Branch	0.006	-0.001	0.17	0.0048
Green Branch	0.003	0.001	0.000012	0.0000014
728 Ohm Resistor Ph-Ph	0.004	0.044	0.000000012	0.0000015
1024 Ohm Resistor Ph-Gnd	0.007	0.052	0.000000050	0.0000028
1024 Ohm Resistor Ph-Ph	0.005	0.03	0.0000000256	0. 0000009216
Conductor-to-Conductor	0.042	0.008		
Metallic Balloon	0.009	0.128	0.00000000030	0.000000066

4. Spacer System – Contact with Objects and Dielectric Strength

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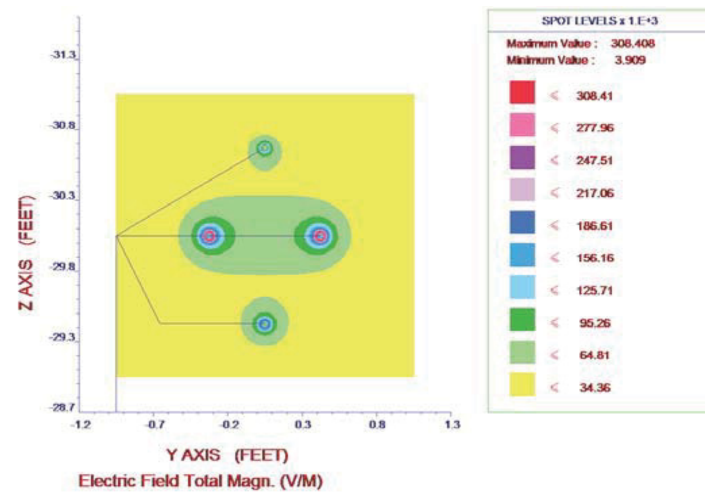
CDEGS Simulation

- A CDEGS model was made according to spacer wire dimensions where all three covered conductor phases and a messenger wire are 8 inches apart.
- The dielectric breakdown of air is 3 MV/m. The simulation results show that the maximum electric field produced with this arrangement is lower than the threshold for the dielectric breakdown of air by a factor of 10.

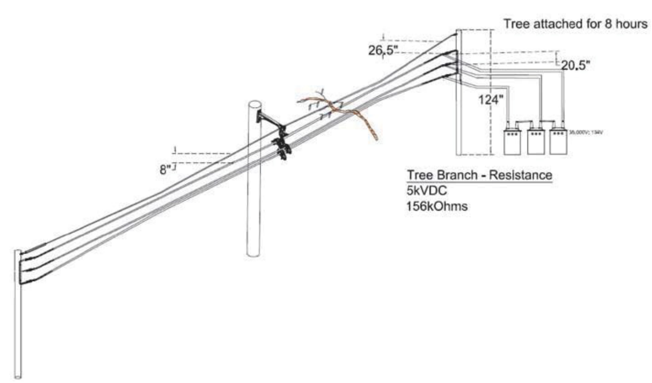


Dielectric Breakdown of Air	Maximum Electric Field Produced w/ 8-inch Spacer Wire Arrangement
3 MV/m	0.3 MV/m

Wet Branch Test Results

- The test simulates scenario of a tree falling into a spacer cable system, assuming the tree brings all phases and the messengers together.
- The covered conductor was designed for 15kV and a voltage of 35kV was applied
- Spacers sprayed hourly with a consistency similar to a fog with salt mixture.
- Branch moisture randomly measured with a content of 26%.
- Results: Covered conductor withstood contact with no failure

Test Subject	Time Duration	Empirical Average Current with Test Subject
Tree Branch	8 Hours	0.865A



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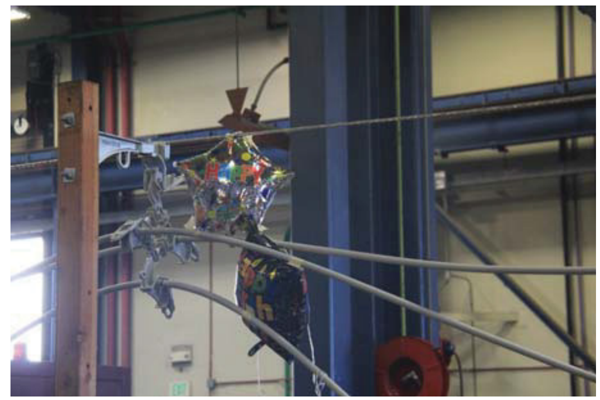
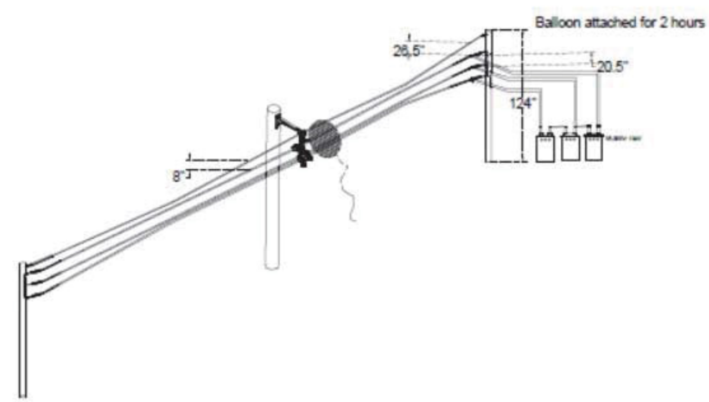
Metallic Balloon Test Results

- Covered Conductor designed for 15kV
- Voltage Applied was 35kV
- Results: Covered conductor withstood contact with no failure

Test Subject	Time Duration	Empirical Average Current with Test Subject
Metallic Balloon	2 Hours	0.418A





Conclusion

- The simulation and test confirmed that the dielectric strength of the spacer cable system will withstand the maximum difference of potential at normal operating voltages of the circuit without breakdown or puncture

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5. Safety Advantages

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Safety

- In the case of a downed conductor, covered conductors will provide a safety advantage over bare wire.
- The covering on the covered conductor will reduce the charging current enough to result in, at most, a slight shock during human contact while contact with bare wire will result in electrocution.
- While evidence of a reduced charging current is available in multiple industry papers, SCE has sponsored a test with NEETRAC on covered conductor touch current to verify this data

Effects of Electrical Current

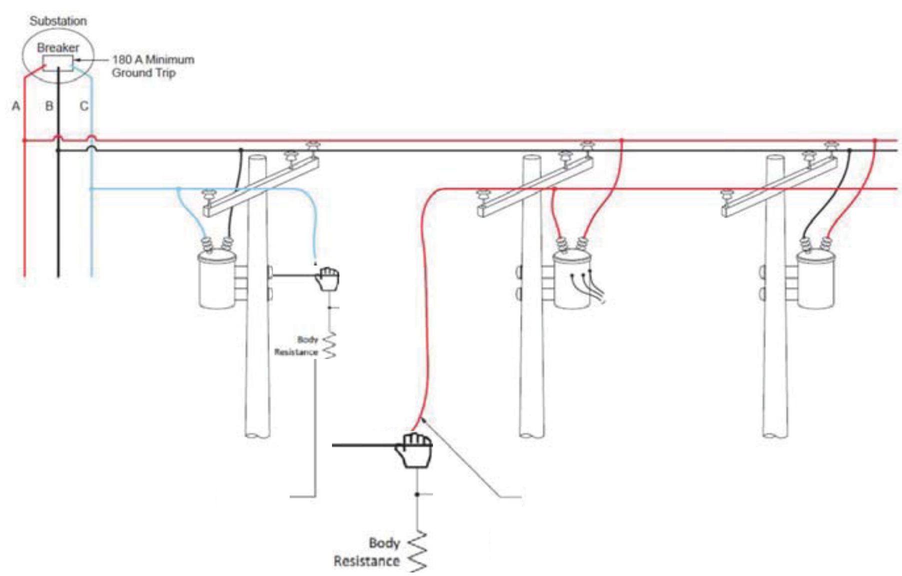
- Effects of Electrical Current on the Human Body

Current	Effect
Below 1 mA	Generally not Perceptible
1 mA	Faint Tingle
5 mA	Slight Shock; Not painful but disturbing. Average individual can let go
6-25 mA (women) **9-30 mA (men)**	Painful shock, loss of muscular control. The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated
50-150 mA	Extreme pain, respiratory arrest (breathing stops), severe muscular contractions. Death is possible

NEETRAC Testing – Energized Downed Conductor

- The following are test cases of energized wire down scenarios that were simulated and empirically tested by NEETRAC
  - Person holding broken **covered conductor** on **line side**
  - Person holding broken **covered conductor** on **load side**
  - Person holding broken **bare conductor** on **line side**
  - Person holding broken **bare conductor** on **load side**

*Note that bare conductor test cases were not performed in the laboratory.



NEETRAC Testing

- Test Information:
  - Conductor: 1/0 Covered Conductor
  - Source: 12.447 kV
  - Test Results: Human contact current measured

	Covered Conductor		Bare Conductor
	Simulation Results (Theoretical Value)	Lab Test Results (Actual Values)	Simulation Results (Theoretical Value)
Line Side	0.220 mA	0.227 mA	5,300 mA
Load Side	0.218 mA	0.227 mA	34.2 mA

- Conclusion:
  - Covered Conductor Touch Current: Generally Not Perceptible
  - Bare Conductor Touch Current: Electrocution
  - Overall, covered conductors can potentially provide public safety benefits during wire down events

6. Understanding Wire Down

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Understanding Wire Down

- Covered conductors will prevent wire downs from occurring by preventing contact related faults.
- Energized wire downs can happen in both bare wire and covered conductor systems
  - The detection of a downed bare wire is not absolute. The main component that determines detection is the surface the downed wire makes contact with. Due to the surface, a high impedance fault may occur regardless of conductor type.
  - During a high impedance fault, the area of exposed conductor is greater in bare wire than in covered conductor. More exposed conductor may increase the chance of ignition.
  - Covered conductor systems will provide a public safety advantage over bare wire systems by reducing the touch current the public is exposed to.
- Alternative wire down detection systems that do not rely on fault current are in development. These systems will be effective for both covered conductor and bare wire systems.
  - SCE: Meter Alarming Downed Energized Conductor
  - SDG&E: Phasor Measurement Unit

7. Break Test

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Covered Conductor Break Testing

- The purpose of this test is to visually observe the conductor and covering at the break point

1/0 ACSR (Conductor Breaking Strength: 4,160 lbs)				
Sample	Break (lbs)	Break Point	Length of Exposed Conductor (in.)	
1	5,230	Midspan	2.12	
2	5,230	Midspan	5.00	0.25
3	Results invalid due to conductor breaking at grip			

#2 Copper (Conductor Breaking Strength: 2,896 lbs)				
Sample	Break (lbs)	Break Point	Length of Exposed Conductor (in.)	
1	3,360	Midspan	0.31	0.15
2	3,380	Midspan	0.38	0.03
3	3,360	Midspan	0.50	0.25

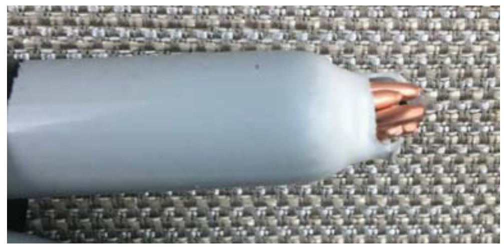
Covered Conductor Break Testing

- ACSR Sample 1

- ACSR Sample 2

Covered Conductor Break Testing

- Copper Sample 1




- Copper Sample 2


- Copper Sample 3


Covered Conductor Break Test

- Conclusion
  - The larger the area of conductor is exposed, the higher the probability of ignition and public safety risk
  - If broken, covered conductors pose reduced probability of ignition and public safety risk on exposed ends compared to bare conductors due to the covering

Chapter II
Expected Service Life

Energy for What's Ahead[SM]

1. Expected Service Life

This section describes the life expectancy of covered conductors, the basis for the projection, and factors that influence service life.

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Service Life

- SCE expects covered conductors to have a service life of **45 years**
- Conclusion of 45 years is based on
  - Manufacturer response
  - Historical Records
  - SCE experience with similar products

Manufacturer Survey

- Manufacturer consensus is that the covered conductor service life is expected to be 40 years minimum

Surveyed Questions	Supplier 1	Supplier 2	Supplier 3
1. What is the expected service life of the covering?	Minimum of 40 years, and probably 60 plus years	40 years	40 years
2. What is the expected service life of the conductor?	Useful service life in excess of 80 years	40 years	40 years
3. What is the expected service life of the covered conductor as a whole?	Excess of 67 years	40 years	40 years

Basis for Expected Service Life

- Advancement of compound technology and the upgrade of manufacturing equipment
- Known service life of XLPE is 40 years minimum
- Conformance to and successful passing of qualification tests ensures life expectancy
- Historical records with systems installed since 1951 are still in operation and performing as designed 67 years ago

Factors that Influence Service Life

- Conductor Temperature
  - Operating at extreme temperature is known to damage the conductor and/or covering
- Extreme contamination
- Severe UV exposure
- Installation methods and condition
- Type and Quality of Accessories

Qualification Testing

- SCE requires the following tests to ensure the longevity of the conductor
  - UV Testing
  - Environmental Stress Cracking
  - Track Resistance
  - Maximum Dielectric Constant
- Passing qualification tests ensures that the covered conductor deployed in SCE facilities meet industry standard and are high quality
- Passing ensures that the covering can perform as intended for a 45 year operating life

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2. UV Resistance

This section describes the requirements of the UV resistance testing.

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Sunlight (UV) Resistance Testing

- SCE requires conformance to ICEA S-121-733-2016 Sunlight Resistance (UV) Testing
- Testing will accurately predict, on an accelerated basis, the effect of sunlight
- UV testing will involve inducing property changes associated with the end use conditions, including the effects of sunlight, moisture, and heat. Testing requires specimens to be exposed to xenon-arc radiation and water-spray exposure.
- The exposure time is 720 hours with a radiation level of 0.35 Watt/meter. This radiation level was chosen based on the most extreme summer weather similar to the state of Florida, which is always equal to or greater in UV intensity than in Southern California.
- The covering is considered sunlight resistant if the original to aged tensile and elongation ratio 80% or greater after the 720 hours of exposure. Additionally, because the covering is grey, the amount of UV absorption will be limited.

Significance

- Testing ensures that the strength of the covering is still at least 80% of the original strength before accelerated UV exposure
- Overall, UV testing requirement ensures the longevity of the covering

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3. Environmental Stress-Cracking

This section describes the requirements of Environmental Stress-Cracking Testing.

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Definitions

- Stress-Crack – An external or internal rupture in a plastic caused by tensile stresses less than its short-time mechanical strength

Environmental Stress-Cracking Testing

- ICEA S-121-733-2016 does not require Environmental Stress-Cracking Resistance for 90°C rated covered conductor because the covering material is inherently resistant to Environmental Stress-Cracking
- Environmental Stress-Cracking is the development of cracks in the material due to low tensile stress and environmental conditions. Under certain conditions of stress with the presence of contaminants like soaps, wetting agents, oils, and detergents, ethylene material may exhibit mechanical failure by cracking.

Significance

- Having a 90ºC Rated covered conductor means that the covering will be inherently resistant to cracking under conditions of stress and in the presence of contaminants

4. Track Resistance

This section describes the requirements of the track resistance testing.

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Definitions

- Electrical Erosion – The progressive wearing away of electrical insulation by the action of electrical discharges
- Track – A partially conducting path of localized deterioration on the surface of an insulating material
- Tracking – The process that produces tracks as a result of the action of electrical discharges on or close to the insulation surface
- Tracking Resistance – A quantitative expression of the voltage and the time required to develop a track under specified conditions

Track Resistance Testing

- SCE requires conformance to ICEA S-121-733-2016 Track Resistant Testing
- Track resistance testing will evaluate the tracking and erosion resistance of the covering and its effects upon the insulation.
- During this test, the covering is exposed to a conducting liquid contaminant at an optimum rate, in a manner that allows continuous electrical discharge to be maintained.
- The effects are similar to those that may occur in service under the influence of dirt combined with moisture condensed from the atmosphere.
- Producing continuous surface discharge with controlled energy will mimic long-term exposure in the field in an accelerated time frame.
- For the sample to pass, the time to track one inch at 2.5 kV must be a minimum of 1000 minutes.

Significance

- Testing ensures that the covering is track resistance
- Track resistance properties will ensure insulation that electrical charges will not erode the insulation over time
- Overall, testing requirement ensures the longevity of the covering

5. Maximum Dielectric Constant

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Definitions

- Dielectric Constant: a quantity measuring the ability of a substance to store electrical energy in an electric field
- Dielectric Strength: the maximum electric field that a pure material can withstand under ideal conditions without breaking down

Maximum Dielectric Constant

- The maximum dielectric constant must be 3.5, per ICEA standards
- The lower the dielectric constant, the higher the dielectric strength.

Significance

- Ensuring that the dielectric constant meets the requirements certifies that the insulation strength of the covering is acceptable and the covered conductor will perform as designed.

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6. Production Testing

This section describes production testing requirements.

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Production Testing

- SCE requires manufacturers to perform routine production testing
  - DC Resistance
    - The DC resistance on the conductor must not exceed 102% of the maximum allowable value
  - Unaged and Aged Tensile and Elongation
    - Tensile elongation is the stretching that a material undergoes. The point of rupture must be greater than 1800 psi for unaged samples. Samples are aged at 121°C for 168 hours. Aged samples must rupture at a minimum of 75% of the unaged value. This test validates the mechanical properties of the covering
  - Hot Creep
    - Hot creep tests validates that the covering is crosslinked, making it a thermoset. Thermosets can withstand higher temperatures and are less likely to deform at high temperatures.
  - Spark Test
    - Spark tests validates the integrity of the insulation. An electrical cloud is generated around the cable. Any pinholes or faults in the insulation will cause a grounding of the electrical field and this flow of current will register a defect in the insulation.
- Passing routine production tests ensures that the covered conductor deployed in SCE facilities meet industry standard and are high quality
- Passing ensures that the covering can perform as intended for a 45 year operating life

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7. Short Circuit Test

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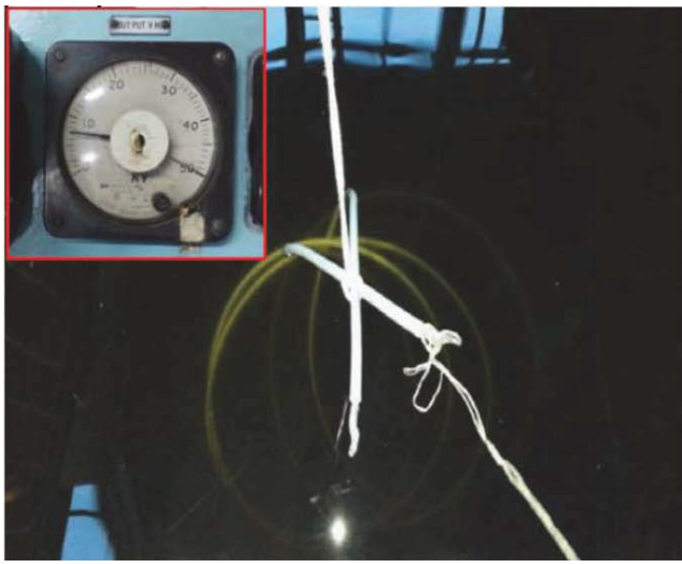
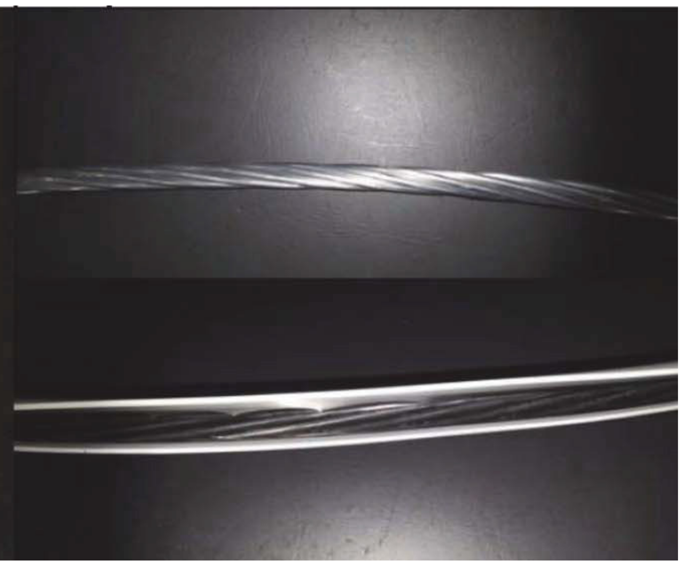
Short Circuit Test

- The purpose of this test is to observe the effects of short circuit current on the covering.

Short Circuit Test



Withstand Test (AC 7.0 kV for 5 mins)
Meets ICEA T-27-581



Internal Dismantling Investigation

Short Circuit Test

Test Sample	Current (A)	Temperature (°F)	Time (Cycles)	Immersion Test Results (AC 7kV for 5 mins)
1	7,200	644	60	Pass
2	7,900	842	60	Pass
3	8,800	1,193	60	Pass
4*	10,000	1,904	60	Pass

*Outer surface slightly softened

Short Circuit Test

- Conclusion
  - The covering withstood extreme temperatures (maximum of 1,904°F) for a time duration similar to what the conductor will experience during a fault event with no damage to the conductor covering.

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8. Flammability

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Flammability of Covered Conductor

- Identified heat sources:
  1. Heating of the conductor (typically from fault current)
     - Performed short circuit current (10kA) test that exposed the covered conductor to 1,904°F for 60 cycles (worst case time duration based on relay tripping)
       - Covered conductor performed well with no damage to the covering
  2. From the fire below
     - Fire: 1,800°F, 3 minutes, 20 feet high flame
     - Testing illustrated the Covered Conductor can withstand 640°F (temperature at conductor) for 3 minutes
       - Heat source was 1,292°F and 5 inches away
     - SCE is conducting further tests to determine the temperature gradient at the conductor level and whether exceeding the temperature at the conductor will exceed 640°F
  3. Other equipment failure-caused fire
     - SCE has not experienced equipment failure-caused fire propagating through historical covered conductor installations
     - SCE has a long history of experience with underground cable and has not experienced equipment failure-caused fire propagating through underground cable
     - Korean Electric Power Company (KEPCO), with over 40 years of covered conductor experience, have not experienced equipment failure-caused fire propagating through the covered conductor.
- Conclusion: Covered conductors will not ignite due to heat sources identified above

9. Covered Conductor Failure Mode

This section articulates the possible failure modes and provides a high-level analysis how the these impact on Covered Conductor at SCE, and finally what SCE has done to address these failure modes

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Known Failure Modes

- Covered conductor could have burn down if not adequately designed or installed
- The following known issues are addressed either by design criteria or installation guideline
  - Electrical tracking on surface of covers
  - Arc generated from lightning strikes
  - Aeolian (Wind-Induced) Vibration
  - Premature Insulation Breakdown

Mitigating Against Electrical Tracking on Surface of Covers

- Electrical tracking occurs when carbon pathways (tracks) formed on the surface of an insulating material which could lead to breakdown
- SCE will only procure CC that have completed extensive qualification testing to industry standards (UV Resistance, Environmental Cracking, and Track Resistance)
- Early material that suffer from tracking issues are crosslinked polyethylene with high carbon content for UV inhibiting purposes
  - SCE specified material using cross-linked high density polyethylene with little carbon black
- Early design of CC specify thin layers of insulation (less than 100 mils)
  - Covered conductor SCE will used has 150 mils of insulation

Arc Generated During Lightning Strikes

- During lightning strikes, an arc could form on the transition from covered to bare conductor, or where there are stripped or open point in the covered conductor
- Direct lightning strike on covered conductor would be more damaging than bare conductor because lightning moves more freely on bare conductors (to look for a path to earth)
- However, SCE is well prepared to mitigate this known issue for several reasons:
    1. SCE service territory is considered low lightning area
    2. Covered conductor is generally less "attractive" to lightning than bare conductor (insulating materials reduces electric field on the surface of covered conductor)
    3. SCE uses the most effective mitigation tool for lightning strikes
- Mitigating Lightning Failure
    1. Industry uses Arc Protection devices (APD's), Power Arc Devices (PAD's) and Lightning Arrestors (LA's) for mitigating lightning strike failures
    2. Lightning Arrestor is the most well-built and effective device of all three
    3. SCE uses Lightning Arrestors and bolster the standards for covered conductor systems to be treated as high lightning area
    4. SCE's high lightning standards require Lightning Arrestors to be installed in all equipment poles (all transformer sizes, capacitor, RAR, switch, voltage regulator, etc.)
    5. SCE standards requires Lightning Arrestors to be installed in covered conductor to underground transitions
    6. SCE will minimize stripping and removal of the covering
    7. SCE standards require stripped or uncovered portions will be covered (i.e. splice)

CONCLUSION: SCE is well positioned for protecting covered conductors from lightning because direct strikes on covered conductor are less likely at SCE, but if happens lightning strikes be mitigated by Lightning Arrestors, i.e. direct to ground instead of stuck on one covered location, or covered to bare transition or flash over to other phases.

Aeolian (Wind Induced) Vibration

- Wind induced vibration of conductors could lead to fatigue failure of the conductor (similar to bending a piece of wire back and forward until it break)
- High conductor tensions lead to Aeolian vibration issues
- Mitigating Aeolian Vibration
  - SCE developed proper sag and tension values for covered conductor
  - SCE's tension limits are in line with Northeast Utilities that have an 80% covered conductor system.
  - The Northeast utilities have not experienced problems due to Aeolian vibration

Premature Insulation Breakdown

- Wear and tear could lead to premature insulation breakdown
  - Insulation breakdown will equate effectiveness of covered conductor to bare
  - Result from improper installation or constant abrasion from vegetation
- Mitigating premature insulation breakdown
  - Outer covering is a high density material, and is resistant to incidental abrasion
  - Discussion with other utilities indicated that older covered conductor design performed as intended even after 50 years
  - Construction standard requires care during installation and handling of the covered conductor

Learning from Past Experience

- SCE have performed literature research, talked to industry experts, visited utilities and suppliers, and employed consultants to inform the design and installation of covered conductor to withstand early known issues
- Based on past performance in various utilities and the robustness of the current covered conductor design, Engineering fully expect the covered conductor to perform for at least 45 years without issues

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Chapter III
Industry Benchmarking and Research

Energy for What's Ahead[SM]

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1. Research

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Global Research

- Global information was gathered from covered conductor research literature as well as government and utility publications.

Global Research – Australia (Historical Installations)

- Covered Conductor has been used in Australia for over 50 years
- Early installations experienced the following problems:
  - Initial coverings of PVS, HDPE, and nylon gave very limited lifetimes and suffered surface degradation.
  - Initial installations were subject to failure due to lightning damage
- In the late 1980s, Australia reconsidered Covered Conductor for safety considerations (human and wildlife), conductor clashing, tree problems, and bushfire mitigation.
  - However, within 2 years of installation, it was found that the covered conductor was incapable of handling anything more than momentary contact
  - Other problems include severe RF emissions and tracking
- In the mid 2000s research for the Australian Strategic Technology Program illustrated that technological advancements and solutions to historical issues regarding covered conductors exist, which may allow for a widespread adoption of covered conductors in Australia

Global Research - Australia

- In 2009, the Victorian Bushfires Royal Commission (VBRC), which was established in 2009 by the government after the devastating Black Saturday bushfires, recommended the following:
  - The progressive replacement of all SWER (single-wire earth return) power lines in Victoria with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk. The replacement program should be completed in the areas of highest bushfire risk within 10 years and should continue in areas of lower bushfire risk as the lines reach the end of their engineering lives
  - The progressive replacement of all 22-kilovolt distribution feeders with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk as the feeders reach the end of their engineering lives. Priority should be given to distribution feeders in the areas of highest bushfire risk.
- Progress of VBRC recommendation implementation:
  - 2010 – Established a Bushfire Powerline Safety Taskforce (BPST) to recommend to the Victorian Government how to maximize the value to Victorians from the VBRC recommendations.
  - 2011 – The Bushfire Powerline Safety Taskforce recommended the following:
    - The BPST recommended to target SWER and 22kV powerlines in the next 10 years
    - The BPST recommended that any new powerlines built in areas targeted for replacement should also be built with underground or covered conductor
    - Estimated a 90% reduction in the likelihood of a bushfire starting by installing covered conductors
    - Recommendations were accepted by the Minster for Energy and Resources on December 29, 2011
    - AUS $750 million Powerline Bushfire Safety program was announced by the Victorian Government
  - 2012 – Areas of highest bushfire risk for purposes of asset installation were identified and a detailed forward works program was developed
  - 2013 – A brief focusing on the first five years of the program, described in more detail the complexities of delivering the substantial set of reforms and provided concise project planning, management, and delivery structure.
  - 2014 – Installation of first replacement powerline in high bushfire risk areas
  - **2016 – Amendments were made to the Electricity Safety (Bushfire Mitigation) Regulations which specify the use of covered conductors or undergrounding for any new or rebuilt circuits in high bushfire risk areas**
    - **The Victorian Government's Powerline Replacement Fund makes available up to $200 million to electrical distribution businesses and private land owners to replace bare wire powerlines**

Global Research – Australia

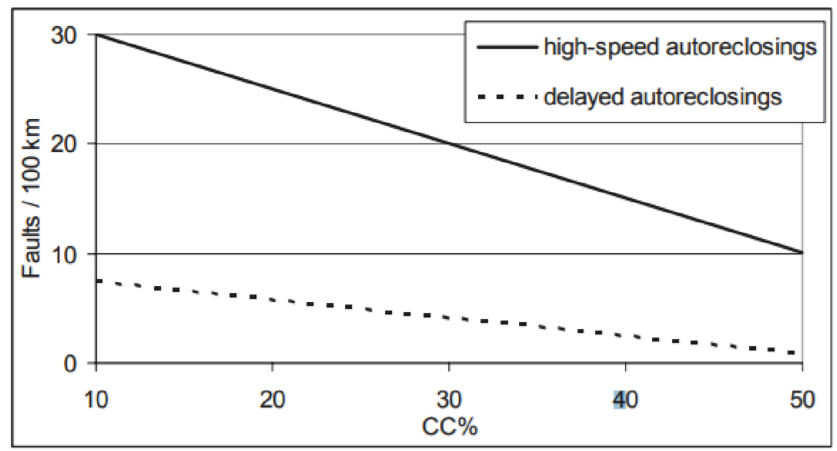
- Utility Implementations of VBRC Recommendations
  - Ausnet
    - Victorian utilities to use either insulated or covered conductor for any planned conductor replacement of more than 4 spans of 1kV-22kV line (within codified areas)
    - For AusNet, the codified areas included approximately 1,000 miles of bare wire, medium voltage powerlines. **They began replacing line in this area in 2014 relying on an established $200M Powerline Replacement Fund (PRF)**
    - AusNet is progressively replacing the remaining bare wire in codified areas outside of PRF activities because of the cost associated with insulated/covered conductors
    - **Construction of any new medium voltage electric line that is part of the supply network must use insulated cable or covered conductor**
  - Powercor
    - Per their 2016 Bushfire Mitigation Plan, Powercor is implementing underground cable/overhead covered conductor when construction either 22kV, single wire earth return (SWER) or low voltage assets for all new construction and the same Electrical Safety (Bushfire Mitigation) Regulations listed for AusNet reconductoring activities
- Utilities outside of Victoria
  - Energy Queensland
    - 2017 Summer Preparedness Plans target installation of covered conductor in bushfire risk areas.
  - Essential Energy
    - Bushfire Risk Management Plan (Issue 13, 2017) was provided to meet the objectives and requirements of the NSW Electricity Supply (Safety and Network) Regulation 2014, which includes a provision for the review of equipment types or construction methods known in their operation or design to have bush fire ignition potential and a mitigation strategy in relation to their use
    - Plan calls for use of underground cable and covered conductor on overhead primary, promoting underground or insulated low voltage lines in rural areas, and identifying at-risk private low voltage lines on customer properties and undergrounding or replacing with CCT

Global Research - Europe

- United Kingdom
  - The UK started installing covered conductors in 1994
  - The typical close spacing and compact construction prompted the first use of covered conductors in the UK
  - As of 2005, UK has installed 9,300 circuit miles of covered conductor
- Sweden
  - Covered Conductor was first introduced in Sweden in 1984.
  - First installation was in a snowy and high wind area to reduce faults due to snow-laden branches resting on the line and wire slapping
  - As of 2005, Sweden installed approximately 2,500 miles of covered conductor
  - 60% of new construction and refurbishment schemes use covered conductor
- Slovenia
  - First CC line was built in December 1993
  - By 2003, CC lines presented about 8% of all medium voltage overhead lines

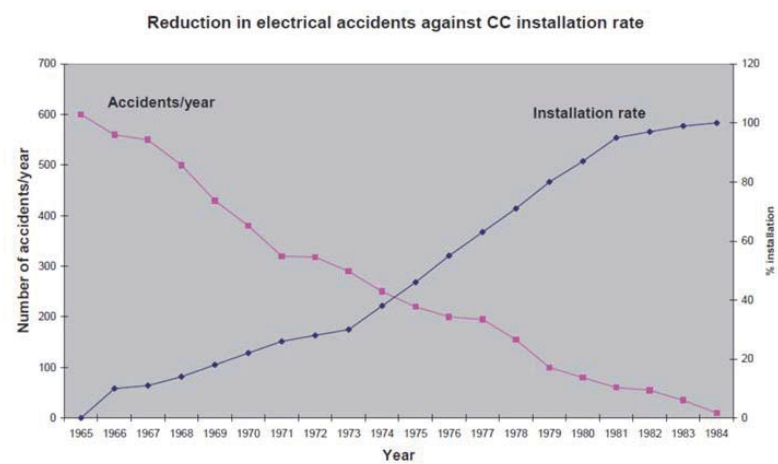
Global Research - Europe

- Finland
  - Finland installed the first installations of covered conductors in Europe.
  - Main impetus for research into covered conductors in the 1970s was the reduction of forest fires caused by trees falling on bare overhead lines.
  - As of 2005, Finland installed approximately 3,100 miles of covered conductor.
  - 60% of new construction and refurbishment schemes use covered conductor.
  - Number of permanent faults in CC lines is about 20% of those in bare conductor medium voltage lines
  - Number of high-speed automatic reclosings reduces to one third when the percentage of covered conductor lines is increased from 10% to 50%



Global Research - Asia

- Japan
  - Started using covered conductors in 1965
  - Driving force behind CC installation is to reduce the number of accidents and fatalities due to bare OH lines and improve reliability



2. Benchmarking

Energy for What's Ahead[SM]

Benchmarking

- SCE benchmarked with a number of utilities abroad and in the United States
- Utilities SCE benchmarked with include:
  - Seattle City Light (Washington)
  - Puget Sound Energy (Washington)
  - Con Edison (New York)
  - Orange and Rockland Utilities (New York)
  - Liberty Utilities (New Hampshire)
  - Groveland Light (Massachusetts)
  - Holyoke (Massachusetts)
  - Middleton (Massachusetts)
  - Ausnet (Victoria, Australia)
  - Korea Electric Power Company - KEPCO (South Korea)

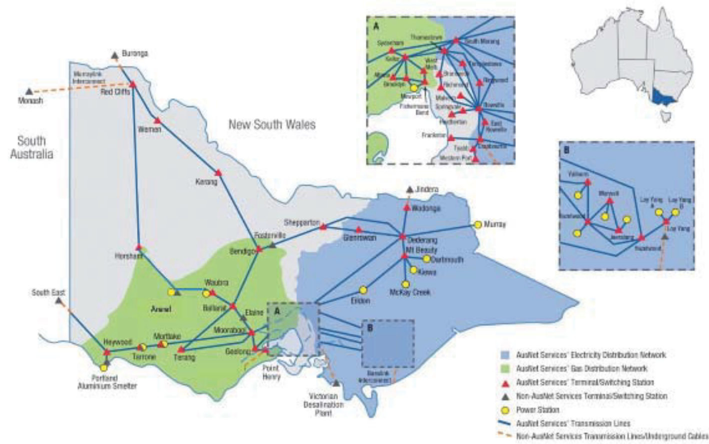
Utility Benchmark Questionnaire

- Sent out survey questionnaire to utilities to learn about covered conductor standards, application and performance:
    - Seattle City Light (Washington)
    - Puget Sound Energy (Washington)
    - Con Edison (New York)
    - Orange and Rockland Utilities (New York)
- Learned about downed wires with covered conductor
    - In Early 1980s, Con Ed experienced plenty of burn downs
        - Failures were at dead ends and equipment leads
        - Failures were at bare to covered transitions
    - Orange and Rockland found that protective relays will trip during a burn down
- Failure modes of covered conductor
    - Nicked conductor during stripping
    - Prolonged incidental contact (months)
- Cable type and Size
    - Seattle City Light and Puget Sound: 125 mils HDPE
    - Con Edison: 175 mils EPR
    - Orange and Rockland: 40-80 mils XLPE
- Voltage
    - Seattle City Light: 7.2 kV
    - Con Edison:
        - 27 kV – Mostly CC
        - 4-14 kV – CC

Round Table Benchmark with Northeast Utilities

- Conducted an in-person discussion on covered conductor experience with the Northeast utilities:
  - Hendrix (manufacturer), Liberty Utilities (New Hampshire), Groveland Light (Massachusetts), Holyoke (Massachusetts), Middleton (Massachusetts).
  - Past standards engineer of Eversource attended as well
- Covered Conductor Systems
  - New England overall is approximately 80% Covered Conductor and 20% Bare
- End of life
  - Covered conductor still looks and performs the same after 50+ years of service
- Issues
  - Manufacturing problems due to ring cuts was experienced in the late 70s before cleanrooms
  - Corona is main failure mode (phase to ground through tree), but it takes years to fail
  - None has experienced Aeolian vibration issues
  - None has encountered water ingress
- Lightning
  - Burn down happens at stripped portion
  - Add lightning arrestors at equipment, transitions to bare, and dead-ends
  - Had enough incidents to decide to install lightning arresters at end of line
  - All advise not to install lightning arresters at every 1000 ft. Avoid stripping as much as possible.

Ausnet



Electricity Transmission
- 6,600km of transmission lines
- 13,000 towers

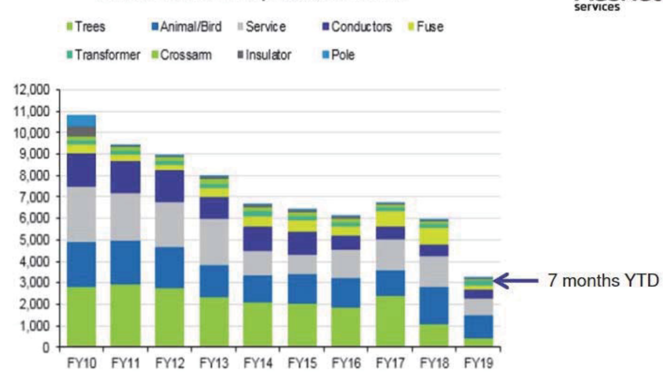
Electricity distribution
- 52,263km of electricity distribution network
- 370,000 poles
- 722,000 customers

Gas distribution
- 11,400km of gas distribution network
- 692,000 customers

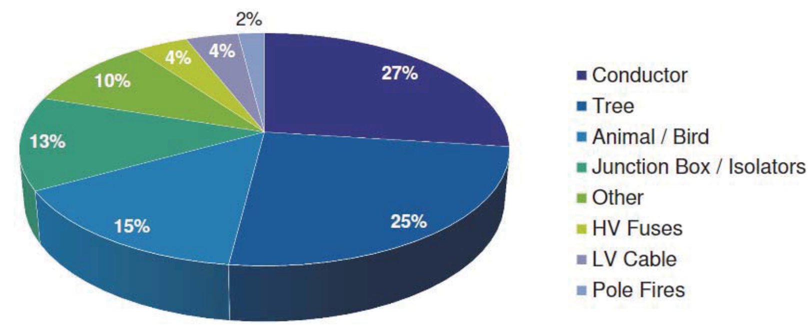
Ausnet – Fire Incidents

Incidents with Potential to Start Fires

Network incidents with potential to start fire



Ground Fire Incidents



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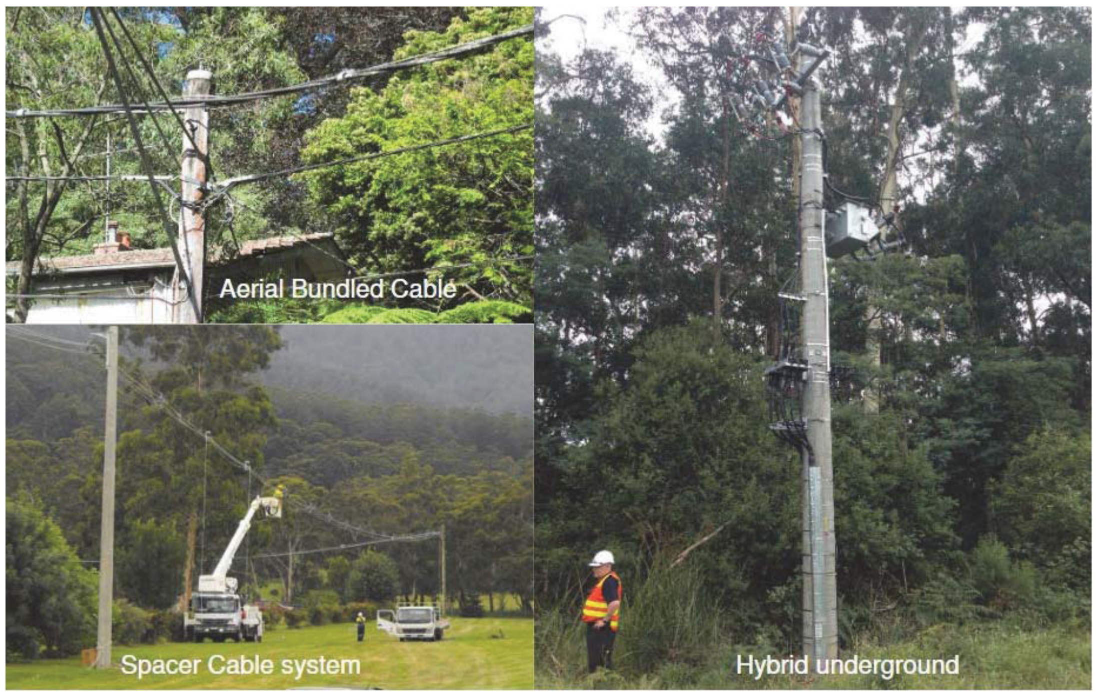
Ausnet – Wildfire Mitigation Programs

- Conductor replacement
- Service cable replacement
- Crossarm replacement – Standard Steel
- Insulator Replacement
- Vegetation Management
- Expulsion Drop Out fuse replacement with Boric Acid
- SWER OCRs replaced with remote controlled ACRs
- Bird/Animal proofing of complex HV structures
- High resolution digital photography inspection

Ausnet – Conductor Replacement



Korea Electric Power Corporation (KEPCO) Visit

- KEPCO Overview
  - Transmission - 21,004 circuit miles, UG = 11.8%
  - Substations - 834
  - Distribution - 297,094 circuit miles, UG = 17.7%
  - SAIDI - 9.61
- Covered Conductor Use and History
  - 100% Covered Conductor System (Bare Neutrals)
  - Covered Conductor used since 1978 (40 years)
  - Reason for Covered Conductor Use is Public Safety and CFO Prevention

KEPCO Distribution Wire History

Before 1960s
- Used Cotton Insulated Wire

→

1962
- Used Bare Wire

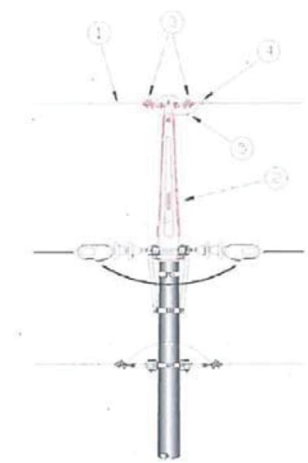
→

1965
- Used ACSR

→

1978
- Used Covered Wire urban areas of large cities to prevent accidents caused by bare wire

KEPCO – Mitigating Known Issues



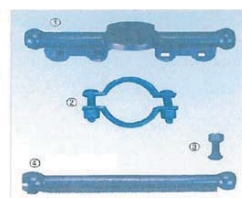
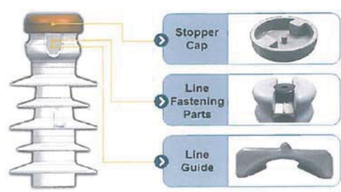
- Lightning Protection
  - Overhead grounding wire
    - Placed on top of pole
    - Block both direct lightning and induced lightning
    - Earth of OH grounding wire is connected to crossarm, which is connected to the neutral line.
    - Grounding rod is earthed every 200m and grounding resistance is kept below 25Ω
  - Arcing horn
    - Installed on the straight line (LP insulator) of the distribution line
      - Install on the line where fault caused by lightning has occurred
      - Install one for every two spans and install lightning arrester for protection of equipment in the section where arching horn is installed

KEPCO – Mitigating Known Issues

- Lightning Protection (Continued)
  - Lightning arresters
    - Lightning arresters to be installed in the following locations
      1. Device and Special Places
         a) The connection point from the substation bus line to the distribution line
         b) Connection point between the aerial line and underground line
         c) Front and rear ends of Recloser, Sectionalizer, Breaker, and Switchgear
         d) Each phase of the front side of the condenser
         e) Primary part of the transformer. However, it can be omitted when the lightning arrester is installed within 656 ft
      2. Distribution Line
         a) Branch, Terminal, Dead end pole
            - However, lightning arrester can be omitted at the following places
              i. Urban areas where high-rise buildings (more than 65 ft in height)
              ii. If lightning arrester is installed within 410 ft
         b) For other places, install every 1640 ft or less, unless a lightning arrester is installed within 656 ft
         c) Connection point between covered and bare wire
         d) The point where wire size changes
         e) The starting and ending points of the overhead ground wire

KEPCO – Mitigating Known Issues

- Aeolian Vibration
  - For prevention KEPCO uses the following insulators

Insulator	Image
Bind Wire	
Bindless LP Cover	 
Bindless LP Insulator	

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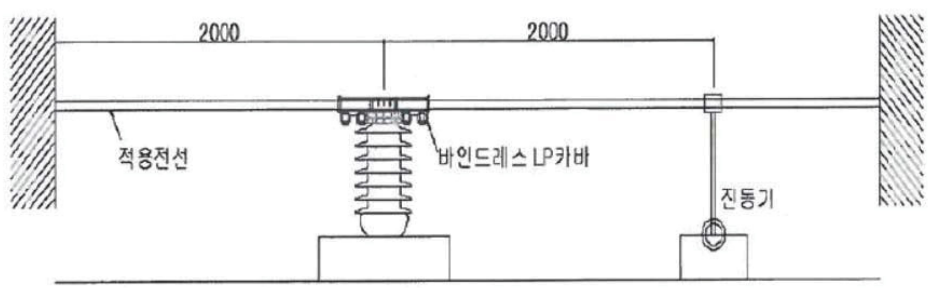
KEPCO – Mitigating Known Issues

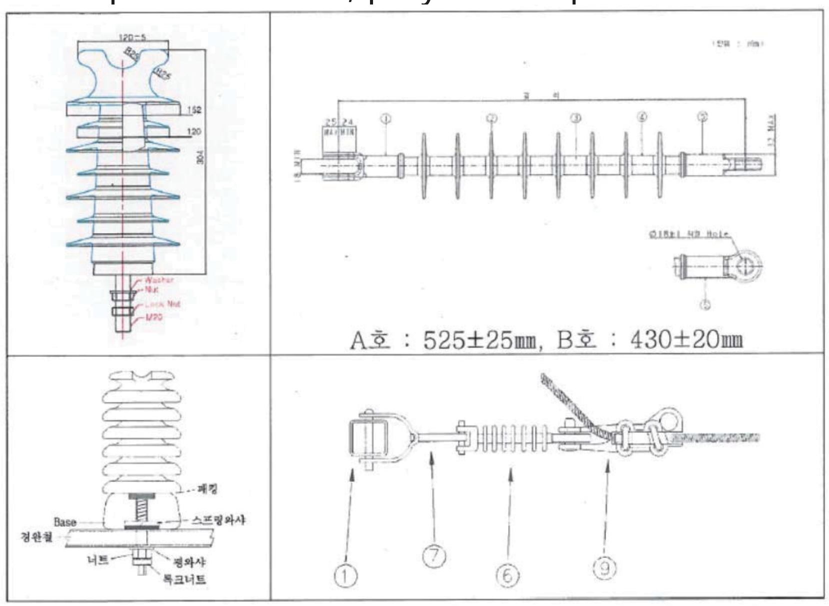
- Aeolian Vibration (Continued)
  - Perform Vibration Testing on Insulators
  - Cable, insulator and LP cover should not be damaged

Vibration Speed (times/minute)	Amplitude (in)	Vibration Direction	Vibration Frequency
1,200	0.24	Vertical	1 million



KEPCO – Mitigating Known Issues

- Insulators
  - Use Polymer Line-post insulator , polymer suspension insulator



KEPCO – Mitigating Known Issues

- Water Blocking
  - Conductors are filled with waterproof semi-conductive compound to prevent water from penetrating easily into the interior of the conductor
- Wire Down Detection
  - When fault current is detected, it is blocked through the protection coordination with the recloser
  - Monitored and controlled through the Distribution Automation System (DAS)
  - Detect 95% of downed wires
  - It is more difficult to detect fault with covered conductor compared to bare

KEPCO – Installation and Construction

- Construction Type
  - KEPCO uses cross-arm configuration
  - Testing spacer but commented that did not go with spacer system due to being 1.5 to 1.7 times more expensive
- Cover Everything
  - Dead-end clamp cover
  - Branch sleeve
  - Compression sleeve
  - Insulated Connector
    - For ground wire

KEPCO – Installation and Construction

- ABC to Covered Conductor Transition

KEPCO – Installation and Construction

- Equipment Connection

KEPCO – Installation and Construction

- Double Dead-end

KEPCO – Operation and Maintenance

- Inspection Standard

구 분	기 준			
Regular inspection	overhead	High-voltage	Downtown	Once every 6 Months
			Residential area	Once every 1 year
			other	Once every 2 years
		Low-voltage		Once every 2 years
	underground	More than once a quarter		
	national important facilities	Once a month		
Safety inspection	More than once a month			

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KEPCO – Operation and Maintenance

- Wire Inspection Criteria
  - Corrosion of wires and connections
  - Damage to the wires in the bind area
  - Confirm state of bind relaxation and dropout
  - Whether wire is cut or damaged
  - Whether or not the support point is defective (clamp)
- Action Type
  - Immediate Action
  - Action within 1 month
  - Action within 2 months

KEPCO – Operation and Maintenance

- Types of Facility Diagnosis
  - High Frequency Diagnosis
    - Measure RF noise caused by deterioration of equipment by using high frequency equipment
  - Ultrasound Diagnosis
    - Detect PD by converting ultrasound of discharge pulse caused by defective equipment into audible sound
  - Thermal Imaging
    - Measure overheat point of equipment with thermal camera
  - Optical Equipment Diagnosis
    - Use high magnification optical camera to observe appearance and condition of the distribution structures and lines
  - Precise Visual Inspection
    - Check condition of distribution facility through visual inspection and measuring the live wire on the pole

3. Industry Surveys

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Background

- SCE requested members of the following groups to participate in a survey about covered conductors
  - Edison Electrical Institute (EEI)
  - Western Underground Committee (WUC)
  - The Association of Edison Illuminating Companies (AEIC)
- A total of 36 utilities participated.

Summary

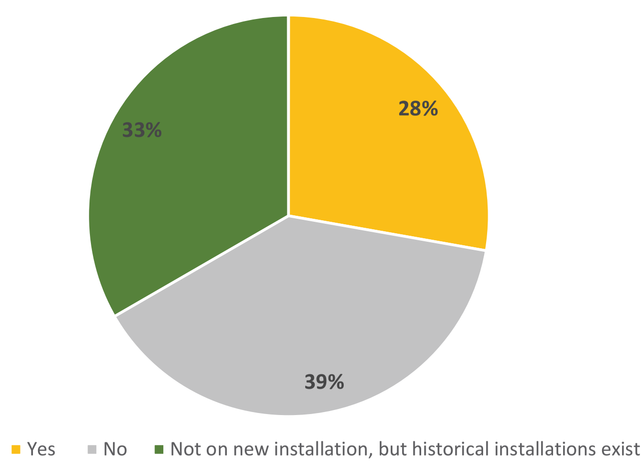
- Bare wire is the standard.
  - On average bare wire makes up 88% of a utility's distribution system
- 28% of participants indicated that they use covered conductors on primary distribution lines.
- 33% of participants indicated that they historically used covered conductors, but no longer use them on new installations
- Most utilities indicated that covered conductor is used to prevent vegetation contact
- Most utilities indicated that the benefit of using covered conductor is less contact related faults

List of Participants

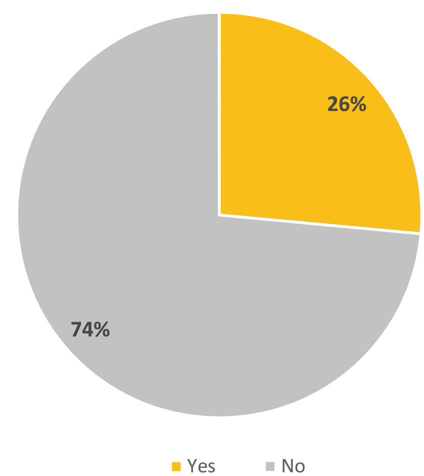
1	AES	20	LADWP
2	Alliant Energy	21	LG&E and KU Energy
3	Ameren	22	Midwest Energy, Inc.
4	American Electric Power	23	National Grid
5	Anonymous Participant	24	Northern Indiana Public Service Co.
6	CenterPoint Energy	25	Northwestern Energy
7	City of Banning	26	Oklahoma Gas & Electric
8	City of Lodi	27	Oncor Electric Delivery
9	City of Mesa Energy Resources	28	Orange & Rockland
10	City of Richland, WA	29	Puget Sound Energy
11	City of Roseville	30	Sacramento Municipality Utility Distrct
12	Con Edison	31	Salt River Project
13	Dominion Energy	32	Snohomish PUD
14	DTE Energy	33	Southern Company
15	Duke	34	Tampa Electric
16	FirstEnergy	35	Tucson Electric Power
17	Florida Power & Light	36	Westar Energy
18	Idaho Power		
19	Kansas City Power and Light		

Covered Conductor Usage

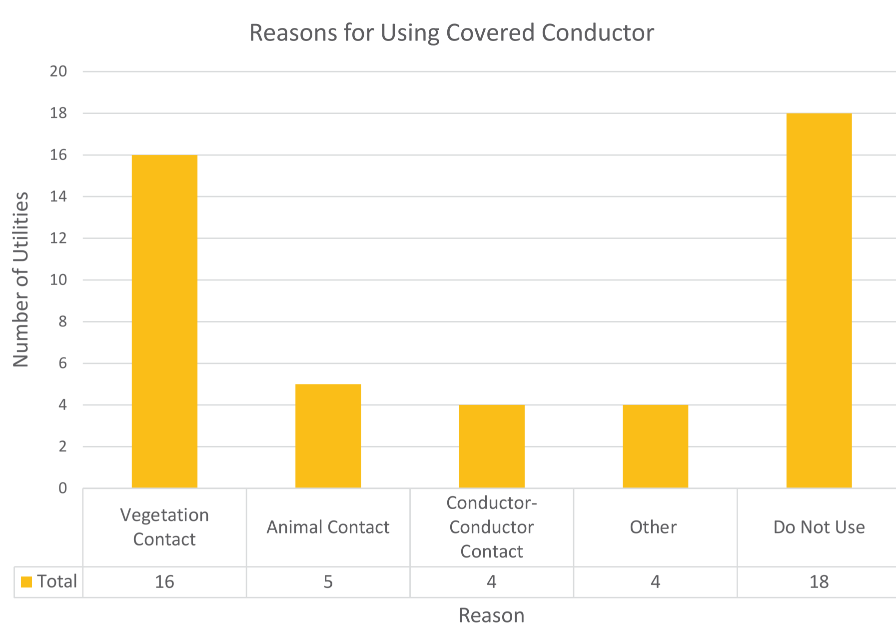
- Do you install covered conductor (Tree wire) for your primary (4 kV or higher) distribution lines?



- Do you install covered conductor (tree wire) for your branch line primary distribution wire? (fused, radial, two phases or less)



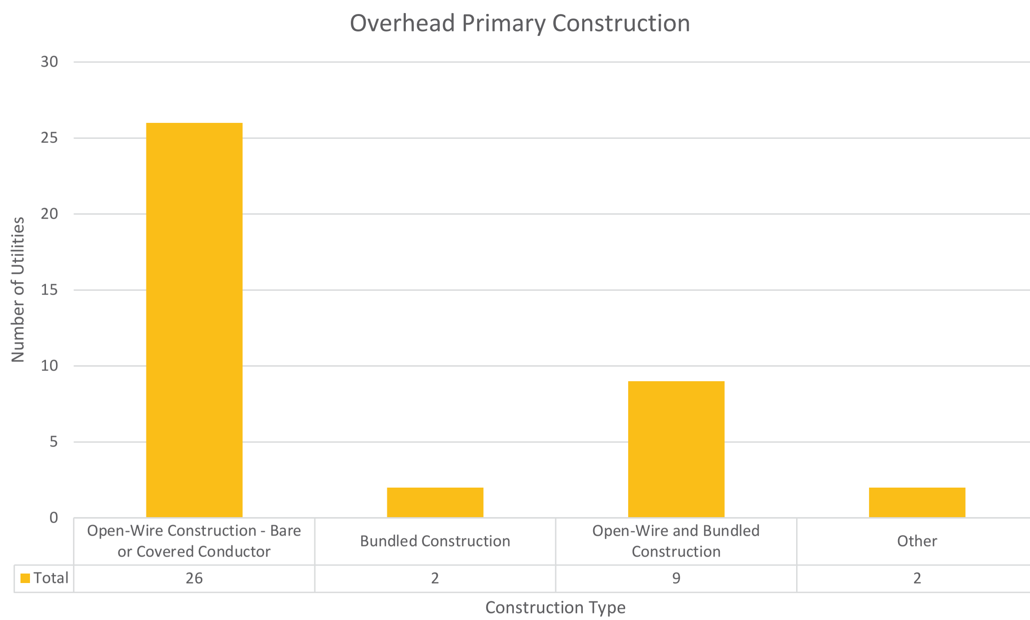
Reasons for Using Covered Conductor



Other

- Clearance and space management
- Higher density of circuit routing on a single pole

Types of Overhead Primary Construction Used



- Other
  - Armless Construction
- Open-wire can mean vertical or horizontal construction

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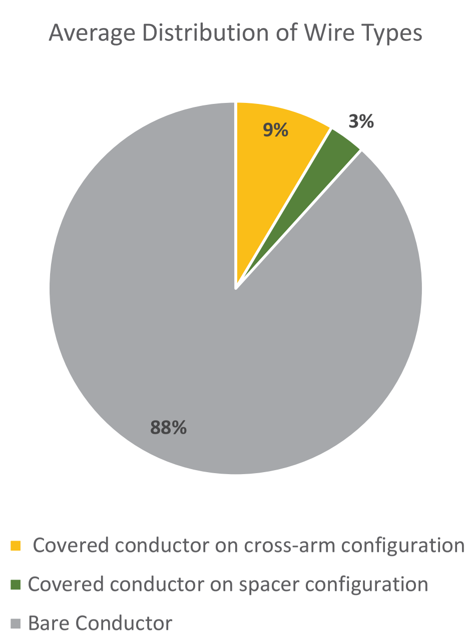
Construction Criteria

- Utilities typically use bundled construction in limited scenarios, which can include the following:
  - Use in areas in lieu of underground due to difficult trenching conditions
  - Express or dedicated feeders with limited or no taps
  - Limited right of way space
  - Heavily treed areas with tight clearances
  - Multiple circuits on a single pole
  - Storm hardening

Distribution of Various Wire Types



- On average, a utility's distribution system is made up of
  - 88% Bare Wire
  - 9% Covered Conductor on cross-arm configuration
  - 3% Covered Conductor on spacer configuration

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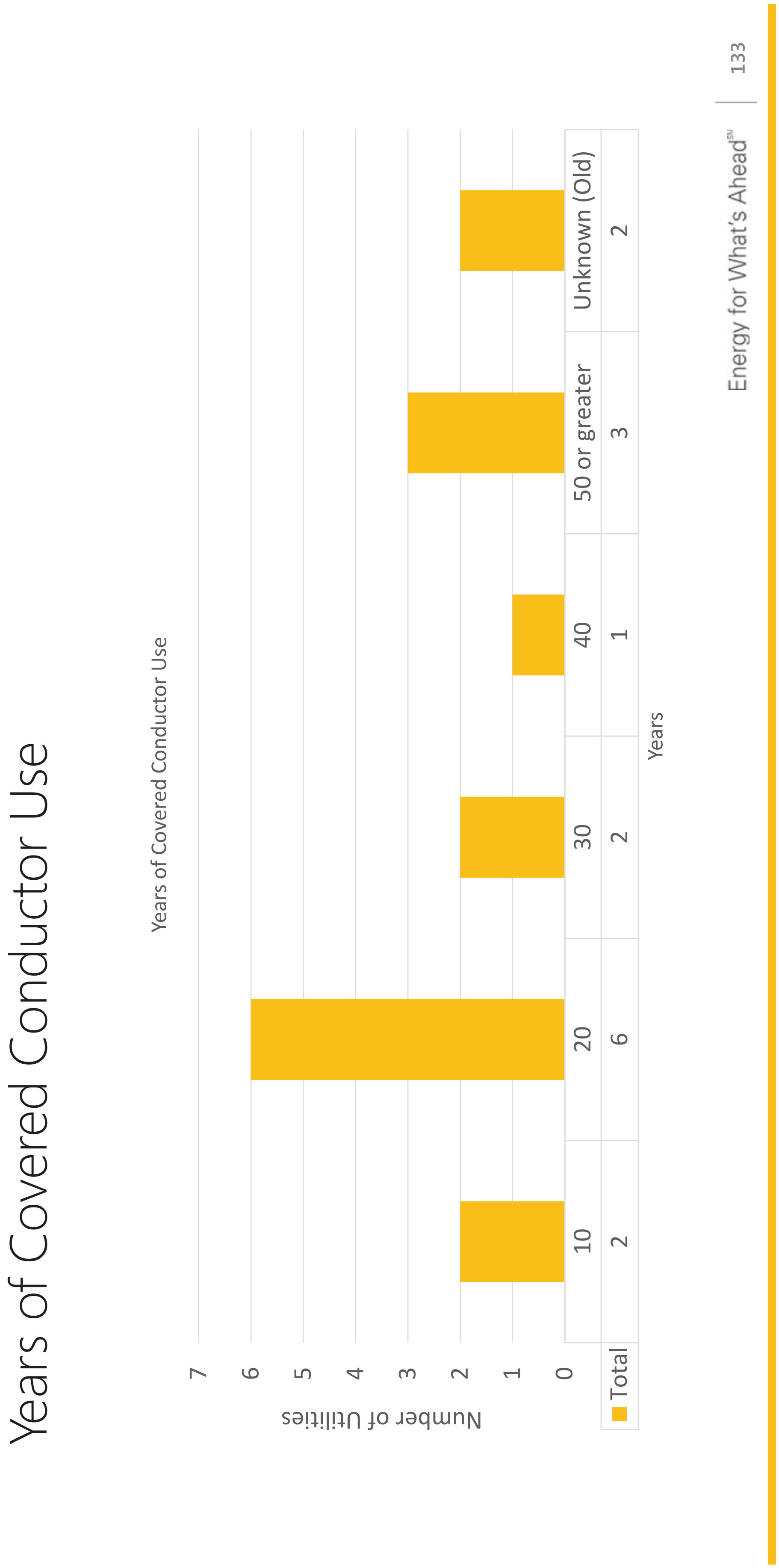
Years of Covered Conductor Use
Years of Covered Conductor Use
Number of Utilities
0
1
2
3
4
5
6
7
10
20
30
40
50 or greater
Unknown (Old)
Total
2
6
2
1
3
2
Years
Energy for What's Ahead℠
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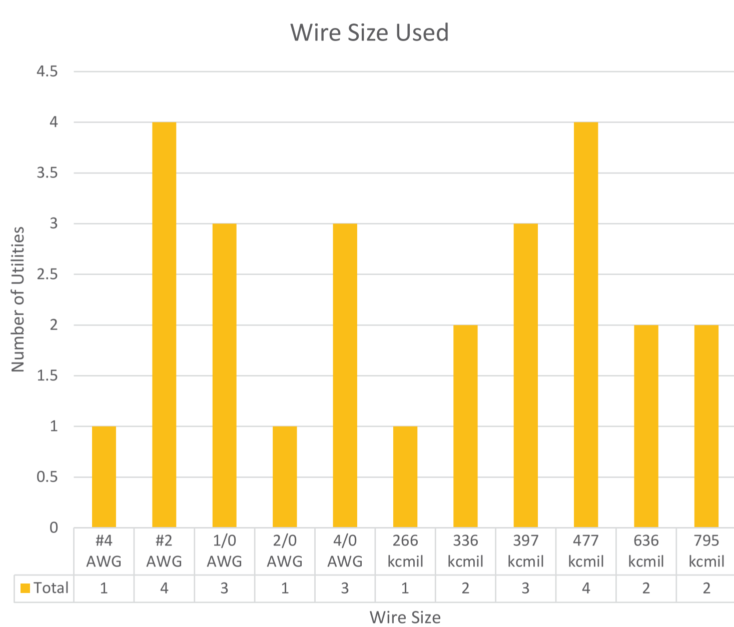
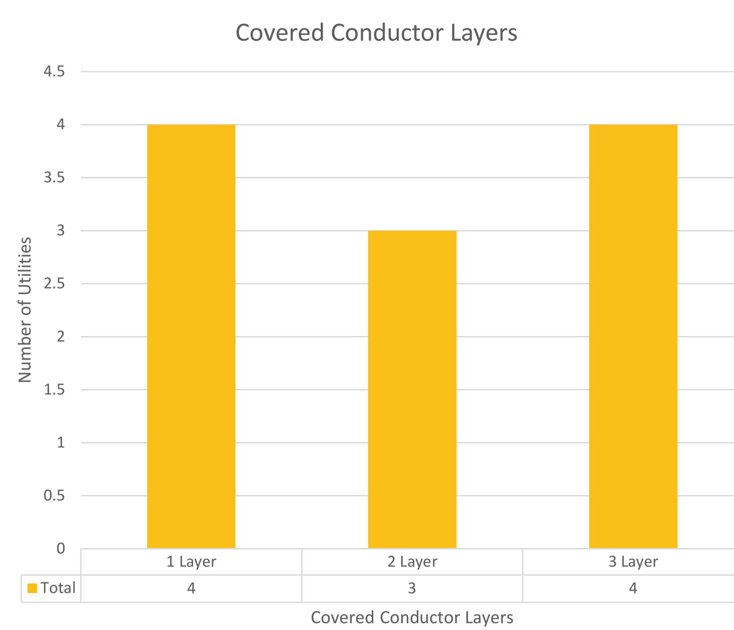
Covered Conductor Wire Sizes and Layers





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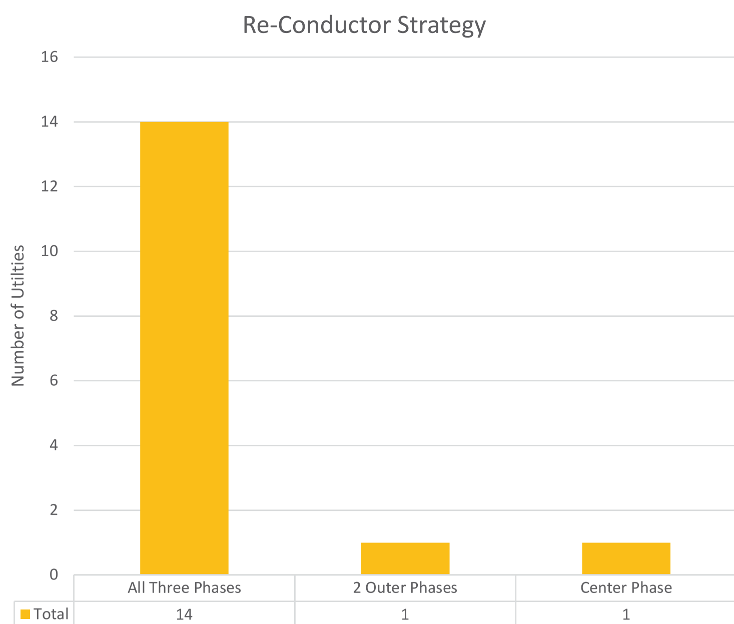
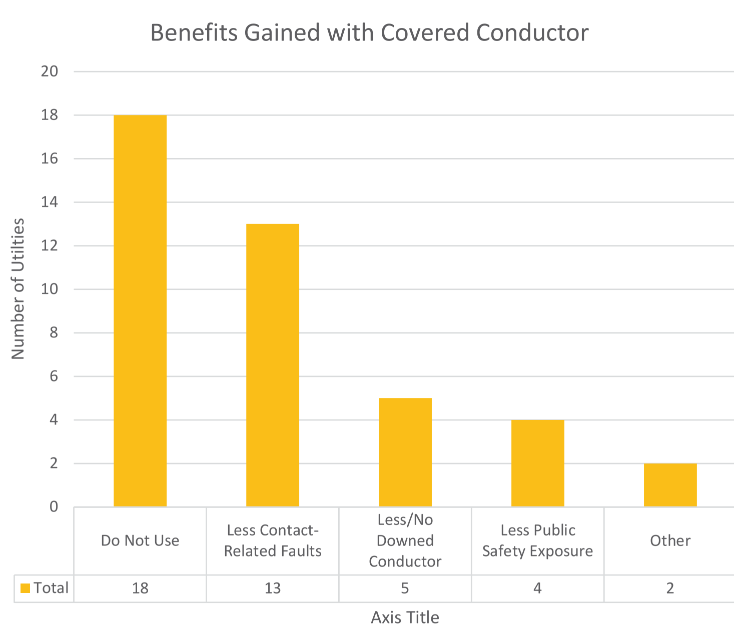
Re-conductoring Main Line



- All utilities indicated that they re-conductor all three phases when moving from bare wire to covered conductor
- One utility indicated that a standard does not exist and therefore performs all three options when re-conductoring to covered conductor:
  - All Three Phases
  - Two Outer Phases Only
  - Center Phase Only

Benefits Gained with Covered Conductor



- Other:
  - Utilities that answered "Other" indicated covered conductor caused more problems such as more downed conductor however, this experience is based on historical covered conductor systems (from 20 years ago or more).

4. Incorporating Lessons Learned

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Known Challenges

The following challenges associated with covered conductor have been identified via research and benchmarking:

1. Aeolian Vibration
2. Abrasion
3. Electrical Withstand
4. Lightning Protection
5. Corrosion
6. Tracking
7. Burn Down
8. Wire Down Detection
9. Radio Frequency

Incorporating Lessons Learned

1. **Aeolian Vibration Limits**
    - Sag and Tensions for the covered conductor will take into account the terrain. There will be two separate tables for light and heavy loading. The loading limits account for wind and ice.
2. **Abrasion**
    - SCE's Covered Conductor design uses a Crosslinked High Density Polyethylene layer to help resist abrasion. Additionally, covered conductor must be handled with care in order to prevent damage to the covering.
3. **Electrical Withstand**
    - SCE uses a triple sheathed covered conductor design, which has been found to be the best choice for long term electrical withstand for trees and with adjacent phases. BIL of SCE's CC is 200 kV.
4. **Lightning Protection**
    - Surge arresters will be installed at all overhead equipment locations and at UG Dips.

Incorporating Lessons Learned

5. **Corrosion**
   - SCE will be using copper covered conductors in coastal applications.
6. **Tracking**
   - SCE's covered conductor design will include a track resistant XLPE outer layer. Additionally, SCE will mitigate tracking by using polymeric insulators, using crimped connectors, and using a low carbon content sheath.
7. **Burn Down of CC**
   - SCE will incorporate the following to prevent burn downs.
     - Suitable lightning protection (installation of surge arresters)
     - Reducing electrical stresses and carbon content on sheath material (polymeric insulator, low carbon XLPE, etc.)
     - Correct installation and tensioning (Sag and Tension will take into account terrain such as wind loading and ice)
     - Tree Trimming (SCE will maintain tree trimming requirements)
8. **Detection of Downed CC**
   - SCE will use SEF method of protection for covered conductors, which is the same protection scheme for bare wire.
9. **Radio Frequency Concerns**
   - SCE will use low carbon black content sheaths and polymeric insulators to significantly reduced tracking, thus reducing RF problem in coastal area.

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Chapter IV
Covered Conductor Construction

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1. Covered Conductor Installation Guideline

This section discusses the covered conductor installation criteria

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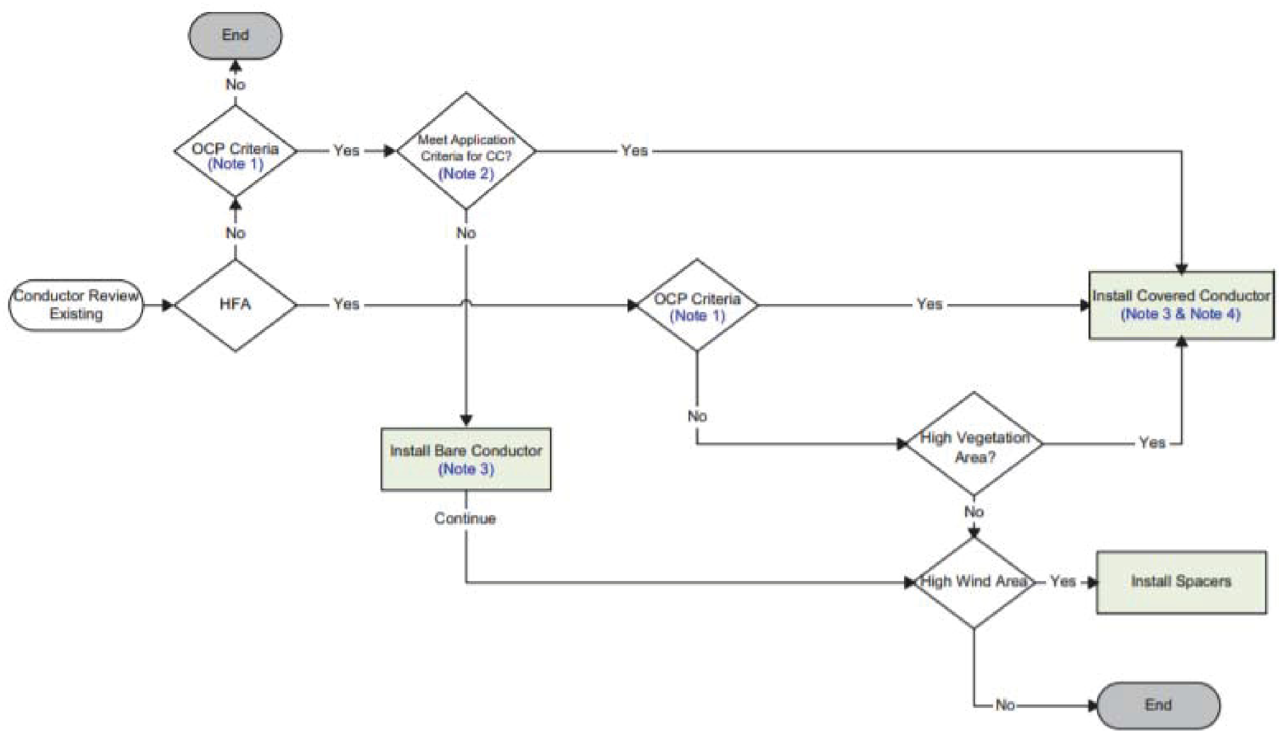
Covered Conductor Usage Criteria

1. System Operating Bulletin 322 Areas (HFRA)
2. Heavy vegetation with potential tree and palm frond contact
3. Known metallic balloon contact causing circuit outages
4. Any area with outages due to known intermittent contact
5. Coastal areas within one mile of the ocean
6. Reduced Tension Unguyed Spans
7. Any specific area that experiences accelerated corrosion

Installation Guideline– Reconductor/ Rebuild Existing Construction



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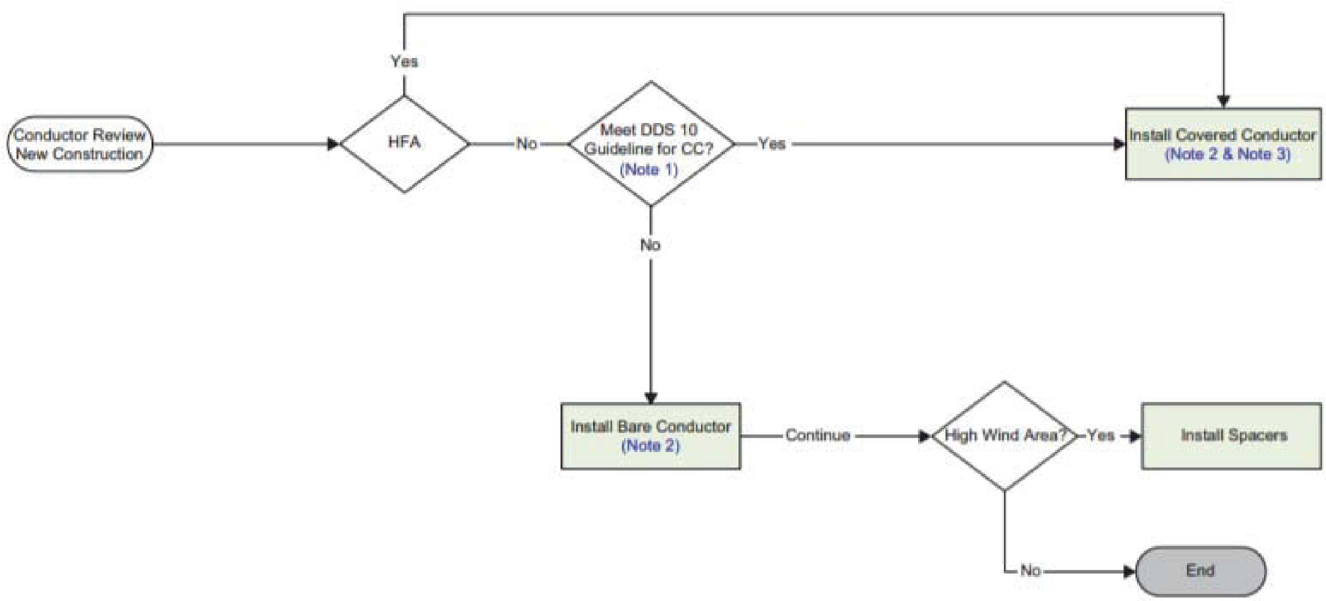
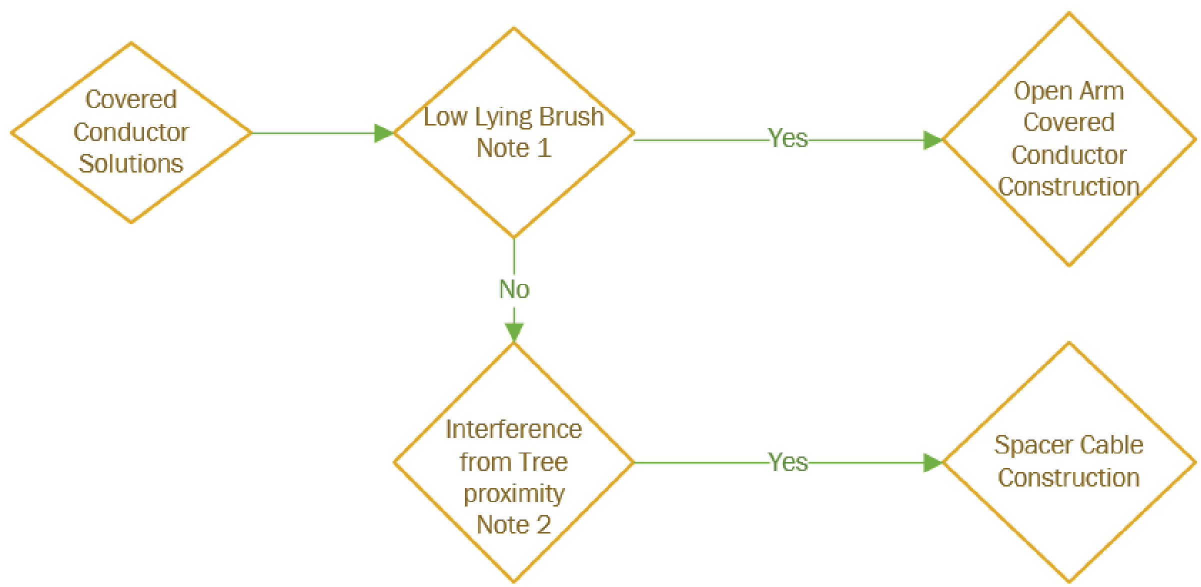
Installation Guideline – New Construction



Covered Conductor Construction



- The geography of SCE's service area means less need for Spacer Cable construction in High Fire Risk Areas

Note1: Vegetation that has low potential to interfere with conductors, i.e. chaparral, brush below poles.
Note 2: Potential for intermittent tree line contact from branches or tree trunks. Vegetation management still required.

2. Covered Conductor on Three Phases and Neutral

This section discusses the key factors considered to select covering all phases in SCE Standards

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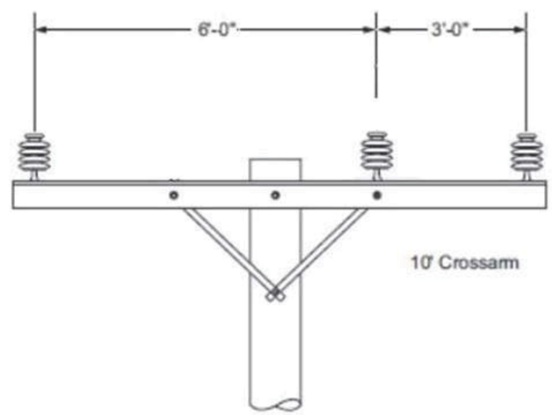
SCE Standards: Covered Conductor on Three Phases and Neutral

- Covered conductor will be used on all three phases in three-wire overhead system (mostly mainline)
- Covered conductor will be used on all two phases in overhead branch lines
- Covered conductor will be used on the neutral wire in four-wire overhead system (20% of SCE system has a neutral wire)

Analysis Factors

- Phase Spacing is key for the covered conductor
- This analysis will assume a three phase system. Refer to the figure below for phase spacing distances on a composite crossarm.



Evaluation of 1 Phase Covered

- In this configuration, it is assumed that only Phase B will be covered. Phase A and C will be bare wire.
- Analysis of effectiveness for mitigating phase to ground contact
  - This configuration will not be effective in preventing phase to ground contact. Phase A or Phase C will be susceptible to incidental contact with trees, therefore not eliminating the risk of a phase to ground fault.
- Analysis of effectiveness for mitigating phase to phase contact
  - This configuration will not be effective for phase to phase contact. There is 9 inches between the bare Phase A and Phase C. A foreign object or wildlife that is long enough could cause phase to phase contact. Palm fronds can be up to 13 feet long and California Condors have wingspans that are up to 10 ft long, which is enough to cause a phase to phase fault.
- Analysis of fire mitigation effectiveness
  - Covered conductor is considered effective for fire mitigation due to its ability to prevent incidental contact. However, its ability to prevent incidental contact will be compromised if the only one phase is covered.
  - Additionally, downed conductor is still possible due to mechanical failures or other equipment failure. The probability of a bare wire igniting a fire is higher than if it was covered.

2 Phase Covered

- In this configuration, it is assumed that Phase A and Phase C will be covered. Phase B will be bare wire.
- Analysis of effectiveness for mitigating phase to ground contact
  - This configuration will not be effective in preventing phase to ground contact. While the probability of a phase to ground contact is lower because Phase A and Phase C will be covered, Phase B will still be susceptible to incidental contact with trees, which will lead to a phase to ground fault.
  - Additionally, some equipment, such as transformers may be within 6 feet from the phases. Phase to ground faults may be possible due to incidental contact between the equipment and the center phase.
- Analysis of effectiveness for mitigating phase to phase contact
  - Because Phase A and Phase C are covered, the probability of phase to phase contact is reduced.
  - Internal SCE studies have shown that current through an object, such as a tree limb, connecting two phases of covered conductor is about 0.2 mA. This value doubles to 0.4 mA if the object is connecting a bare wire and covered conductor.
  - Insulation degradation on the covered conductor will happen at a faster rate, leading to failure happening at a faster rate.
- Analysis of fire mitigation effectiveness
  - The fire mitigation effectiveness is still less than if the system was fully covered. Phase to ground incidental contact is still possible even with two phases covered, leading to arcing that could cause ignition.
  - Furthermore, downed conductor is still possible due to mechanical failure or other equipment failure. The probability of a bare wire igniting a fire is higher than if it was covered.

Evaluation of 3 Phases Covered

- In this configuration, it is assumed that Phase A, Phase B, and Phase C will be covered.
- Analysis of effectiveness for mitigating phase to ground contact
  - Because the system is fully covered, there is a very low probability of incidental contact causing phase to ground faults.
- Analysis of effectiveness for mitigating phase to phase contact
  - Because the system is fully covered, there is a very low likelihood of incidental contact causing phase to phase faults.
- Analysis of fire mitigation effectiveness
  - Covered conductor is considered effective for fire mitigation due to its ability to prevent incidental contact. By fully covering all three phases, the possibility of faults due to incidental contact is greatly reduced.
  - If a downed wire scenario were to happen, covered conductors are less likely to cause a spark that bare wire. Therefore, the chance of ignition has been greatly reduced.

Neutral Covered

- In this configuration, it is assumed that Phase A, Phase B, Phase C and the Neutral will be covered.
- Analysis of effectiveness for mitigating phase to neutral contact
  - Because the system is fully covered, there is a very minute likelihood of incidental contact causing phase to phase faults.
- Analysis of fire mitigation effectiveness
  - In a downed wire scenario, a covered neutral will be less likely to cause a spark than a bare neutral.
  - Chance of ignition is reduced

Other Factors to consider

- Sagging
  - Covered conductor and bare wire are sagged at different tensions
  - If covered conductors were to be sagged like bare wire, it may cause vibration problems
  - Covered conductors have more sag than bare
  - Mixing bare and covered conductor in one crossarm will cause uneven sags
  - Uneven sags may increase the risk of conductor slapping, leading to an increased chance of insulation degradation, arcing, and ignition.
- Benchmark
  - Other utilities use a 3 phase covered system

Conclusion

- Partially covering the system (1 phase covered, 2 phase covered, bare neutral) will dilute the effectiveness of covered conductor.
- Using covered conductor for all three phases and the neutral promotes SCE's grid resiliency and the elimination of an ignition source.

3. SCE Covered Conductor Open Cross-arm Construction

This section illustrates how Covered Conductor and Wildlife Covers being used in SCE Standards to achieve maximum protection from incidental contacts

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SCE Construction Diagrams

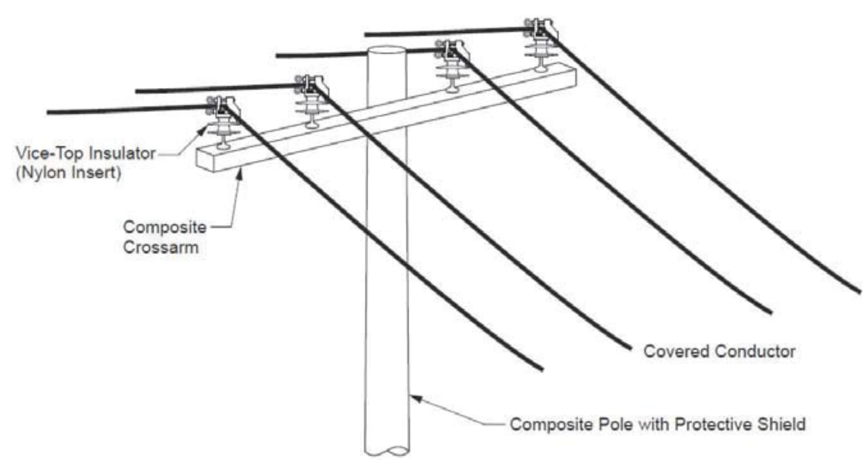
- SCE's covered conductor systems will be all covered
- This includes wildlife covers on dead-ends, terminations, and equipment bushings, jumper wires
- Also illustrated are other Wildfire resilient equipment/hardware, such as composite pole, composite cross-arm, polymer insulator for covered conductor
- These illustrations depict the four common pole configurations:
  - Tangent pole: means covered conductor pass thru insulators
  - Dead-end pole: covered conductor will stripped off to connect to dead-end insulator
  - Transformer pole: stripping cover required for connecting to transformer (or equipment)
  - Riser pole: stripping cover required to connecting to underground cable

Tangent 4 Wire Construction and Splicing

Tangent pole does not need other covering hardware

- **Tangent Construction**
- All Wires, including Neutral will be covered
- Use Polymer Insulator
  - Using material with different dielectric properties will cause a voltage gradient and induce voltage stress, causing the insulation to degrade over time

3 Phase, 4 Wire Tangent (Straight-Line) Construction



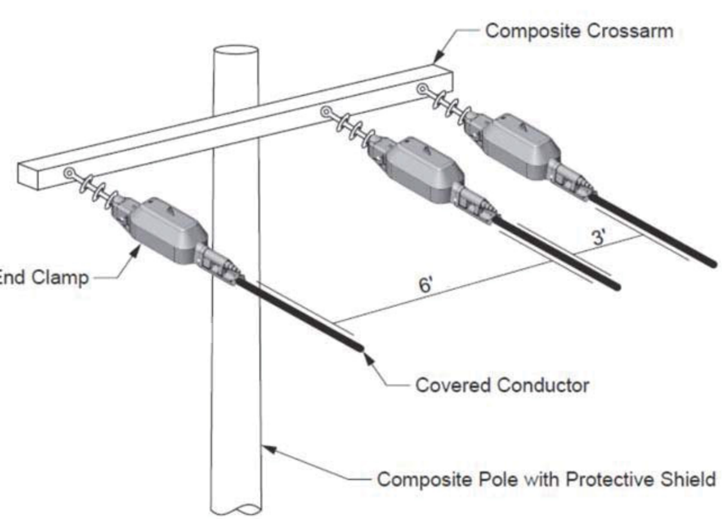
Same concept for three-wire and two-wire constructions

Three-wire Dead-end Construction

Introduce new standards for dead-end cover, composite pole and cross-arm

- Covered Conductors need to be stripped at the dead-end
- Use Dead-end Covers to protect exposed areas

Single Dead-End (3 Phase, 3 Wire) Construction

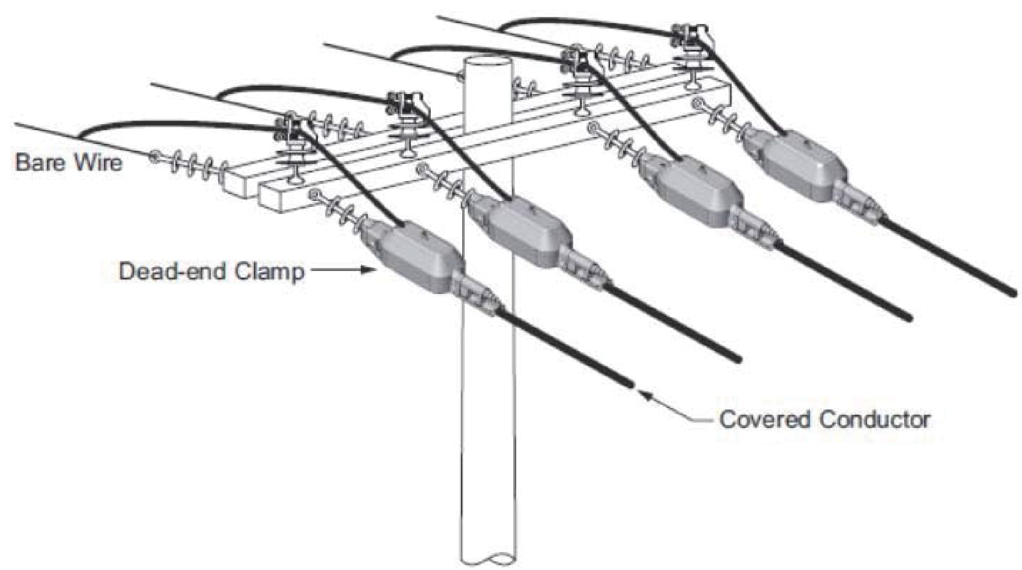


Same concept for four-wire and two-wire constructions

Bare Wire to Covered Conductor Transition

- Use dead-end pole when transitioning from bare wire to covered conductor
- Splices are not allowed when transitioning from bare to covered

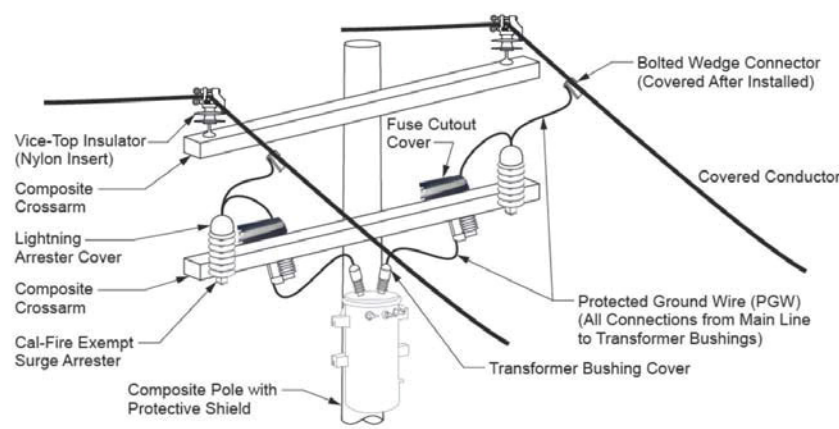
Figure CC 180–1: Covered Conductor to Bare Wire Transition



Tangent 2 Wire with Transformer Construction

- **Use Surge Arresters at all Overhead Equipment**
  - Treat Covered Conductor systems like high lightning area
  - Covering prevents the arc from moving
- **Use Bolted Wedge Connector**
  - Cover after installation
- **Use Protected Ground Wire**
  - Connections to equipment will be covered
- **Wildlife protection on equipment**
  - Cover Lightning Arrester, Transformer Bushing, and Fuse

Overhead Transformer with 2 Phase, 2 Wire Tangent (Straight Line) Construction and Associated Protection (Fuses, Lighting Arresters, Wildlife Guards)

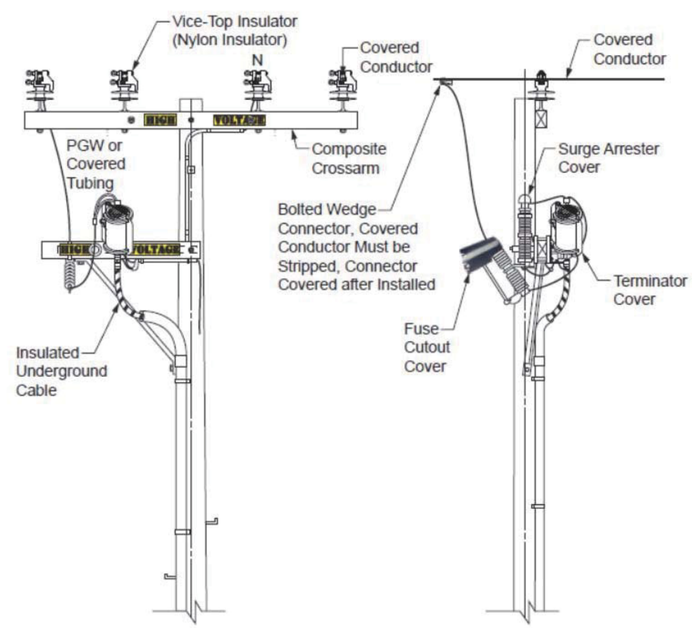


Same concept for connecting to other equipment: capacitor, switch, remote automatic recloser, etc.

Riser Pole Construction

- **Use Surge Arresters at all UG Dips**
  - Treat Covered Conductor systems like high lightning area
- **Cover Terminations**

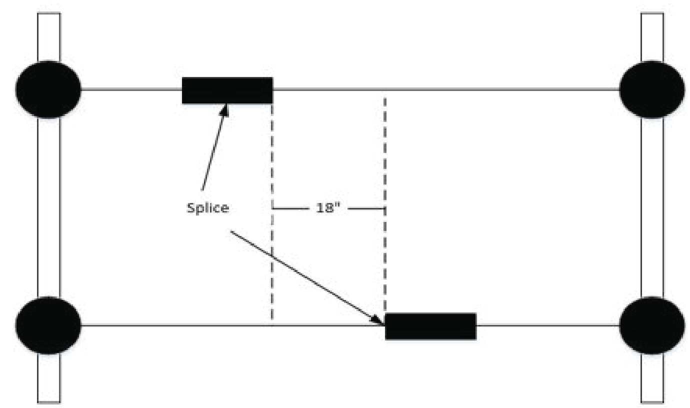
Typical Construction for Underground Dip (Riser) Pole with Associated Protection (Fuses, Lightning Arrester and Wildlife Protection)



Same concept for three-wire and two-wire constructions

Splices

- Splices will be covered
- Splices for adjacent conductors shall not be installed next to each other and should be staggered 18 inches end to end.



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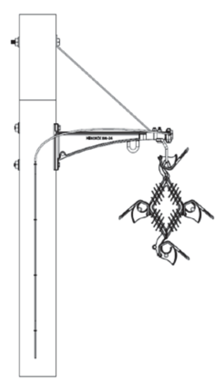
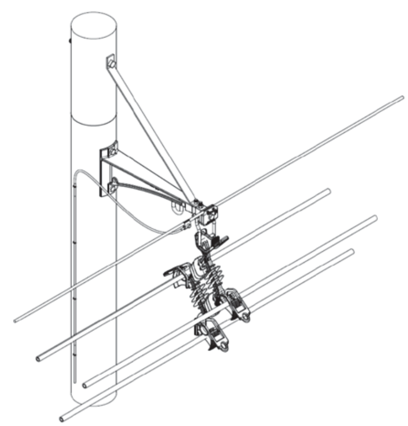
4. SCE Spacer Cable Construction

Energy for What's Ahead℠

Spacer Cable – Technical Specifications

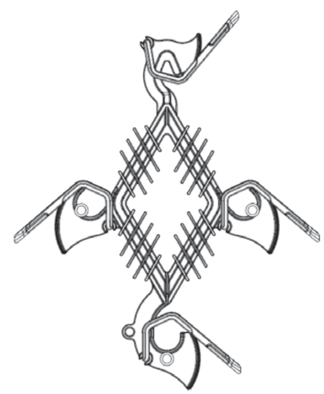
- Spacer Cable system:
  - A high-strength (alumoweld) messenger suspends the weight of the covered conductors through a diamond shaped spacer bracket.
  - Insulated spacers installed at a 30-foot interval with a spacing of 12 to 18 inches (spacer bracket dependent) between conductors.
  - Covered Conductors are the same SCE specification in both open cross arm as well as spacer cable.





Spacer Choice

- Southern California Edison will use a 12 and 18 inch spacer bracket.
  - In areas where contamination is deemed to be moderate to low the 12″ bracket will be utilized.
  - In areas where heavy contamination is elevated an 18″ bracket shall be used.



Spacer Cable – Areas of Install

- Areas of Installation
  - High Vegetation areas.
  - Areas with tree and branch overgrowth.
  - Areas where intermittent contact with vegetation is possible.
  - Conductor Spans of Great Length.

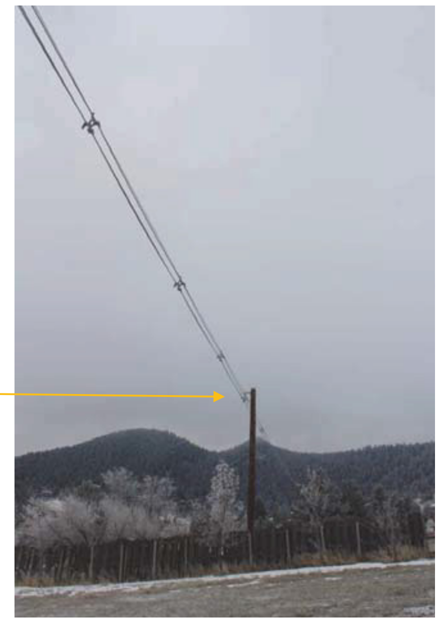
In all areas of installation vegetation management is still a requirement.

Clearance is acceptable but overgrowth can be effected in storm conditions.

Construction of Spacer

Tangent Poles:

- 24" Tangent Bracket
- 12" Bracket (Dependent of Contamination)
- Messenger is sized per span length and conductor size.
- Messenger to be grounded at approximately 600 foot intervals or less.



5. Chawa Covered Conductor Installation

Energy for What's Ahead℠

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Site

Site on March 7, 2019

Site During Dry Seasons

Site Pictures

Covered Conductor on Tangent Pole

Site Pictures

Covered Conductor with Pole Switch

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Site Pictures

Covered Conductor with Transformer

Workpaper Title:

An Engineering Analysis on Impacts of Contact from Objects (CFO) on Bare vs Covered Conductors

Engineering Analysis on the Impacts of Contact from Objects on Bare vs. Covered Conductors

Prepared by: Southern California Edison Apparatus and Standards Engineering

Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

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Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

1.0 Executive Summary

SCE performed an engineering analysis and supporting testing on covered conductor to evaluate its effectiveness for mitigating incidental contact with a variety of objects as reflected by review of the fault potential. Objects include vegetation (tree branch/limb, palm frond), wildlife, metallic balloons, and conductors contacting one another. These studies support testimony representations related to the proposition that low energy is produced from covered conductor contact with objects as reflected within the test studies discussed within this report. Furthermore, computerized engineering simulations and empirical tests demonstrated that covered conductor reduced the occurrence of faults caused by contact with objects, a potential source of fire ignition.

Three methods were used to evaluate the fault potential impact of covered conductors when in contact with objects:

1. **Currents were estimated by inputting calculations of circuit parameters into Power Systems Computer Aided Design (PSCAD).** An electrical circuit was built in the software package PSCAD for bare and covered conductors. The capacitance[1] between the branch and the covered conductor was approximated as parallel plate capacitors[2] with similar dimensions to the branch. The resistance[3] of the branch and the insulation were calculated based on dimensions and resistivity of the respective materials.
2. **Currents were estimated using the Current Distribution Electromagnetic Fields Grounding and Soil Structure Analysis (CDEGS) software simulation tool.** The CDEGS simulation tool models the geometry and material properties of the circuit. Contacts from objects on bare conductors were modeled as references for fault current and energy comparison with the same contact scenarios on covered conductors. A general case was first modeled in CDEGS assuming average tree branch dimensions and a 16 kV phase-to-phase voltage circuit. Specific cases were then modeled in CDEGS as a basis for empirical testing.
3. **System Voltage Testing was performed on a 12 kV phase-phase circuit at SCE's Equipment Demonstration and Evaluation Facility (EDEF) connected to SCE's 12 kV distribution system**. This test was performed using only covered conductor, not bare conductor as information exists for bare conductor due to its industry use.

SCE first performed the PSCAD simulation and then subsequently performed the CDEGS simulation and conducted the tests at SCE's EDEF. All three methods generally showed similar results. SCE presented the PSCAD simulation figures (summarized in Table 1) in testimony because PSCAD is the most conservative of the three methods (i.e., it is the least likely to overestimate the fault mitigation benefits of covered conductor), producing the highest estimates of current and energy levels. All three methods demonstrated that charging currents on the outer cover, when in contact with various objects, are below 1 mA. This magnitude of current is well below values corresponding to perceptible tingling upon contact (National Institute for Occupational Safety

[1] Capacitance is the ability of a system to store an electric charge.
[2] A capacitor is a device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator.
[3] Resistance is a measure of the difficulty to pass an electric current through an object

and Health, 2009)[4]. Currents below 1 mA equate to low energy values, reducing the chance of fault and potential ignition risk. By comparison, a cell phone charges at 3 to 4 watts while an outlet charger left disconnected from a phone consumes 1 to 2 watts (Heikkinen & Nurminen, 2012). Comparatively, covered conductor empirical testing yielded energy values ranging from 0.00000007 watts (Metallic Balloon) to 0.0048 watts (Brown Branch), significantly lower than the energy of a charger disconnected from a phone. Table 1 and Table 2 illustrate the low energy and current results from the simulation and testing. Overall, the computer analysis, empirical testing, and observations reaffirmed that the energy values when compared to bare conductors were significantly lower as shown in the results below.

Table 1 shows a comparison of current and energy values of a branch on bare conductor versus covered conductor that were simulated in PSCAD and CDEGS. Both simulation methods illustrate that the currents are significantly below 1 mA, resulting in low energy values that is unlikely to result in arcing.

Table 1: Summary of Covered Conductor vs. Bare Conductor General Case Simulation Results

Simulation Method	Conductor Type	Current in Branch	Resistance of Branch	Power into Branch
PSCAD	Bare Conductor	2800 mA	5800 Ω	45,472 W
	Covered Conductor	**0.18 mA**	5800 Ω	0.00019 W
CDEGS	Bare Conductor	2730 mA	5800 Ω	43,227 W
	Covered Conductor	0.04 mA	5800 Ω	0.00001 W

2 summarizes the current and energy results from the computer simulations (CDEGS) and empirical testing (EDEF). Both methods illustrate that the currents are significantly below 1 mA, resulting in low energy values that is unlikely to result in arcing. summarizes the current and energy results from the computer simulations (CDEGS) and empirical testing (EDEF). Both methods illustrate that the currents are significantly below 1 mA, resulting in low energy values that is unlikely to result in arcing.

Table 2: Summary of Simulated and Tested Results for Specific Gases

Simulated/Test Subject	Current		Energy	
	Simulation Current with Test Subject (mA)	Empirical Current with Test Subject (mA)	Power -Simulation (Watts)	Power –Empirical Testing (Watts)
Palm Frond	0.005	0.001	0.00525	0.00021
Brown Branch[1]	0.00	-0.001	0.17	0.0048
Green Branch	0.003	0.001	0.000012	0.0000014
728 Ohm Resistor Ph-Ph	0.004	0.044	0.000000012	0.0000015
Metallic Balloon	0.009	0.128	0.00000000030	0.000000066

[1] The negative value of the current in the Brown Branch is the result of being at the bottom range for the measuring devices used for testing and signifies the small magnitude of current.

[4] See Section 11.8 for the effects of current on the human body as published by National Institute for Occupational Safety and Health

2.0 Scope and Purpose

The purpose of the study was to calculate and compare the expected short circuit current, energy, and arcing when various objects such as tree branches come into contact with bare and covered conductors.

2.1 Hypothesis

When a tree branch makes contact with two energized bare distribution electric conductors, the voltage between the two phases can be great enough to push electric current through the branch. A phase-to-phase fault occurs when a carbon ionization path is established through the branch, which allows electrons to move freely and create an electric short. Falling embers from this phase-to-phase arcing could have the potential to serve as a fire ignition source (Russell).

The hypothesis is that covered conductors, due to the layers of insulation, will reduce the energy transferred to the tree branch which in turn reduces the potential for arcing. This study was performed to quantify the effectiveness of this insulation.

The voltage on the conductor induces a charge on the outer layer. This charge, however, results in an insignificant amount of current present on that layer of the covered conductor. Therefore, contact with any given point on the undamaged outer cover is inadequate to produce arcing. In addition, the outer layer of the covered conductors is designed with track-resistant properties. This means that the covering materials prevent small charging current along the conductor from collecting and forming a conductive ionized path.

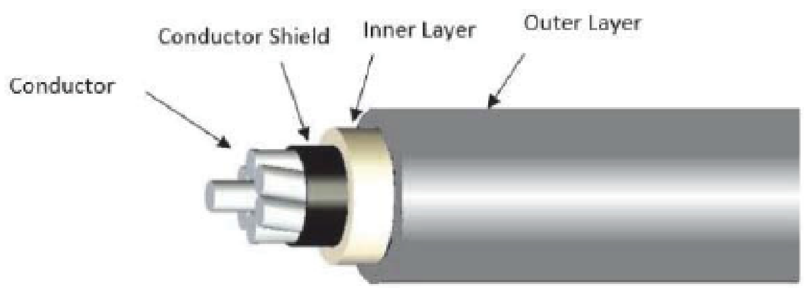
3.0 Covered Conductor Design

This study used covered conductors comprised of four components (Southwire, 2018) (Hendrix Aerial Cable Systems) (Hendrix Aerial Cable Systems, 2018):

1. Aluminum Conductor Steel Reinforced (ACSR) or Hard Drawn Copper (HDCU)
2. Conductor Shield (15 MILS)
3. Inner Insulation layer (75 MILS)
4. Outer Insulation layer (75 MILS)

Figure 1 shows a telescopic illustration of the covered conductor, allowing the four components of the covered conductor to be displayed.

Figure 1: Covered Conductor Design



3.1 Conductor Shield

The conductor shield is made of a semiconducting thermoset polymer. Its purpose is to reduce stress concentrations caused by flux lines from the individual conductor strands. By encircling the strands, it effectively transforms the strands into a single uniform conducting "cylinder" as the images below illustrates. The reduction of electrical stress, especially if the covered conductor is in contact with another object, will help preserve the integrity of the insulation and increase the service life of the covered conductor.

Figure 2 illustrates the electrical field on a conductor without a conductor shield. The overlap in the fields, as the arrows in the figure shows, results in electrical stress.

Figure 2: Flux Lines without Conductor Shield (Southwire)

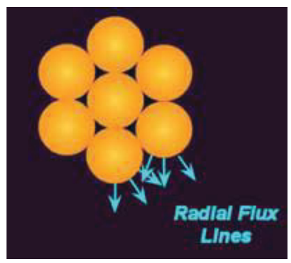
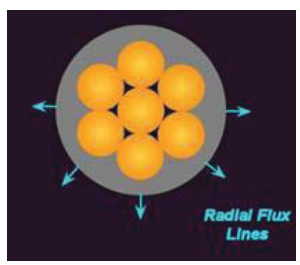


Figure 3 illustrates the electrical field on a conductor with a conductor shield. The conductor shield prevents the electrical fields from overlapping, allowing for uniformity around the entire conductor and a reduction in electrical stress.

Figure 3: Flux Lines with Conductor Shield (Southwire)



As illustrated on Figure 3, the conductor shield helps to reduce electrical stress, especially when in contact with the ground. For example, it is possible for a tree branch to make long-term make phase-ground contact with the covered conductor. The conductor shield minimizes the voltage stress on the contact area, provided that the tree branch weight does not exceed the line and pole strength. An industry test result has shown that covered conductor with a conductor shield prolongs the time to failure by up to four times in an accelerated test protocol (wet wood contact and 2.5 times normal voltage). For the non-accelerated test protocol (wet wood contact and normal voltage), the covered conductor did not fail after 142 days, and the test ended (Ladinger).

3.2 Inner Layer

The inner layer is a crosslinked Low Density Polyethylene (XL-LDPE), which is an insulating material. The insulation contributes to the high impulse strength of the cover, protecting from phase-to-phase and phase-to-ground contact.

3.3 Outer Layer

The outer layer is a crosslinked High Density Polyethylene (XL-HDPE). It has the same insulating function as the inner layer. However, due to being high density, it is also a "tougher" layer, making it abrasion and impact resistant. The outer layer is also track resistant, which limits the charging current flowing on its surface. This track resistant property will help maintain the integrity of the insulation surface over time by significantly reducing electrical tracking that could lead to erosion of the insulation. Additionally, the XL-HDPE is specified for UV stability, making it less susceptible to UV degradation.

4.0 Calculation Methodology

Two methods were used to calculate the expected short circuit current when a foreign object contacts a bare or covered conductor. One method uses the software package Power Systems Computer Aided Design (PSCAD) while the other method uses the software package Current Distribution Electromagnetic Fields Grounding and Soil Structure Analysis (CDEGS). In both cases, electrical properties were calculated for the foreign object based on typical material properties. PSCAD uses a circuit analysis approach, while CDEGS computes electric and magnetic fields. Section 5.0 presents the PSCAD simulations. Section 6.0 presents the CDEGS simulations. Refer to section 4.3 for parameters used in both simulation methods. Section 8.0 present specific cases that were also modeled in CDEGS as a basis for empirical testing performed.

4.1: PSCAD Modeling

An electrical circuit was built in PSCAD for bare and covered conductors. The capacitance between the branch and the covered conductor was approximated as parallel plate capacitors with similar dimensions to the branch. The resistance of the branch and the insulation were calculated based on dimensions and resistivity of the respective materials. Conservative values were input as circuit parameters and based on the assumptions made, the PSCAD simulation should provide the highest estimates of current and energy.

4.2: CDEGS Modeling

The HIFREQ module of the software package CDEGS is able to directly calculate electric and magnetic fields, currents, and voltages from the geometry and material properties of the system. This removes the requirement to approximate the circuit parameters as simple resistors and capacitors. Therefore, this method is more aligned with field conditions.

4.3 Parameters Used for Models

4.3.1 PSCAD Parameters

Table 3 illustrates the parameters used in the PSCAD modeling. PSCAD involves modeling an electrical circuit. The parameters above were used for the capacitance and resistance values.

Table 3: PSCAD Modeling Parameters

Parameter	Value
Insulation Capacitance	60 pF
Insulation Resistance	5.95×10^{11} Ω
Tree Limb Length[5]	0.91 m
Tree Limb Resistance	5,800 Ω

Refer to Section 11.7 for the parameter calculations.

4.3.2 CDEGS Parameters

Table 4 illustrates the parameters used in the CDEGS modeling. CDEGS uses the geometry and material properties of the circuit. Therefore, capacitance values and resistance values are automatically calculated in the simulation.

Table 4: CDEGS Modeling Parameters

Parameter	Value
Tree Limb Length[6]	2.74 m
Tree Limb Resistance	5,800 Ω

Refer to Section 11.7 for the parameter calculations.

[5] The length of a tree branch should surpass the phase spacing to truly simulate a practical scenario. However, PSCAD simulations restrict the branch from surpassing the phase spacing. Therefore, a tree branch length and phase spacing of 0.91 m (3 ft) was used in the simulation to meet SCE phase spacing requirements. The length of the branch will not affect the simulation results because current and energy are a function of the branch's resistance and not its length.

[6] The CDEGS model used a tree branch length of 2.74 m (9 ft) to reflect a real world scenario where the limb length may exceed the phase spacing. A length of 9 ft was used to closely model a palm frond.

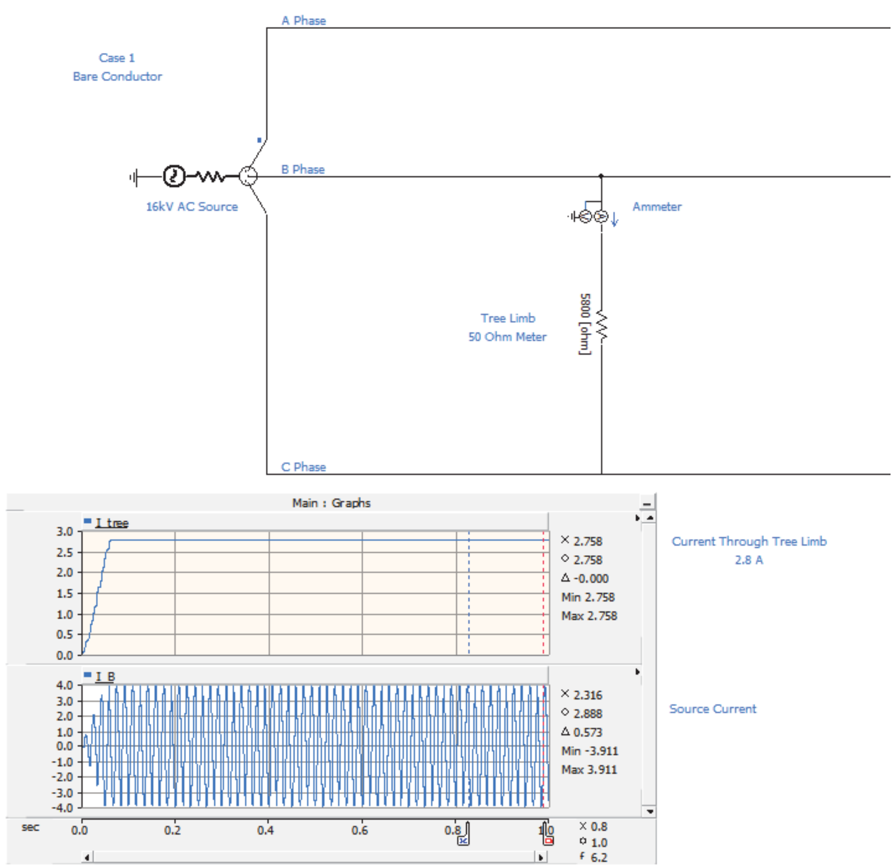
5.0 PSCAD Generic Case Models

5.1: Bare Conductors

Based on the values shown in Section 4.3.1, the following model in PSCAD was formed for the case in which a tree branch makes contact with bare conductors. The results show that an initial current of 2.8 A is produced when a tree branch falls on bare conductors. This current will quickly increase as the resistance of the branch decreases due to the formation of a carbon ionization pathway, eventually leading to a phase-to-phase fault.

Figure 4 illustrates the circuit created in PSCAD simulating a 3 foot branch across two phases of bare conductor. A resistance of 5,800 Ω was used to model the tree branch.

Figure 4: PSCAD Bare Conductor Model

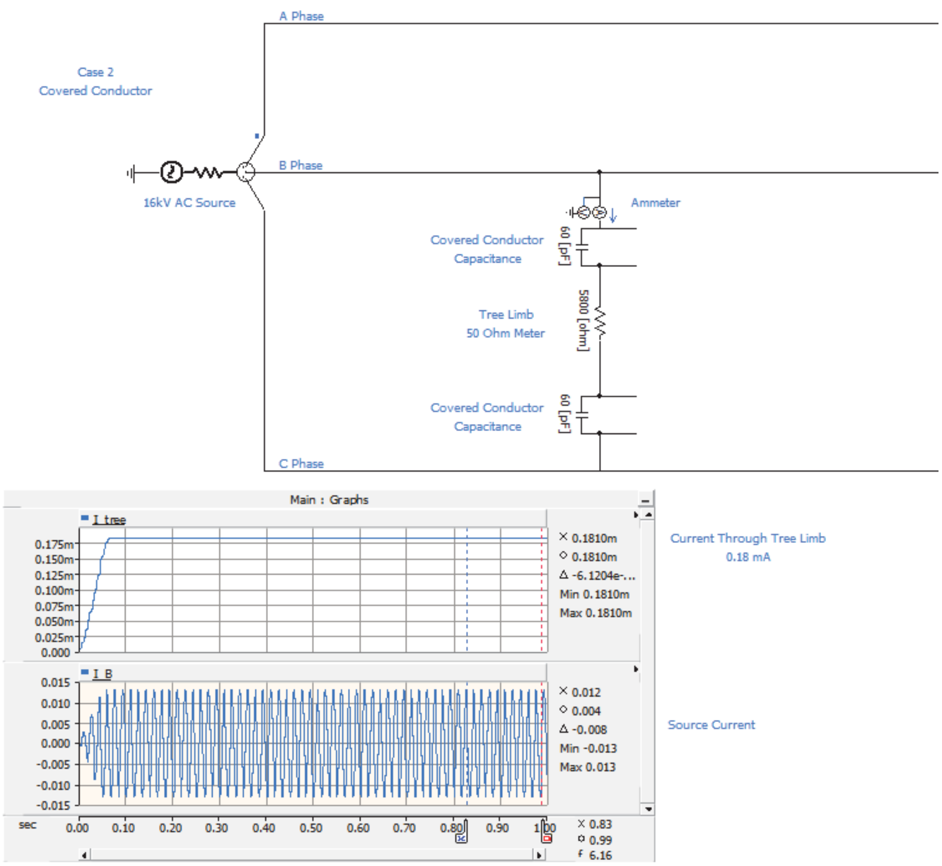


5.2: Covered Conductors

The following model in PSCAD was used for the case where a tree branch falls on covered conductors, based on the parameters in Section 4.3.1. The results show a current of 0.18 mA when the tree branch falls on covered conductors. This current magnitude is not sufficient to produce the energy required for arcing.

Figure 5 illustrates the circuit created in PSCAD simulating a 3 foot branch across two phases of covered conductor. A resistance of 5,800 Ω was used to model the tree branch. Capacitors were used to model the current transferred from the conductor to the branch with the covering in between.

Figure 5: PSCAD Covered Conductor Model



6.0 CDEGS Generic Case Models

Currents and voltages were calculated using the CDEGS software simulation tool. The CDEGS simulation tool models the geometry and material properties of the circuit. Contacts from objects on bare conductors were modeled as references for fault current and energy comparison with the same contact scenarios on covered conductors. A general case was first modeled in CDEGS assuming average tree branch dimensions and a 16 kV phase-to-phase voltage circuit.

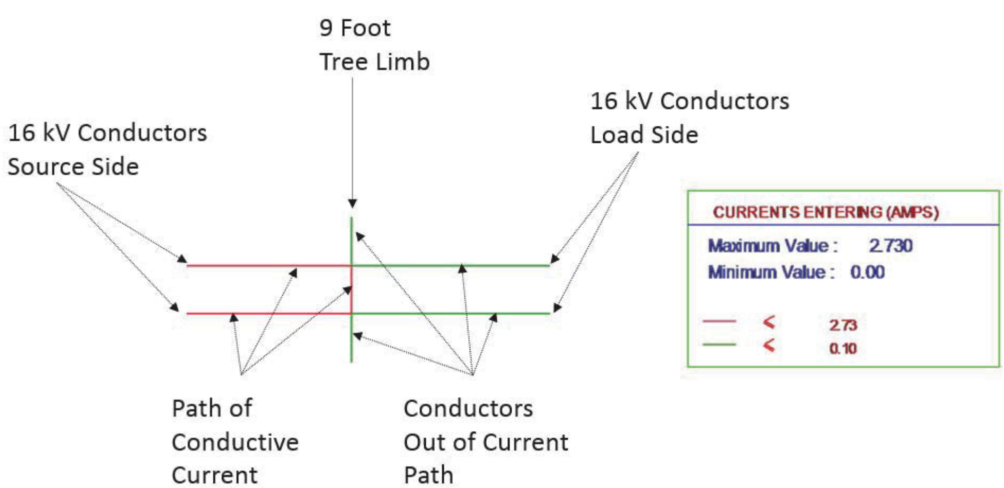
Section 6.1, through computer simulation, models tree branch contact on bare conductors. Section 6.2 illustrates the model for tree branch contact on covered conductors.

6.1 Bare Conductors

The following simulated model was used for the case where a tree branch falls on bare conductors, based on the parameters in Section 4.3.2. Approximately 2.73 A is flowing through the shorting contact, shown in Figure 6. This model was for a general case, assuming average tree branch dimensions and a 16 kV phase-to-phase voltage circuit.

Figure 6 shows the simulated model of a 9 foot tree limb across parallel bare conductors. The colors in the figure depict the values of the current in the system. Red equates to a current of 2.73 A (2730 mA) and green equates to 0.10 A (100 mA). This amount of current may lead to arcing.

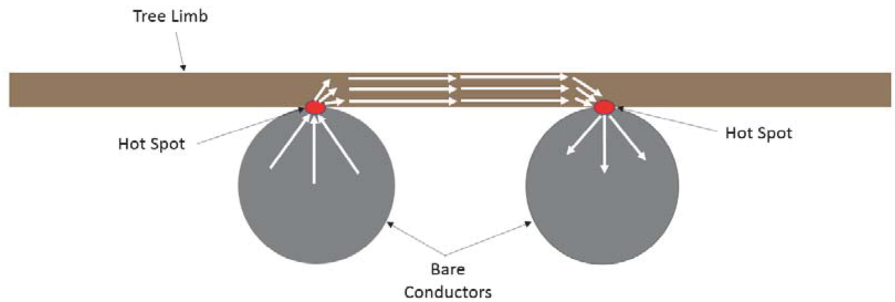
Figure 6: Simulated Bare Conductor Longitudinal Current



Current will always flow through the path of least resistance. The path of least resistance in this case is through the tree branch. The current on the branch could create a potential fire ignition event since the contact areas, which are points of high current concentrations, could be more likely to heat up quickly.

Figure 7 shows a representation of the flow of current between the bare conductors and the tree limb. The majority of the current enters and leaves the tree limb at discrete points or hot spots. These hot spots are points of high current density and could be more likely to heat up quickly.

Figure 7: Current Path for Tree Limb on Bare Conductor



6.2 Covered Conductors

Simulation software models the electrical characteristics of the actual conductors and insulation. The results shown in Figure 8 and Figure 9 show a total of 0.04 mA of current flowing through the tree limb. This model was for a general case, assuming a 9 foot tree branch length and a 16 kV phase-to-phase voltage circuit.

Figure 8 shows the simulated model of a 9 foot tree limb across parallel covered conductors and the longitudinal current flowing through the branch. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled to 1×10^{-3}. Therefore, the values shown on the table must be multiplied by 0.001 to obtain the true value. For example, the purple line, which corresponds to the maximum current density in the tree limb, equates to 0.00004 A (0.04 mA), indicating that the highest amount of current going through the branch is 0.04 mA. This current is extremely low and would be unlikely to cause arcing.

Figure 8: Simulated Covered Conductor Longitudinal Current

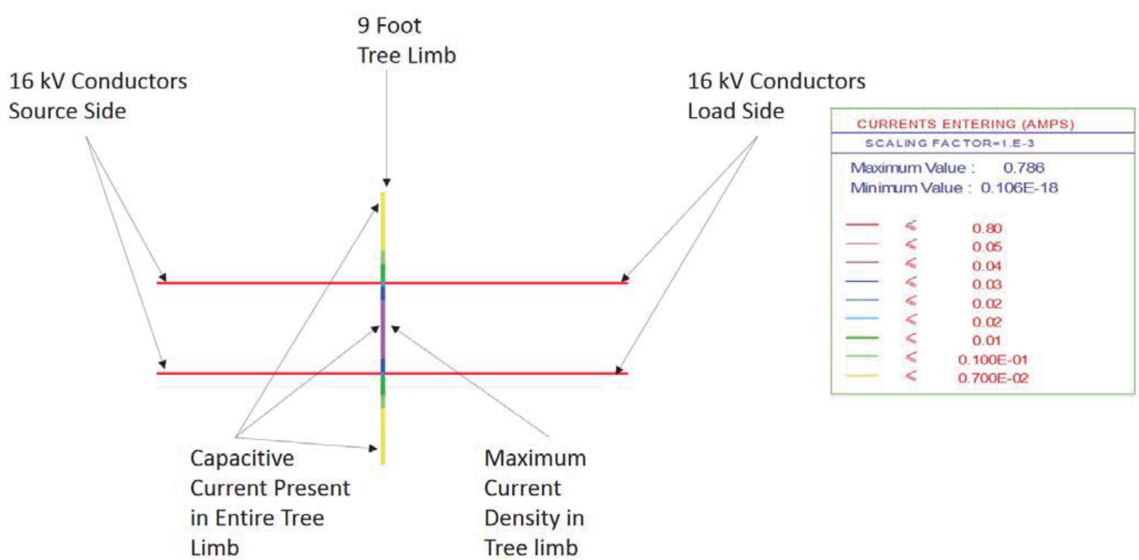
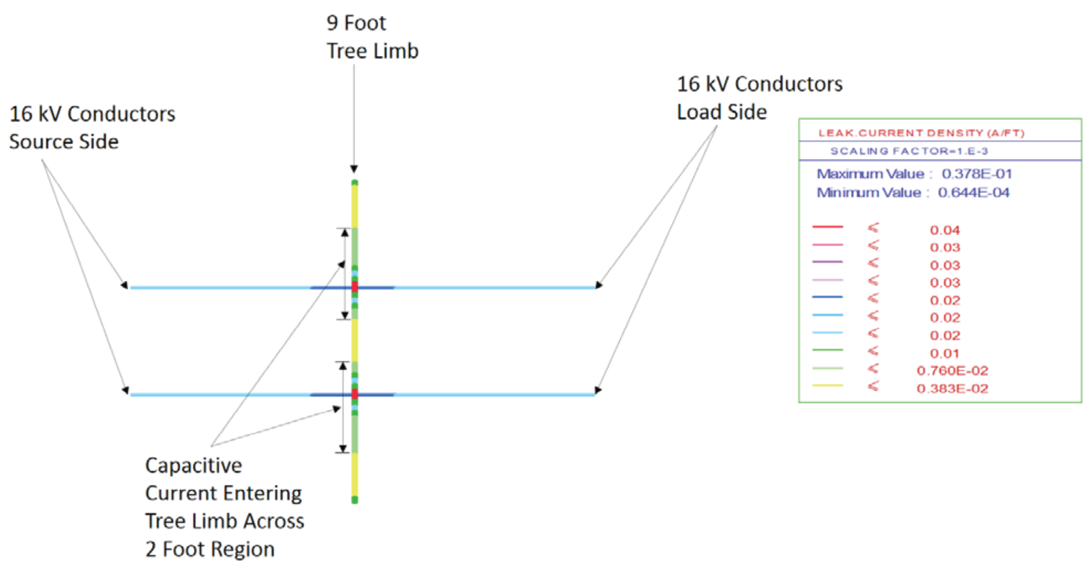


Figure 9 shows the simulated model of a 9 foot tree limb across parallel covered conductors and the point of current entry. The point of current entry is the area where the tree branch and covered conductor make contact. The colors in the figure depict the values of the current in the system. The values in the table above are scaled by 1×10^{-3}. Therefore, the values shown on the table must be multiplied by 0.001 to obtain the true value. For example, the red line, which corresponds to the capacitive current entering the tree limb, equates to 0.00004 A (0.04 mA), indicating that the highest amount of current entering the branch is 0.04 mA. This current is extremely low and is unlikely to cause arcing.

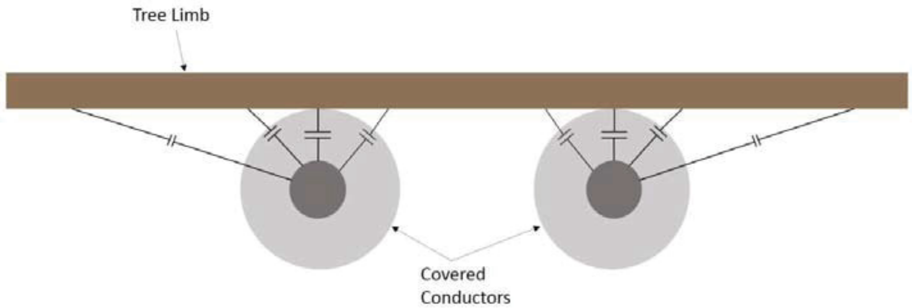
Figure 9: Simulated Covered Conductor Current Point of Entry



Unlike the bare conductor case, the path of current is spread across a wide area. There is current across the entire length of the tree limb, but the highest current occurs in the center as shown in Figure 8. Figure 9 shows the majority of the current enters the tree limb across an approximately two foot long region instead of at a discrete point. This is a consequence of the multiple parallel paths for current as shown in Figure 10. The points of high current density needed to spark a fire do not exist.

Figure 10 shows a representation of the multiple parallel paths for capacitive current between the covered conductors and the tree limb. This leads to the majority of the current entering the tree limb across an approximately two foot long region instead of at a discrete point.

Figure 10: Capacitance between Covered Conductors and Tree Limb



7.0 Generic Case: Current and Energy of Bare vs. Covered Conductors

Both simulation models (PSCAD in Section 5.0 and CDEGS in Section 6.0) illustrate an approximate current of 2.8 A (2800 mA) on the tree branch when it is in contact with bare conductors. Comparatively, a tree branch on covered conductors results in a current values of 0.00018 A (0.18 mA) and less than 0.00001 A (0.01 mA) through the branch in PSCAD and CDEGS, respectively. The simulated current values and the calculated resistance values of a tree branch (Section 4.3) can be used to calculate energy into the branch using the following equation:

$$P = I^2R$$ ***Equation 1***

Where
P is the power (energy)
I is the current
R is the resistance

When calculating power, the difference between covered conductor and bare is more apparent because power is proportional to the magnitude of current squared.

Table 5 summarizes the results of both simulation methods and translates the current into energy. Energy was calculated using current squared multiplied by the resistance ($P = I^2R$). The PSCAD values are comparable to CDEGS values when modeling a tree branch on bare conductor. In the covered conductor simulation, the PSCAD current results are greater than the CDEGS results. Conservative modeling was used in PSCAD to obtain the maximum possible current through the branch, leading to higher current value in the simulation. Both simulation methods show by using covered conductors, the rate of energy into the branch is reduced by a factor of more than a hundred thousand. This reduction will significantly reduce the probability of arcing and potential for fire ignition.

Table 5: Current and Energy General Case

Simulation Method	Conductor Type	Current in Branch	Resistance of Branch	Power into Branch
PSCAD	Bare Conductor	2800 mA	5800 Ω	45,472 W
	Covered Conductor	0.18 mA	5800 Ω	0.00019 W
CDEGS	Bare Conductor	2730 mA	5800 Ω	43,227 W
	Covered Conductor	0.04 mA	5800 Ω	0.00001 W

8.0 SCE Distribution System Voltage Testing - EDEF

System Voltage Testing was performed on a 12 kV phase-phase circuit at SCE's Equipment Demonstration and Evaluation Facility (EDEF) powered by the SCE distribution system. No contacts on bare conductors were tested because these faults are well understood in the industry. Only contacts from objects on covered conductors were performed.

8.1 Simulation

Simulations modeled a 12 kV phase-phase circuit with various foreign objects laid across the phase conductors. Conductor-Conductor contact was also modeled. These simulations served as the basis for testing performed at SCE's EDEF. Current values in the simulations, models are compared at the same point measured at EDEF testing. Results for these simulations are presented in the following sections and the results can be seen in Section 11.7 3 of the Appendix.3 of the Appendix.

8.2 Test Set Up

This test was used to validate the current values modeled in the simulation and physically demonstrate that short term phase-phase contact on covered conductors (CC) will not cause faults or arcing.

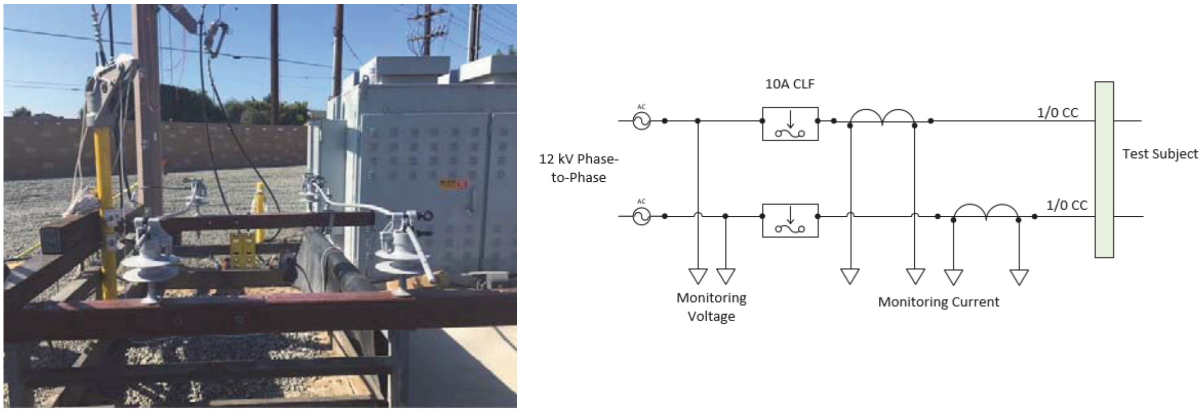
Figure 11 shows the actual test set up and a schematic of the test set up. Two phases of covered conductors were isolated from a 3 phase, 4-wire system. The circuit was energized at 12 kV phase-phase. The covered conductors were spaced 36 inches apart and supported by 25 kV Polymer Pin-Type Vice Top Line Insulators with Nylon Inserts. The insulators were connected to an 8 foot composite crossarm. Current transformers were used to monitor the current on the covered conductors. Objects used included a palm frond, a brown branch, a green branch, metallic balloons, and conductor-conductor contact. Refer to Section 11.5 for circuit map. 1/0 AWG covered conductor was used for all test cases.

During testing, the current in the covered conductor was recorded without the test subject making contact (Tare Current without Test Subject). The Tare Current without Test Subject is considered as the reference current since this current is considered as noise for the purposes of this test. An object was then placed on both phases and the current was recorded again (Current with Test Subject). The difference between the Tare Current without Test Subject and the Current with Test Subject was calculated to obtain the effect of the object on the system with the tare removed. The Change in Current with Test Subject is considered to be the current observed on the conductor for purposes of this report.

The same methods were applied to the simulations of the test cases to produce the data below.

Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

Figure 11: Empirical Test Set Up



8.2.1 Palm Frond

A palm frond was placed mid-span of the covered conductor set-up, as shown on Figure 12. The palm frond rested on the covered conductor for 5 minutes while the circuit was energized at 12 kV phase-phase. For the duration of the test, two current transformers monitored the leakage current on the covered conductors. No arcing was observed when the circuit was energized. No damage on the covered conductors and palm frond was observed after the test, refer to Appendix Section 11.4 for a microscopic cutaway view of the post-test covered conductor**.**

Table 6 summarizes and compares the empirical results with the simulated results. Overall, the current observed when the palm frond made phase-phase contact was 0.001 mA

Figure 12: Palm Frond Test Set-Up

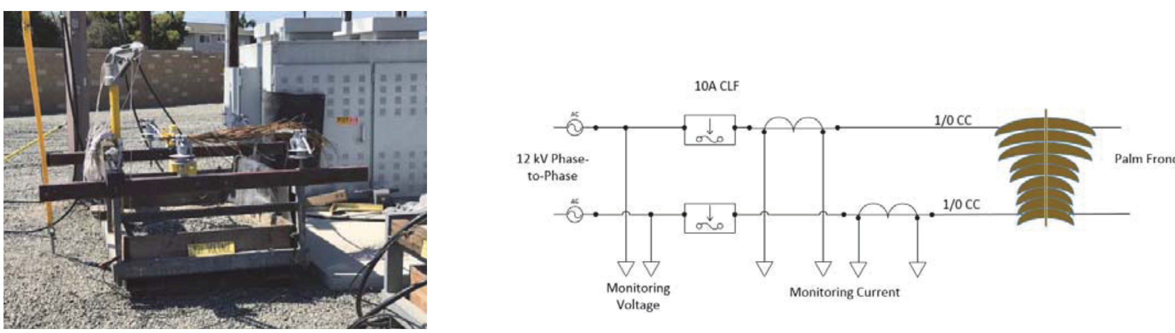


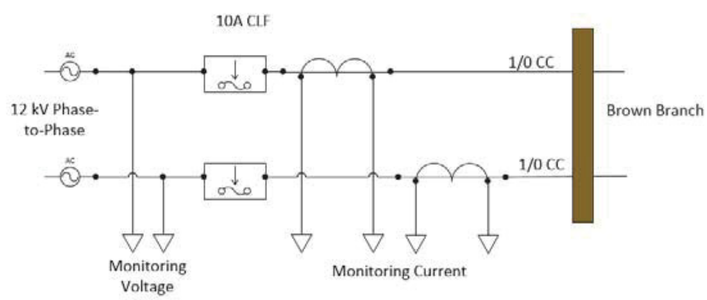
Table 6: Simulated and Empirical Palm Frond Results

Test Subject	Moisture Content (%)	Test Subject Resistance @ 5kVDC	Length of Subject (in.)	Diameter of Subject (in.)	CDEGS Tare Current w/out Test Subject (mA)	CDEGS Current with Test Subject (mA)	CDEGS Change in Current with Test Subject (mA)	Tare Current w/out Test Subject (mA)	Current with Test Subject (mA)	Change in Current with Test Subject (mA)
Palm Frond	4.60%	210 MΩ	45 in.	0.822 in.	0.110	0.115	0.005	0.016	0.017	0.001

8.2.2 Branch

A brown branch (3.60% moisture) was placed mid-span of the covered conductor set-up, as shown in Figure 13. The branch rested on the covered conductor for 5 minutes and 59 seconds while the circuit was energized at 12 kV phase-phase. For the duration of the test, two current transformers monitored the leakage current on the covered conductor. No arcing was observed when the circuit was energized. No damage on the covered conductor and dry branch was observed after the test, refer to Appendix Section 11.4 for a microscopic cutaway view of the post-test covered conductor**.**

Figure 13: Brown Branch Test Set-Up



A green branch (12.20% moisture) was placed mid-span of the covered conductor set-up after testing the dry branch, as shown in Figure 14. The branch rested on the covered conductor for 5 minutes and 16 seconds while the circuit was energized at 12 kV phase-phase. For the duration of the test, two current transformers monitored the leakage current on the covered conductors. No arcing was observed when the circuit was energized. No damage on the covered conductors and green branch was observed after the test, refer to Appendix Section 11.4 for microscopic cutaway view of the post-test covered conductor**.**

Figure 14: Green Branch Test Set-Up

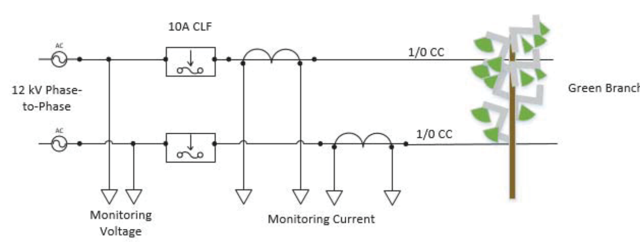


Table 7 summarizes and compares the empirical results with the simulated results. Overall, the current observed when the palm frond made phase-phase contact was – 0.001 mA for the brown branch and 0.001 mA for the green branch. The negative value of the current in the brown branch is due to the current being at the low end of the measuring device's limit.

Table 7: Simulated and Empirical Branch Results

Test Subject	Moisture Content (%)	Test Subject Resistance @ 5kVDC	Length of Subject (in.)	Diameter of Subject (in.)	CDEGS Tare Current w/out Test Subject (mA)	CDEGS Current with Test Subject (mA)	CDEGS Change in Current with Test Subject (mA)	Tare Current w/out Test Subject (mA)	Current with Test Subject (mA)	Change in Current with Test Subject (mA)
Brown Branch	3.60%	4760 MΩ	49 in.	1.527 in.	0.110	0.116	0.006	0.016	0.015	-0.001
Green Branch	12.20%	1.35 MΩ	35.5 in.	0.493 in	0.110	0.113	0.003	0.016	0.017	0.001

8.2.3 728 Ω Resistor (Animal Contact)

A 728 Ohm (Ω) resistor was placed mid-span of the covered conductor set-up, as shown in Figure 15. The 728 Ω resistor represented wildlife contact. The resistor rested on the covered conductor for 4 minutes and 19 seconds while the circuit was energized at 12 kV phase-phase. For the duration of the test, two current transformers monitored the leakage current on the covered conductors. No arcing was observed when the circuit was energized. No damage on the covered conductors and the resistor was observed.

Figure 15: Animal Contact Test Set-Up

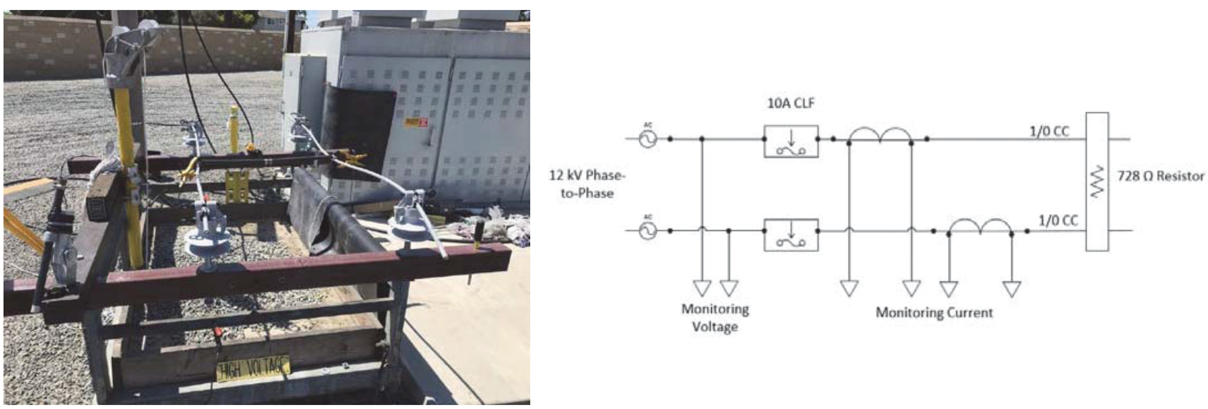


Table 8 summarizes and compares the empirical results with the simulated results. Overall, the current observed for phase-phase animal contact was 0.044 mA.

Table 8: Simulated and Empirical Animal Contact Results

Test Subject	Moisture Content (%)	Test Subject Resistance @ 5kVDC	Length of Subject (in.)	Diameter of Subject (in.)	CDEGS Tare Current w/out Test Subject (mA)	CDEGS Current with Test Subject (mA)	CDEGS Change in Current with Test Subject (mA)	Tare Current w/out Test Subject (mA)	Current with Test Subject (mA)	Change in Current with Test Subject (mA)
728 Ohm Resistor Ph-Ph	NA	728 Ω	36 in.	1 in.	0.110	0.114	0.004	0.016	0.06	0.044

8.2.4 Metallic Balloon

Two metallic balloons were placed mid-span of the covered conductor set-up, as shown in Figure 16. The metallic balloons rested on the covered conductors and one another to form a continuous bridge between the phases for 5 minutes and 5 seconds while the circuit was energized at 12 kV phase-phase. For the duration of the test, two current transformers monitored the leakage current on the covered conductors. No arcing was observed when the circuit was energized. No damage on the covered conductors and metallic balloons was observed after the test, refer to Appendix Section 11.4 for microscopic cutaway view of the post-test covered conductor**.**

Figure 16: Metallic Balloon Contact Test Set-Up

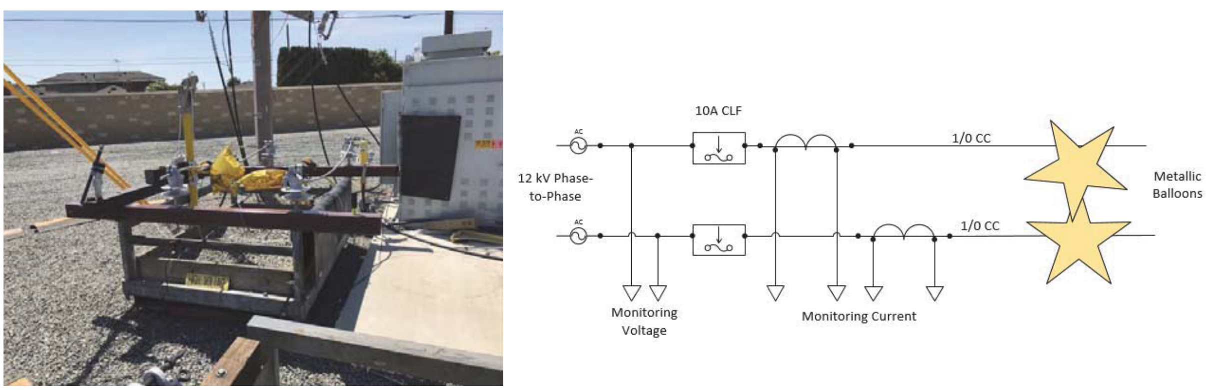


Table 9 summarizes and compares the empirical results with the simulated results. Overall, the current observed when the metallic balloon made phase-phase contact was 0.128 mA.

Table 9: Simulation and Empirical Metallic Balloon Results

Test Subject	Moisture Content (%)	Test Subject Resistance @ 5kVDC	Length of Subject (in.)	Diameter of Subject (in.)	CDEGS Tare Current w/out Test Subject (mA)	CDEGS Current with Test Subject (mA)	CDEGS Change in Current with Test Subject (mA)	Tare Current w/out Test Subject (mA)	Current with Test Subject (mA)	Change in Current with Test Subject (mA)
Metallic Balloon	NA	4 Ω	NA	18 in.	0.110	0.119	0.009	0.016	0.144	0.128

8.2.5 Conductor-to-conductor contact

A pulley system was used to simulate conductor-to-conductor contact, as shown in Figure 17. The two covered conductors made contact for 4 minutes and 17 seconds while the circuit was energized at 12 kV phase-phase. For the duration of the test, two current transformers monitored the leakage current of the covered conductors. No arcing was observed when the circuit was energized. No damage on both covered conductors were observed after the test, refer to Appendix Section 11.4 for microscopic cutaway view of the post tested covered conductor.

Figure 17: Conductor-to-Conductor Contact Test Set-Up

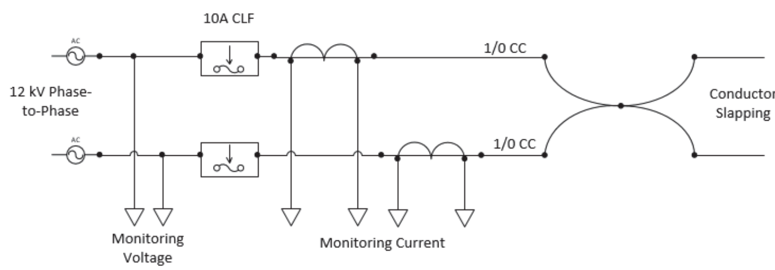


Table 10 summarizes and compares the empirical results with the simulated results. Overall, the current observed when the palm frond made phase-phase contact was 0.008 mA.

Table 10: Simulation and Empirical Conductor-to-conductor Test Results

Test Subject	Moisture Content (%)	Test Subject Resistance @ 5kVDC	Length of Subject (in.)	Diameter of Subject (in.)	CDEGS Tare Current w/out Test Subject (mA)	CDEGS Current with Test Subject (mA)	CDEGS Change in Current with Test Subject (mA)	Tare Current w/out Test Subject (mA)	Current with Test Subject (mA)	Change in Current with Test Subject (mA)
Conductor-to-conductor	NA	610 GΩ	102 in.	NA	0.110	0.152	0.042	0.016	0.024	0.008

8.3 EDEF Test Conclusion

The empirical testing demonstrated that real world scenarios such as tree branches and stray metallic balloons yield significantly different results when comparing bare to covered conductors. Empirical testing exhibited no sparking or current over 1 mA. This is important when considering that a 12 kA distribution substation is located 500 circuit feet from the test location, offering reduced impedance. The close proximity, as shown in Section 11.5 of the Appendix, to the source would allow a higher fault magnitude if catastrophic events were to occur. Evidence of covered conductor effectiveness was not only seen in the measured instantaneous observations but also in the post analysis. Post analysis of the covering as seen through cut insulation wafers exhibited in Appendix Section 11.4 displays no visible damage through any layer of the conductor's insulation. Infrared reference snap shots as shown in Section 11.6 were also taken at the point of contact between conductors and test subjects as well as conductor-to-conductor contact. The previous tests in combination with Table 5 through Table 9 exhibit a current magnitude less than 1 mA. All test current values were consistent with simulated results. Tests and analysis confirm the effectiveness of the conductor's covering as well as the significant benefits to grid resiliency.

Table 11 summarizes the computer simulated (CDEGS) and empirical (EDEF) current and energy results. All current values were below 1 mA, leading to energy values that are unlikely to cause arcing.

Table 11: Simulation and Empirical Test Results Summary

Simulated/Test Subject	Current		Energy	
	CDEGS Current with Test Subject (mA)	**EDEF Current with Test Subject (mA)**	**Power -CDEGS (Watts)**	**Power -EDEF (Watts)**
Palm Frond	0.005	0.001	0.00525	0.00021
Brown Branch	0.006	-0.001	0.17136	0.00476
Green Branch	0.003	0.001	0.000012	0.0000014
728 Ohm Resistor Ph-Ph	0.004	0.044	0.000000012	0.0000015
Metallic Balloon	0.009	0.128	0.00000000030	0.000000066

[1]*The negative value of the current in the Brown Branch is at the low end threshold of the measuring devices used for testing, signifying the small magnitude of current.*

9.0 Conclusion

The empirical testing performed at EDEF validated the ability of covered conductor to withstand contact from various objects without a high fault current or arcing. The low current thresholds shown by the model were confirmed by empirical data, demonstrating that the insulating capabilities of covered conductor limits the risk of arcing (and the associated potential for fire ignition). The empirical results show that using covered conductors eliminated sparking, limited energy to less than 1 watt and reduced current into an object to much less than 1 mA. Putting this into perspective, a typical cell phone charges at 3 to 4 watts, while a charger left unplugged without a phone consumes 1 to 2 watts (Heikkinen & Nurminen, 2012). In comparison, the highest power calculated is in the low end range of a cell phone charger unplugged from a phone. Also, considering the thresholds of the National Institute for Occupational Safety and Health (NIOSH) (National Institute for Occupational Safety and Health, 2009), the data gathered are well below the published values associated with perceptible tingling upon contact.

The minimal current in conjunction with the temperature change (≈+/-1.6ºC) in the infrared snap shots shown in Section 11.6 indicates that contact has a minimal effect on either the conductor or test subject in the time duration of testing. The empirical testing enabled conductor to conductor contact without creating any phase-phase faults or even minor sparking. In addition, post analysis sample wafers of the covered conductor exhibited no visible signs of damage in either layer of insulation, further demonstrating the insulation's durability.

The analysis and empirical testing demonstrated that the use of covered conductors can prevent phase-to-phase and phase-to-ground faults and the associated risk sparking and arcing, potential fire ignition sources.

10.0 References

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11.0 Appendix

11.1 Covered Conductor Deterioration

The analysis presented in this report applies only to undamaged covered conductor. If the insulation has entirely stripped off, then the results will be the same as for bare conductor. If the insulation has slight deterioration, the values are assumed to be nearly identical to those for undamaged covered conductor. If the covered conductor deteriorates to the point where the dielectric strength of the insulation material is less than the applied voltage, arcing can occur and currents may be similar to the case of bare conductor.

11.2 Summary of Results for General Case

Table 12: Summary Table of Contact From Object Using Computer Simulation

Summary Table of Contact From Object Using Computer Simulation							
Contact from Object (CFO)	**Object Resistance[1]**	**Bare Conductor**			**Covered Conductor**		
		Contact Current	**P-P Voltage**	**Power**	**Contact Current**	**P-P Voltage**	**Power**
Tree/Vegetation	7,100 Ω	2.3 A	16 kV	40,000 W	0.0002 A	16 kV	<< 0.001 W
Metallic Balloon	0.003 Ω[3]	29,000 A[5]	16 kV	2,523,000 W	0.0002 A	16 kV	<< 0.001 W
Animal	500 Ω[4]	32 A	16 kV	512 kW	0.0002 A	16 kV	<< 0.001 W
Conductor-Conductor[2]	0.003 Ω[3]	29,000 A[5]	16 kV	2,523,000 W	0.0002 A	16 kV	<< 0.001 W

1. Object Resistance values are to be assumed and validated in lab tests.
2. Conductor-Conductor is bare-to-bare and covered-to-covered. Bare and Covered conductor mixed scenario is not considered.
3. Arc resistance is calculated using contact current and Reference 7 (Lee, 1982).
4. The most commonly studied animal is cattle which are typically around 500 Ω (Minnesota Rural Electric Association, 2016). Smaller animals have higher resistances.
5. The current will be decided by the system fault current at the point of contact.

For comparison, the highest fault current 12 kV substation on the SCE system is 28,826 A and the highest fault current 16 kV substation on the SCE system is 14,737 A.

11.3 Simulated Plots for Empirical Test Cases

Note the different scaling factors indicated in the legend for each plot.

Figure 18 shows the simulated model of the palm fond used during empirical testing across parallel covered conductors. The longitudinal current is the current flowing through the palm frond. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled by 1×10^{-3}. Therefore, the values shown on the table must be multiplied by 0.001 to obtain the true value.

Figure 18: Simulated Palm Frond on Covered Conductor Longitudinal Current

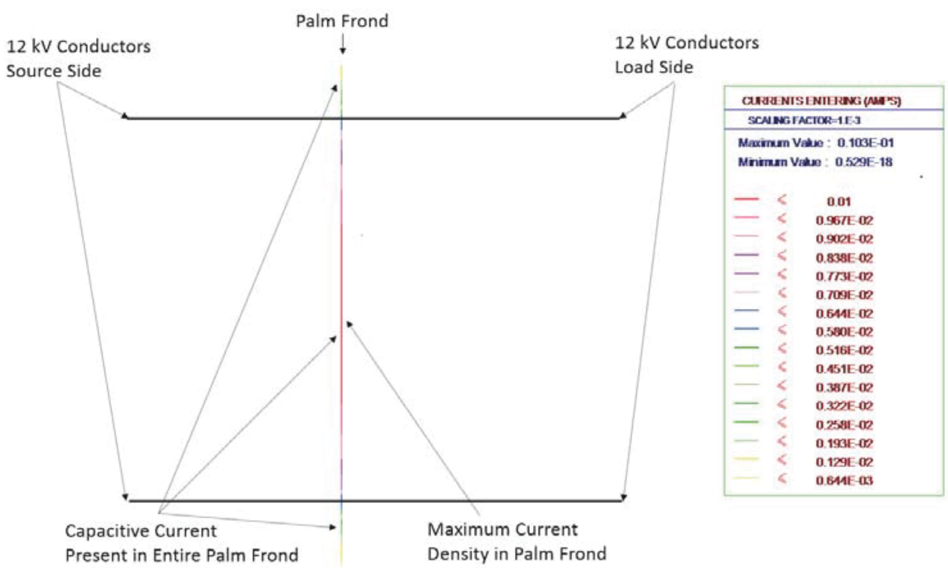


Figure 19 shows the simulated model of the dry branch used during EDEF testing across parallel covered conductors. The longitudinal current is the current flowing through the dry branch. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled by 1×10^{-4}. Therefore, the values shown on the table must be multiplied by 0.0001 to obtain the true value.

***Figure 20* shows the simulated model of the green branch used during empirical testing across parallel covered conductors. The longitudinal current is the current flowing through the green branch. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled by 1 × 10^{-6}. Therefore, the values shown on the table must be multiplied by 0.000001 to obtain the true value.**

Figure 19: Simulated Green Branch on Covered Conductor Longitudinal Current

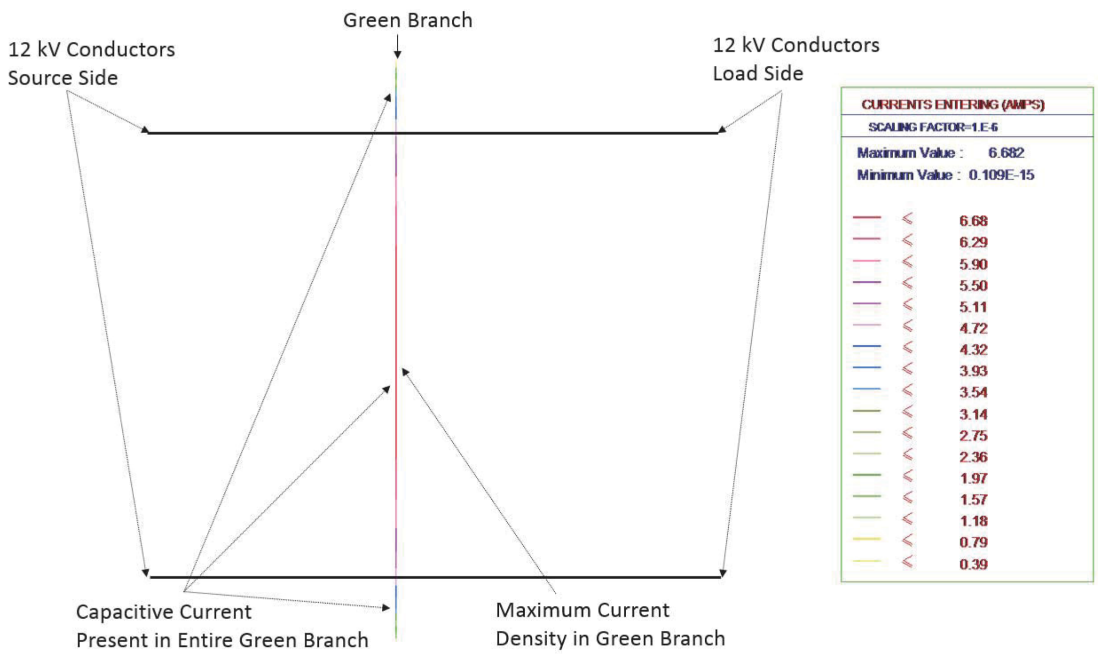


Figure 21 shows the simulated model of the 728 ohm resistor simulating animal contact used during empirical testing across parallel covered conductors. The longitudinal current is the current flowing through the resistor. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled by 1×10^{-6}. Therefore, the values shown on the table must be multiplied by 0.000001 to obtain the true value.

Figure 20: Simulated 728 Ohm Resistor on Covered Conductor Longitudinal Current

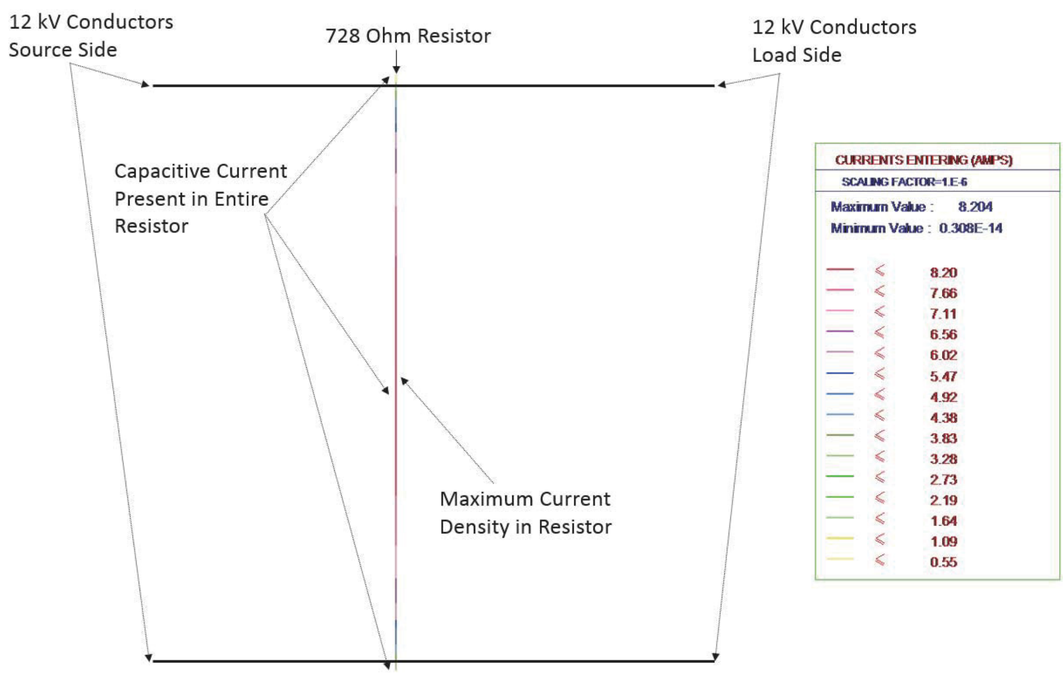


Figure 22 shows the simulated model of the metallic balloon used during empirical testing across parallel covered conductors. The longitudinal current is the current flowing through the metallic balloon. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled by 1 × 10^{-6}. Therefore, the values shown on the table must be multiplied by 0.000001 to obtain the true value.

Figure 21: Simulated Metallic Balloon on Covered Conductor Longitudinal Current

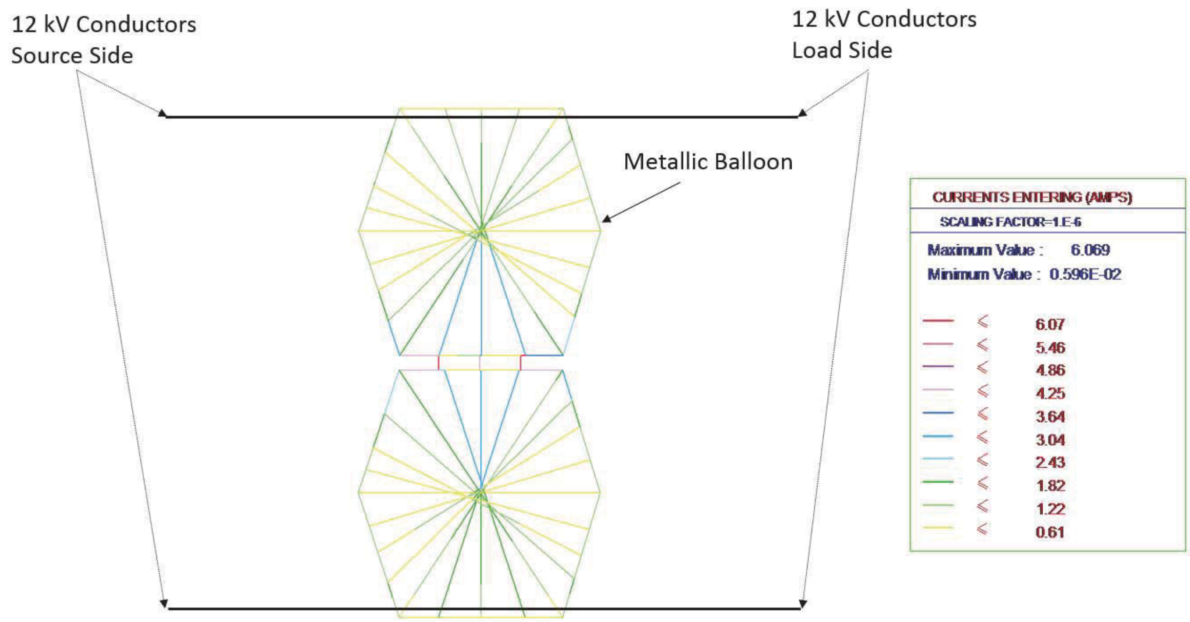
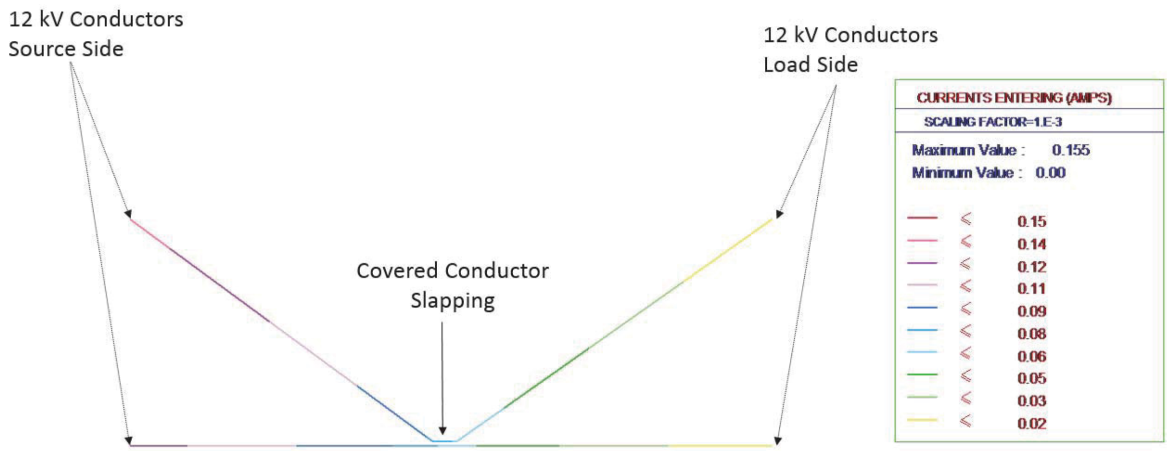


Figure 23 shows the simulated model of the covered conductor-conductor empirical test. The longitudinal current is the current flowing on the covering of the covered conductors. The colors in the figure depicts the values of the current in the system. The values in the table above are scaled by 1×10^{-3}. Therefore, the values shown on the table must be multiplied by 0.001 to obtain the true value.

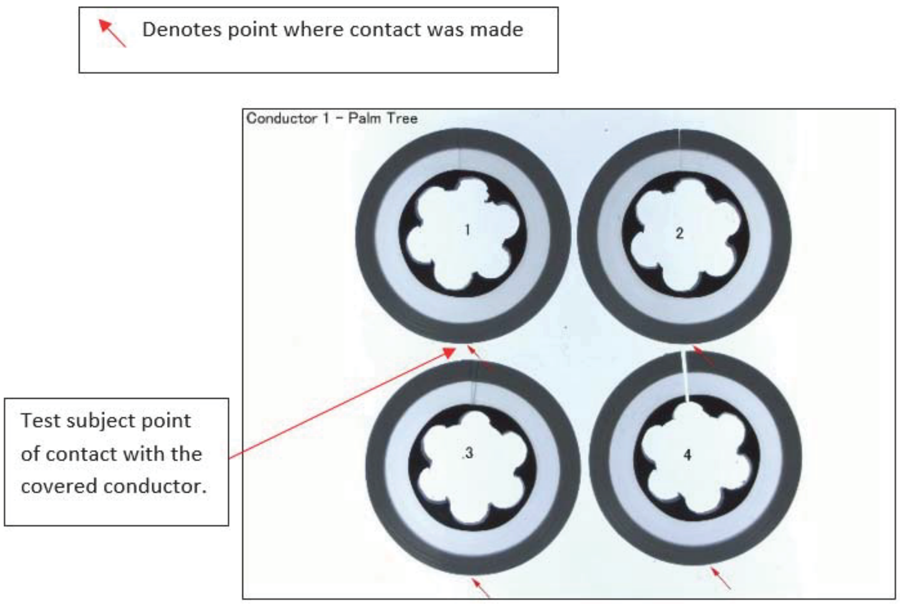
Figure 22: Simulated Covered Conductor-Conductor Longitudinal Current



11.4 Microscopic view of Covered Conductor Wafers

During the EDEF tests, palm frond, branch, and slap test sample areas on the conductor were marked at each spot where the test subject came in contact with the covered conductor. At the conclusion of the test both conductors were taken to the Root Cause and Equipment Performance Group. The group cut the conductors at the point of contact as marked by field personnel and analyzed comparing to a non-tested specimen.

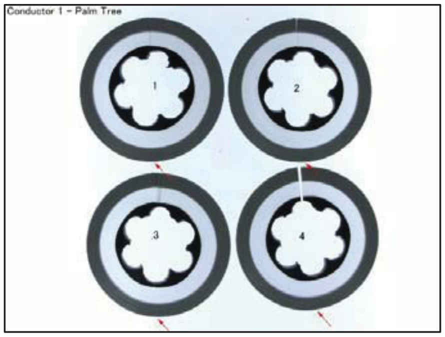
Samples analyzed did not show any visible characteristics of partial discharge or abnormality. The red arrows as indicated in the following pictures are at the point where the test subject touched the covered conductor. It is important to note that the vertical cut as shown in the microscopic slides are part of the analysis process and not representative of a conductor issue.



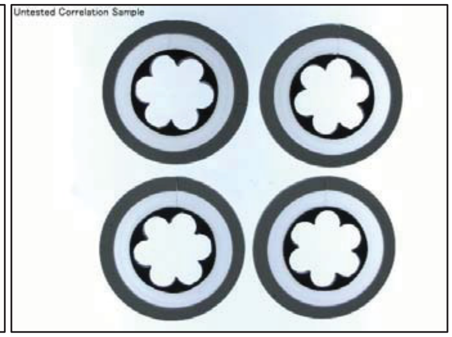
Reference of Wafer Sample

Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

Brown Palm Frond Conductor

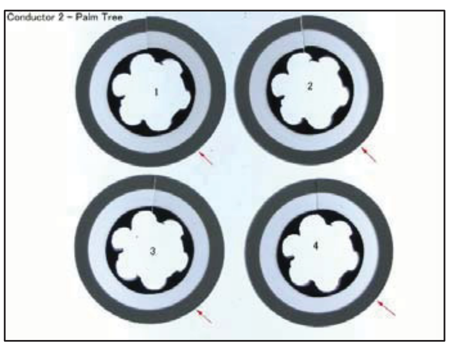


Palm Frond – Conductor 1

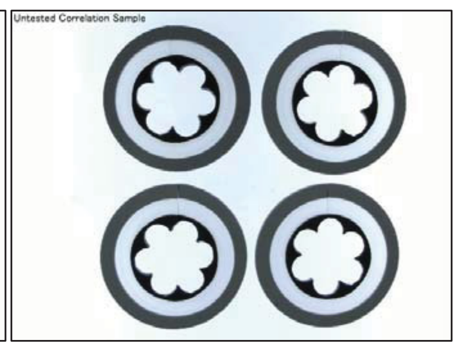


Reference-Non-Tested Sample

Green Palm Frond Conductor

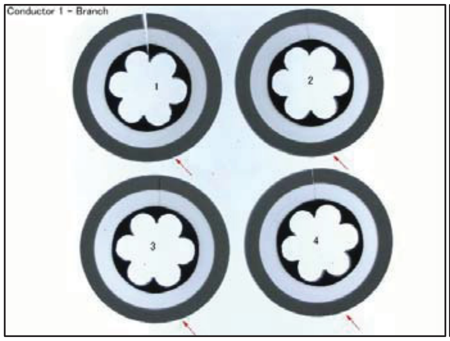


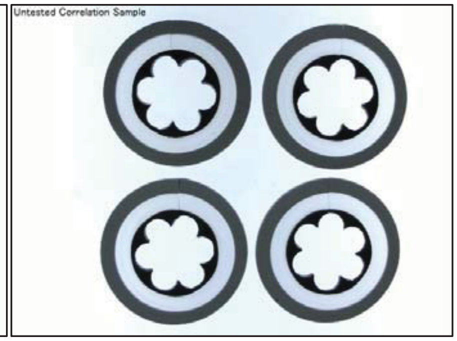
Palm Frond – Conductor 2



Reference-Non-Tested Sample

Brown Branch Conductor

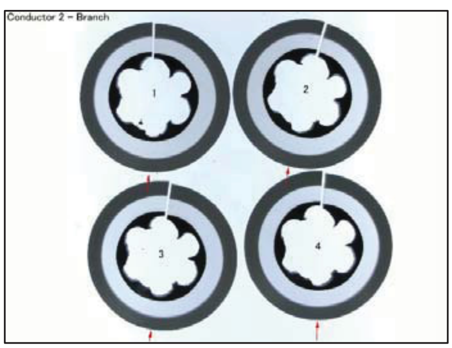


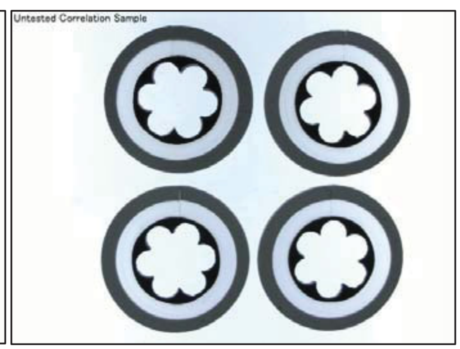


Branch – Conductor 1

Reference-Non-Tested Sample

Green Branch Conductor



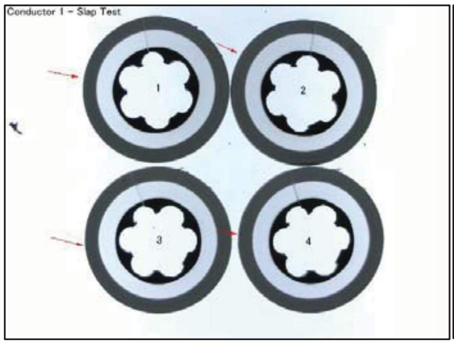


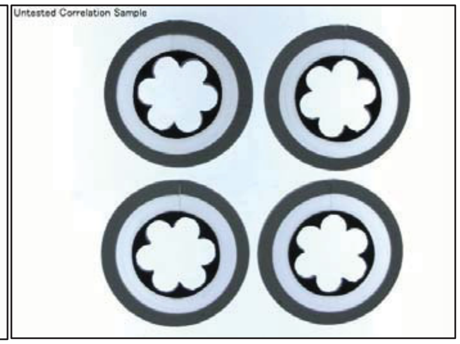
Branch – Conductor 2

Reference-Non-Tested Sample

Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

Conductor-Conductor

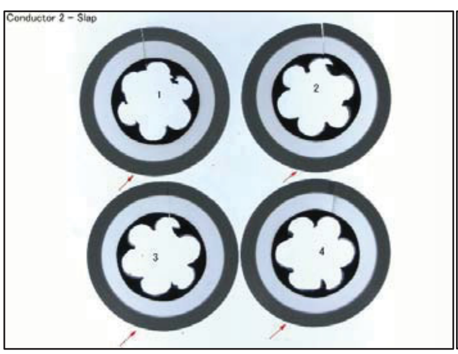


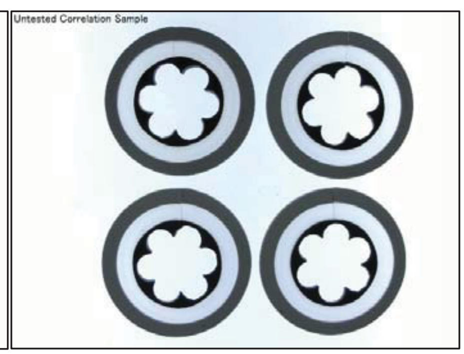


Slapping Conductor – Conductor 1

Reference-Non-Tested Sample

Conductor-Conductor -2

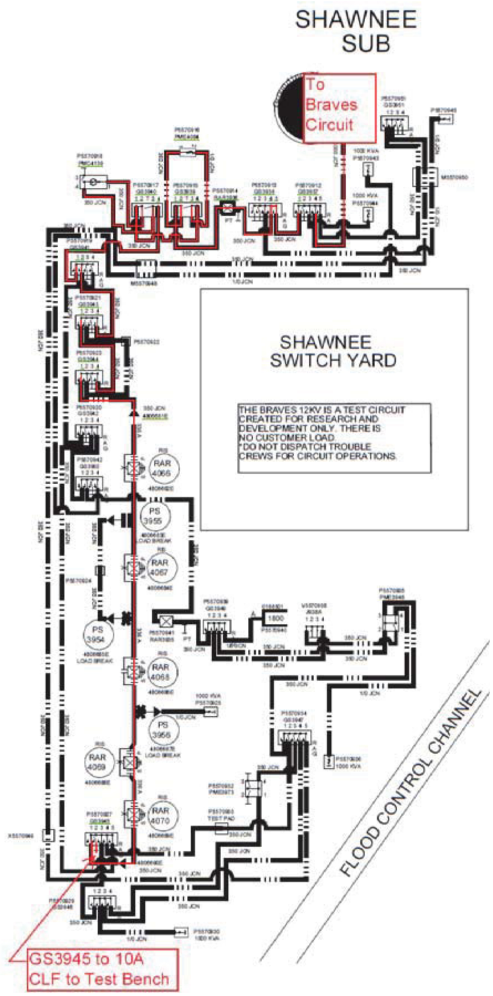




Slapping Conductor – Conductor 2

Reference-Non-Tested Sample

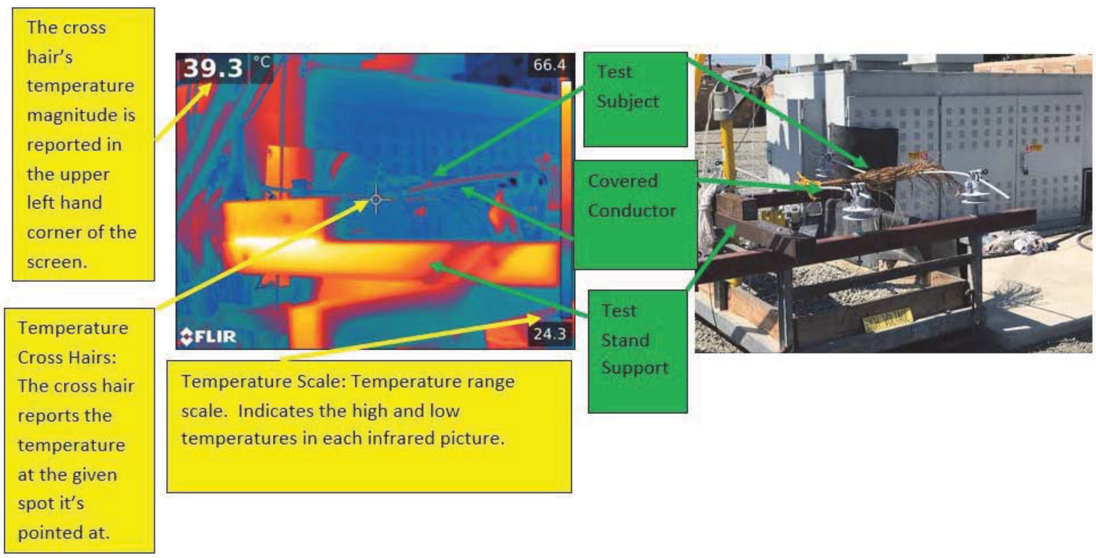
11.5 EDEF Circuit Map



11.6 Infrared Observation of Test Subjects

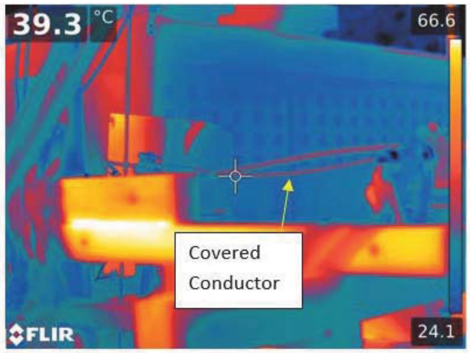
An infrared observation was performed during the testing of the covered conductor. The purpose of the observation was to visually detect any heat that may occur at the contact point between the conductor and test subject. The camera used was a FLIR Infrared Camera T1030SC with an emistivity set at 0.95. The temperature cross hairs were focused on the contact point between the test subject and the covered conductor. Throughout the tests, no significant heat increase was observed at the contact point between test subject and conductor. The below figure is a descriptive example of the data detailed in the picture.

Description of Details in the Infrared Picture

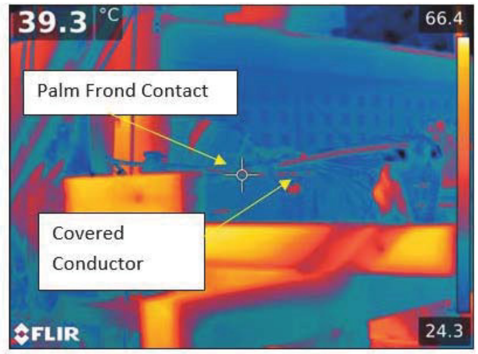


11.6.1 Infrared – Palm Frond on Covered Conductor

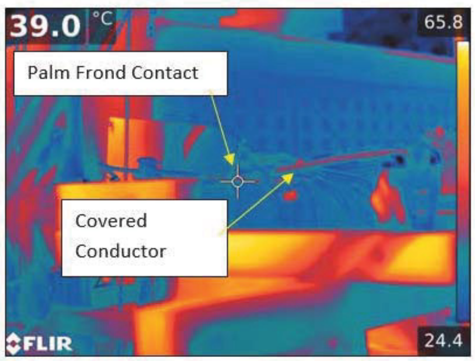
Average Reference Temp of Conductor without test subject: 39.3°C



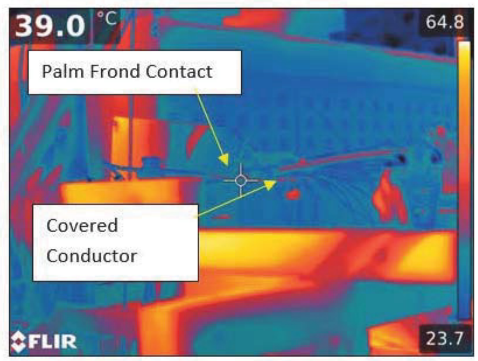
10:07:33 AM De-Energized – Test Subject Temp: 39.3°C



10:09:15 AM Energized – Test Subject Temp: 39.3°C



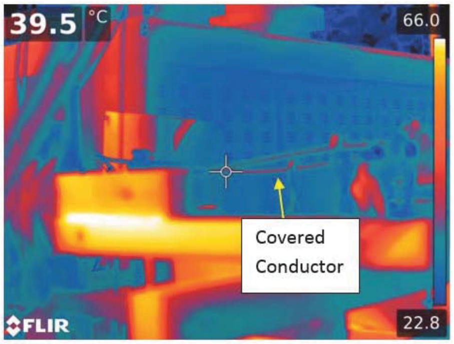
10:12 AM Energized – Test Subject Temp: 39.0°C



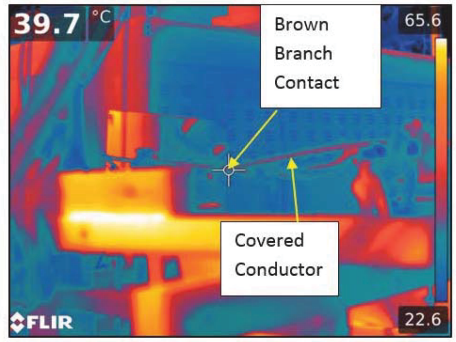
10:14 AM De-Energized –Test Subject Temp: 39.0°C

11.6.2 Infrared – Branch on Covered Conductor

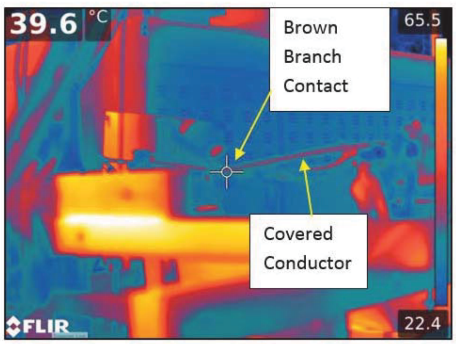
Average Reference Temp of Conductor without test subject: 39.5°C



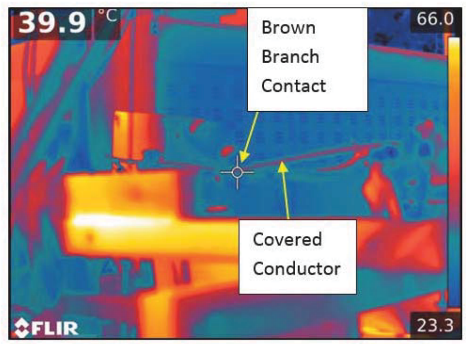
10:25 AM De-Energized – Conductor Temp.: 39.5°C



10:28:15 AM Energized – Test Subject Temp.: 39.7°C



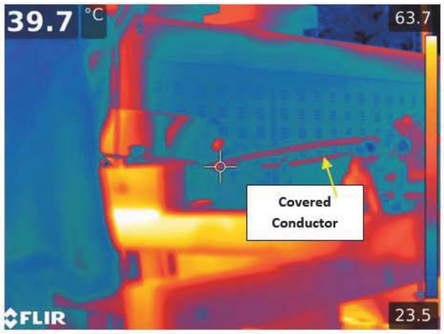
10:30:05 AM Energized – Test Subject Temp.: 39.6°C



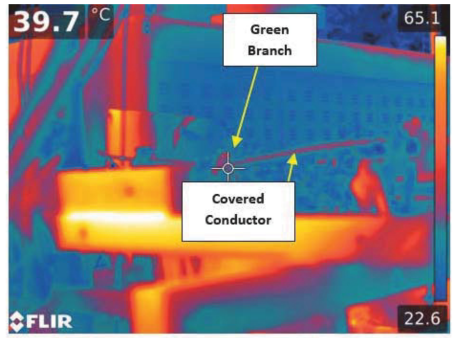
10:31:45 AM Energized – Test Subject Temp.: 39.9°C

11.6.3 Infrared – Green Branch on Covered Conductor

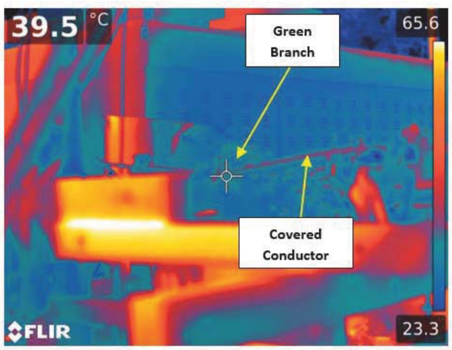
Average Reference Temp of Conductor without test subject: 39.7°C



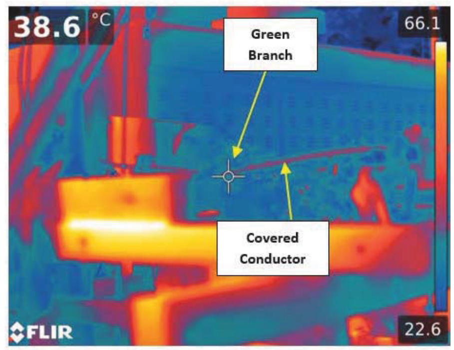
10:31 AM De-Energized – Conductor Temp.: 39.7°C



10:37 AM Energized –Test Subject Temp.: 40°C



10:39 AM Energized –Test Subject Temp.: 39.5°C

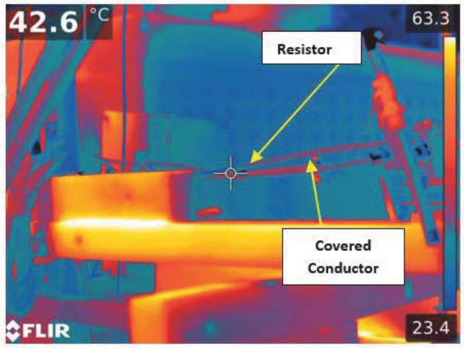


10:43 AM Energized –Test Subject Temp.: 38.6°C

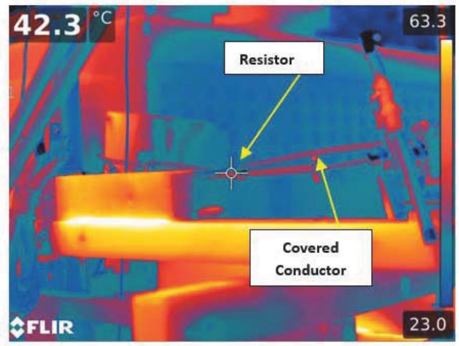
Engineering Analysis on the Impacts of Contact from Objects (CFO) on Bare vs. Covered Conductors

11.6.4 Infrared – 728Ω Resistor Phase-Phase on Covered Conductor

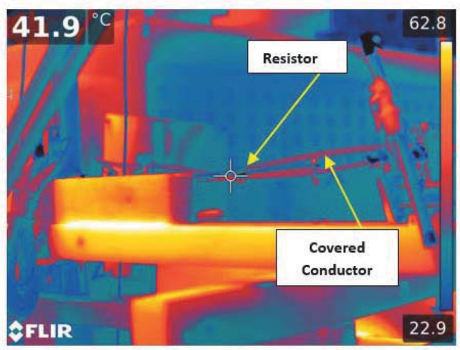
Average Reference Temp of Conductor without test subject: 42.6°C



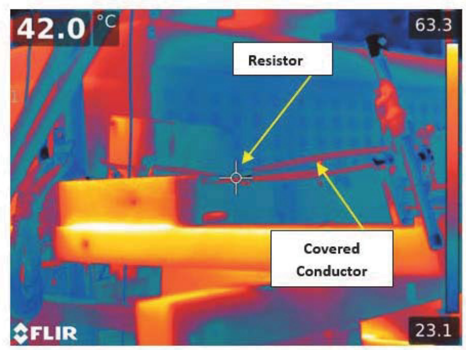
11:13 AM De-Energized –Conductor Temp.: 42.6°C



11:14 AM Energized –Test Subject Temp.: 42.3°C



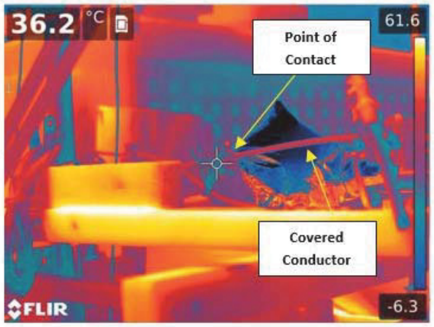
11:15 AM Energized –Test Subject Temp.: 41.9°C



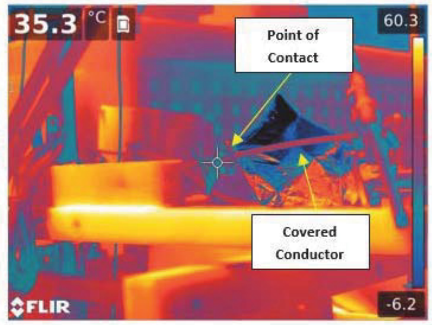
11:18 AM Energized –Test Subject Temp.: 42.0°C

11.6.5 Infrared – Metallic Balloon on Covered Conductor

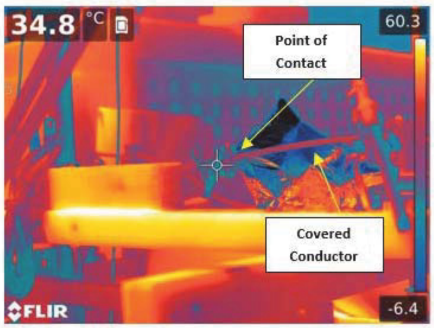
Average Reference Temp of Conductor without test subject: 37.9ºC



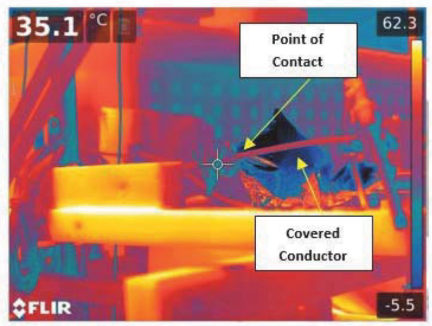
11:24 AM De-Energized –Conductor Temp: 36.2°C



11:25:20 AM Energized –Test Subject Temp: 35.3°C



11:26.30 AM Energized –Test Subject Temp: 34.8°C



11:29:00 AM Energized –Test Subject Temp: 35.1°C

*Note: The metallic balloon infrared pictures are for visual temperature reference. The temperature cross-hairs were slightly off of the point of contact.

11.7 Simulation Parameters Calculation

11.7.1 Covered Conductor Parameters

11.7.1.1 Insulation Capacitance

The capacitance from the branch to the conductor is approximated as a parallel plate capacitor with the same area as the branch.

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d}$$ ***Equation 2***

Where
C is capacitance [Farads]
ε_0 is the permittivity of free space = 8.85 x 10^{-12} [Farads/meter]
ε_r is the relative permittivity of the material
A is the area of the capacitor [m^2]
d is the separation between the two plates [m]

The radius of a tree branch is assumed to be 4.5 cm for the purpose of this generic analysis. The area of the capacitor is approximated as the cross sectional area of the tree branch.

$$A = \pi r^2$$

$$A = \pi(0.045\ m)^2 = 0.0064\ m^2$$

The distance between the plates is approximated as the thickness of the covered conductor insulation.

d = 150 mil = 0.00381 m

The relative permittivity of the insulation material, $\in_r$, is 4.1.

From the above parameters and Equation 1, the capacitance between the branch and the covered conductor is approximately 60 pico-Farads (pF).

11.7.1.2 XLPE Insulation Resistance Calculation

The resistance across the XLPE insulation was approximated as having the same cross sectional area as the branch and the same thickness as the insulation on the conductor.

$$R = \frac{\rho l}{A}$$ ***Equation 3***

Where
l is the length of the object [meters]
A is the cross sectional area of the object [m^2]
ρ is the resistivity of the material [ohm meters]

The length is equal to the insulation thickness.

l = 150 mil = 0.00381 m

The area is equal to the cross sectional area of the branch

$$A_{PSCAD}=0.0078\ m^2$$

$$A_{CDEGS}=0.0064\ m^2$$

The resistivity is equal to the resistivity of the insulation material

$$\rho=10^{12}\ ohm\ m$$

From the above parameters and Equation 2, the resistance between the branch and the covered conductor is approximately 5.95×10^{11} ohms (Ω).

Since the resistance value of the insulation is much greater than the capacitive reactance value of the insulation, the resistance in parallel with the capacitance can be excluded from the model. Resistive current through the insulation is negligible.

11.7.2 Tree Limb Parameters

The following tree limb parameters were used to model the general case:

1. The length is approximated to 3 feet for PSCAD and 9 feet for CDEGS

$$L_{PSCAD} = 3\ feet = 0.91\ m$$

$$L_{CDEGS} = 9\ feet = 2.74\ m$$

2. The radius of a tree branch is assumed to be 5 cm for PSCAD and 4.5 cm for CDEGS modeling

3. The resistivity is equal to the resistivity of the wood.

ρ=50 ohm-m (Defandorf, Electrical Resistance to Earth of a Tree, 1956)

The resistance of the tree limb can be calculated based on the above parameters and Equation 1.

$$R = \frac{\rho L}{A} \qquad \textbf{\textit{Equation 4}}$$

Where
L is the length of the object [meters]
A is the cross sectional area of the object [$meters^2$]
ρ is the resistivity of the material [ohm meters]

From the above parameters and Equation 1, the resistance between the branch and the covered conductor is approximately 5,800 Ω for both PSCAD and CDEGS models.

11.8 Effects of Electrical Current

Table 13: Effects of Electrical Current on the Human Body (National Institute for Occupational Safety and Health, 2009)

Current	Effect
Below 1 mA	Generally not Perceptible
1 mA	Faint Tingle
5 mA	Slight Shock; Not painful but disturbing. Average individual can let go
6-25 mA (women) 9-30 mA (men)	Painful shock, loss of muscular control. The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated
50-150 mA	Extreme pain, respiratory arrest (breathing stops), severe muscular contractions. Death is possible

11.8 Summary of Results for EDEF

Table 14*: *Summary of Simulated and Empirical Testing Results

Equipment Demonstration Evaluation Facility (EDEF) Test											
						Simulated			Empirical Testing		
Cable Size (AWG)	Test Subject	Moisture Content (%)	Test Subject Resistance @ 5kVDC (MEGOHMS)	Length of Subject (in.)	Diameter of Subject (in.)	CDEGS Tare Current w/out Test Subject (mA)	CDEGS Current with Test Subject (mA)	CDEGS Change in Current with Test Subject (mA)	Tare Current w/out Test Subject (mA)	Current with Test Subject (mA)	Change in Current with Test Subject (mA)
1/ 0	Palm Frond	4.60%	210	45 in.	0.822 in.	0.110	0.115	0.005	0.016	0.017	0.001
1/ 0	Brown Branch	3.60%	4760	49 in.	1.527 in.	0.110	0.116	0.006	0.016	0.015	-0.001
1/ 0	Green Branch	12.20%	1.35	35.5 in.	0.493 in	0.110	0.113	0.003	0.016	0.017	0.001
1/ 0	Animal Contact (728 Ohm Resistor) Ph-Ph	NA	0.000728	36 in.	1 in.	0.110	0.114	0.004	0.016	0.06	0.044
1/ 0	Metallic Balloon	NA	0.000004	NA	18 in.	0.110	0.119	0.009	0.016	0.144	0.128
1/ 0	Conductor-Conductor	NA	NA	102 in.	NA	0.110	0.152	0.042	0.016	0.024	0.008

Workpaper Title:

NEETRAC Report

SCE Covered Conductor Touch Current

NEETRAC Project: 18-025

Test Data

April 23, 2018

Georgia Tech NEETRAC
National Electric Energy Testing, Research and Applications Center

Requested by: Mr. Robert Tucker
Southern California Edison

Principal Investigator: Raymond C. Hill, PE
Lead Engineer – High Voltage Lab

Co-PI & Author: Anil B. Poda
Research Engineer

Reviewed by: Raymond C. Hill, PE

18-025: SCE Covered Conductor Test Cases

1.0 INTRODUCTION

Southern California Edison requested Georgia Tech / NEETRAC ((National Electric Energy Testing, Research & Application Center) to perform laboratory tests and simulation studies on a 12 kV distribution system with overhead insulation covered conductor using WinIGS simulation software.

The study cases performed in this project are described below:

I. Fault Current Analyses

II. SCE System Study Test Cases

III. Laboratory tests on covered conductor and verifying the Laboratory results using WinIGS software

A 20-foot insulated covered conductor sample was provided for testing by Southwire upon SCE's request. The initial measurement (capacitance and reactance) values of the cable were measured at NEETRAC using an LCR meter.

As part of the fault current analyses, a 2 mile long 12 kV distribution system was designed based on the circuit parameters provided by Mr. Robert Tucker of SCE and some assumptions were considered by NEETRAC as shown in Section 5.0. The possible fault currents under different conditions (LL, LLG and SLG) were generated (modeled) at 1 mile from the substation. The results and the measured cable values were reviewed by Mr. Robert Tucker before proceeding with other simulation test cases. The results were comparable with the SCE's system field conditions.

After the fault current analyses, the 12 kV distribution system model was used to simulate several possible field test cases considering bare conductor and insulated covered conductor designs as shown in Section 3.0. In each test case, with a person making bare hand contact, voltage and current were calculated by the software and the test results placed in Table 2.

The insulated covered conductor was tested in the laboratory for two test scenarios as stated in Section 4.0. The laboratory test results were verified using the WinIGS software. The laboratory test results and WinIGS simulated results are placed in Table 3.

Testing and evaluations were performed at the Georgia Tech / NEETRAC Medium Voltage Laboratory in Forest Park, Georgia, USA during the month of April 2018. The preparation and installation of the test setup was performed by NEETRAC personnel.

2.0 SCE SYSTEM FOR FAULT CURRENT ANALYSES

2.1 12 kV System

Phase B conductor is broken in between PWS1 and PWS2 poles.

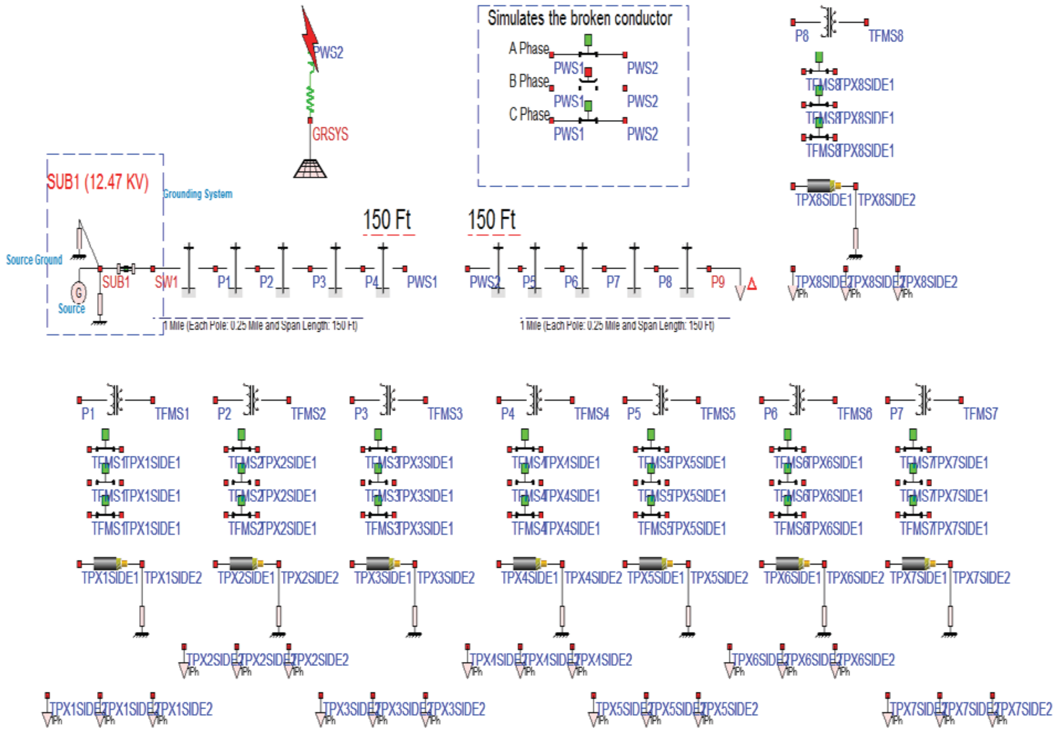


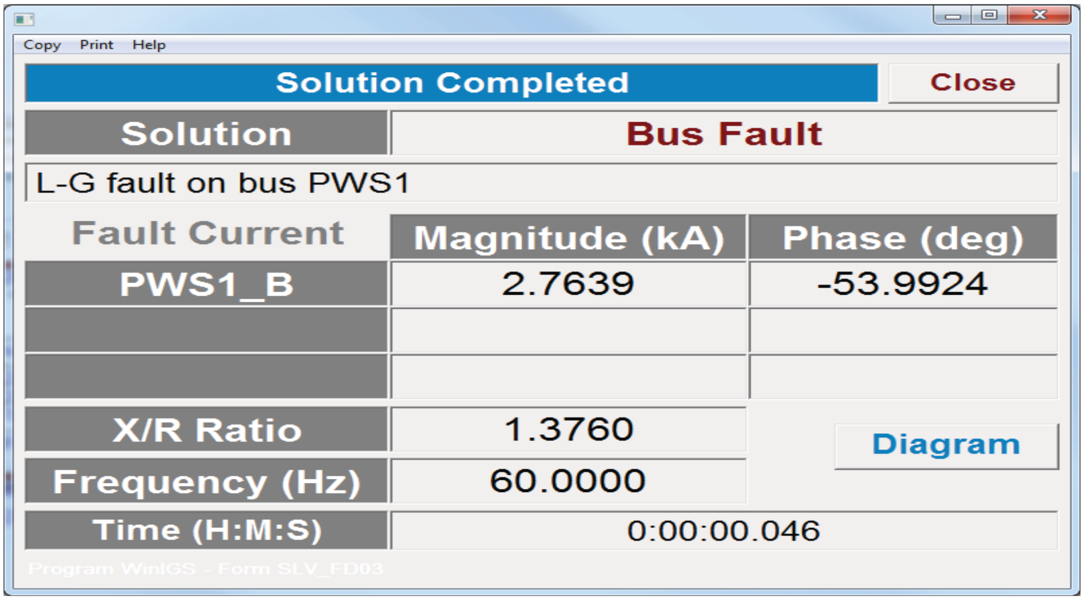
Figure 1: 12 kV System used for Fault Current Analyses

2.2 Fault Currents at 1 Mile from Sub

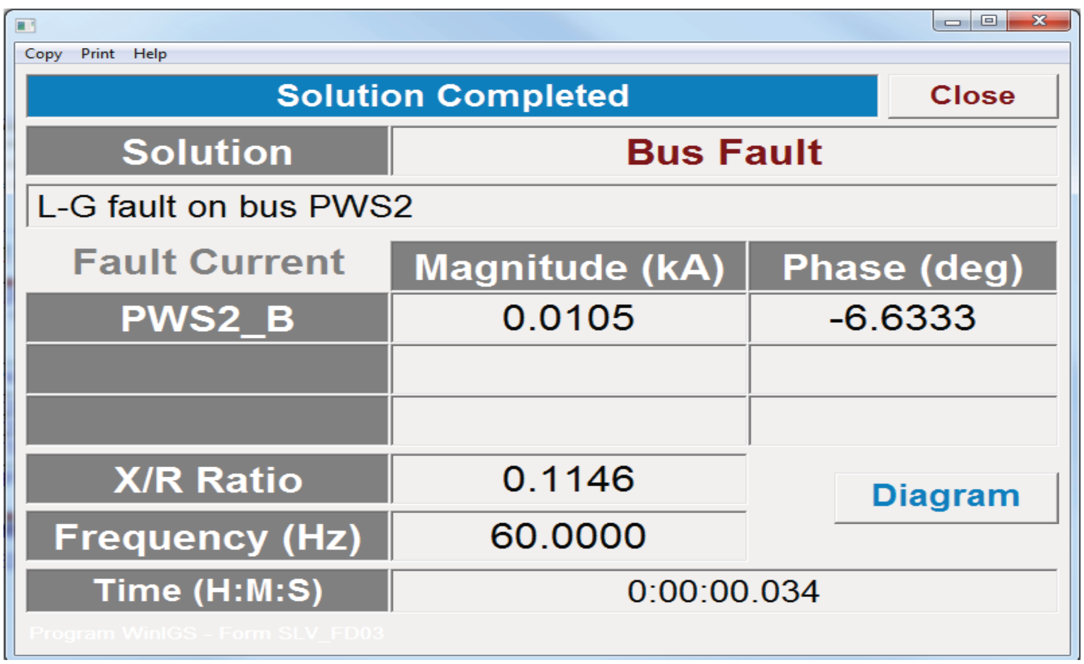
Table 1: Fault Currents Available at 1 Mile from Substation

Fault Type (W.r.to Phase B)	**LLG**	**LL**	**SLG**
Fault Current – Line Side (PWS1)	4.0854	3.7837	2.7639
Fault Current – Load Side (PWS2)	0.0018	0.0027	0.0105
Sequance Impedance	Positive/Negative	Positive/Negative	Zero

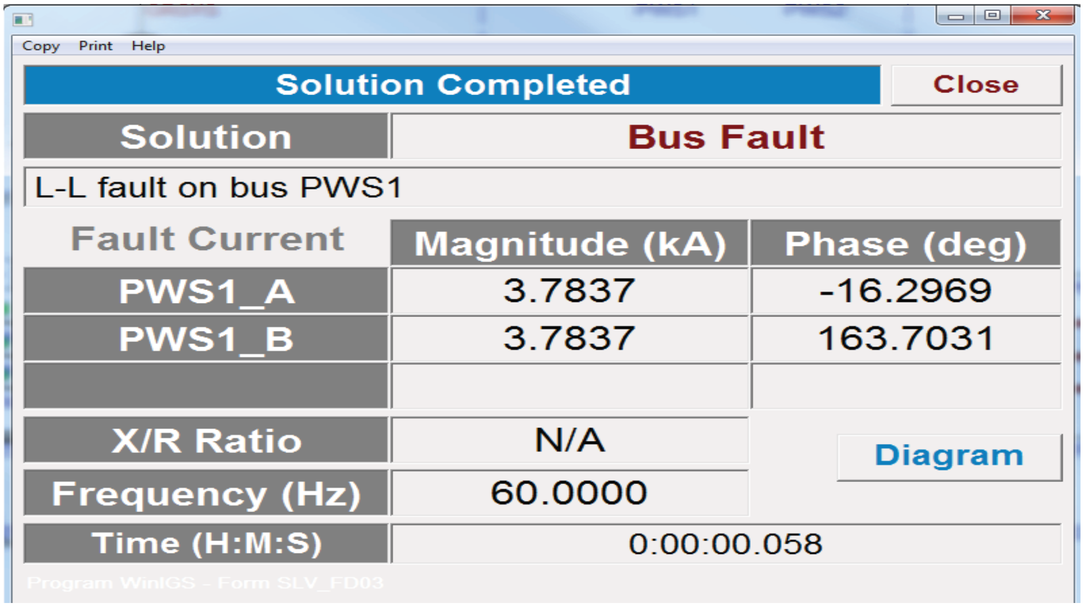
2.3 Zero Sequence - SLG Fault on Line Side: 2.76 KA



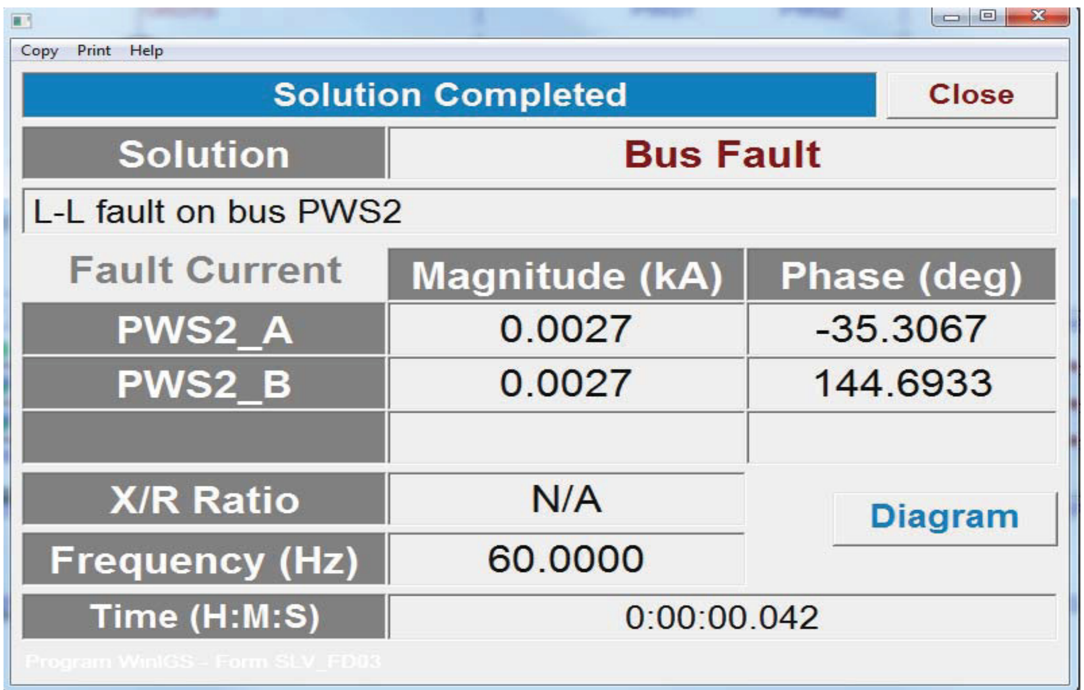
2.4 Zero Sequence - SLG Fault on Load Side: 0.0105 KA



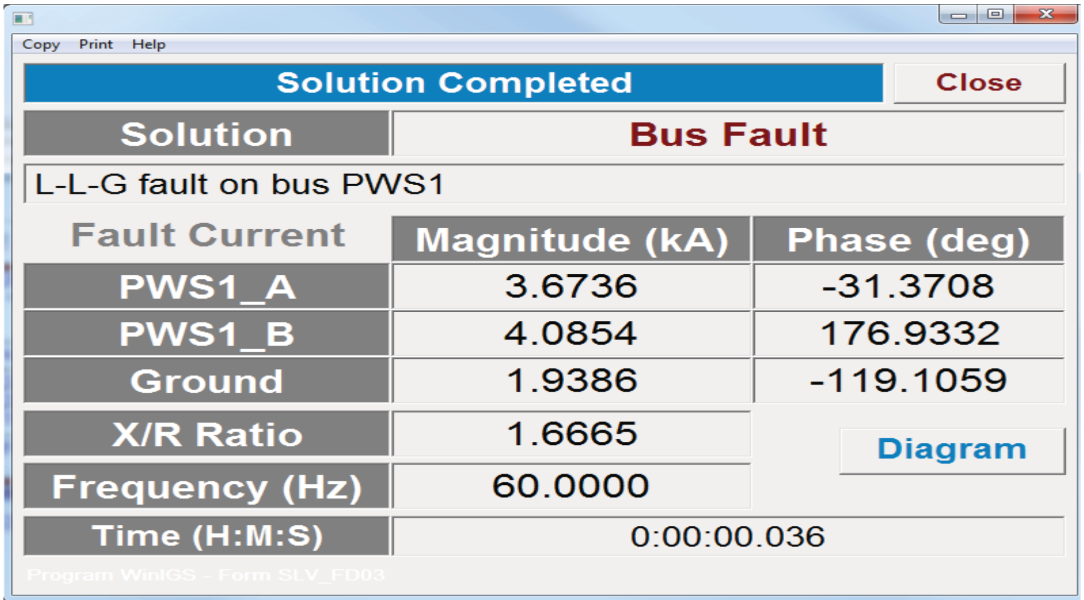
<u>2.5 Positive/Negative Sequence – LL Fault on Line Side: 3.7837 kA</u>



<u>2.6 1.7 Positive/Negative Sequence – LL Fault on Load Side: 0.0027 kA</u>



2.7 Positive/Negative Sequence – LLG Fault on Line Side: 4.0854 kA



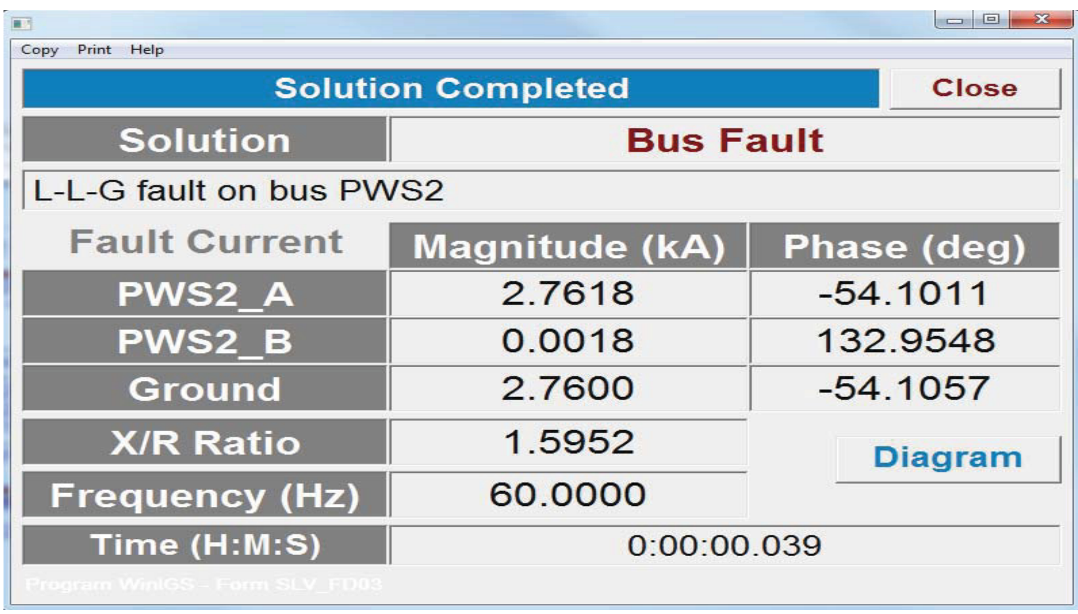
Copy Print Help

Solution Completed | Close

Solution	Bus Fault	
L-L-G fault on bus PWS1		
Fault Current	Magnitude (kA)	Phase (deg)
PWS1_A	3.6736	-31.3708
PWS1_B	4.0854	176.9332
Ground	1.9386	-119.1059
X/R Ratio	1.6665	Diagram
Frequency (Hz)	60.0000	
Time (H:M:S)	0:00:00.036	

Program WinIGS - Form SLV_FD03

2.8 Positive/Negative Sequence – LLG Fault on Line Side: 0.0018 kA



Copy Print Help

Solution Completed | Close

Solution	Bus Fault	
L-L-G fault on bus PWS2		
Fault Current	Magnitude (kA)	Phase (deg)
PWS2_A	2.7618	-54.1011
PWS2_B	0.0018	132.9548
Ground	2.7600	-54.1057
X/R Ratio	1.5952	Diagram
Frequency (Hz)	60.0000	
Time (H:M:S)	0:00:00.039	

Program WinIGS - Form SLV_FD03

3.0 SCE SYSTEM TEST CASES

Test Case 1: Person holding *continuous bare* conductor under normal operating conditions (Figure 2)

Test Case 2: Person holding *continuous insulated* conductor under normal operating conditions (Figure 2)

Test Case 3: Person holding *broken bare* conductor on line side while the conductor is touching the ground (Figure 3)

Test Case 4: Person holding *broken bare* conductor on line side while the conductor is *not* touching the ground (Figure 4)

Test Case 5: Person holding *broken bare* conductor on load side while the conductor is touching the ground (Figure 5)

Test Case 6: Person holding *broken bare* conductor on load side while the conductor is *not* touching the ground (Figure 6)

Test Case 7: Person holding *broken insulated* conductor on line side while the conductor is touching the ground (Figure 3)

Test Case 8: Person holding *broken insulated* conductor on line side while the conductor is *not* touching the ground (Figure 4)

Test Case 9: Person holding *broken insulated* conductor on load side while the conductor is touching the ground (Figure 5)

Test Case 10: Person holding *broken insulated* conductor on load side while the conductor is *not* touching the ground (Figure 6)

Table 2: SCE System – Public Contact Test Case Results

Test Case (Reference)	Person contact W.r.to conductor Description	Person Contact Phase (1 mile from Sub)	Person Contact Voltage	Person Contact Current	Voltage across the Short Conductor[3] (50 Ohm)	Current Flowing through the Short Conductor[3] (50 Ohm)
Case 1 (Figure 2)	Holding continuous bare conductor	Phase A	7.17 kV	7.17 A	-	-
Case 2 (Figure 2)	Holding continuous covered conductor	Phase A	202.5 mV	202.4 µA	-	-
Case 3 (Figure 3)	Holding broken bare conductor touching ground	Phase B – Line Side	6.99 kV	6.99 A	6.99 kV	139.9 A
Case 4 (Figure 4)	Holding broken bare conductor hanging in air	Phase B – Line Side	7.17 kV	7.17 A	-	-
Case 5 (Figure 5)	Holding broken bare conductor touching ground	Phase B – Load Side	0.37 kV	0.37 A	0.37 kV	7.35 A
Case 6 (Figure 6)	Holding broken bare conductor hanging in air	Phase B – Load Side	3.16 kV	3.36 A	-	-
Case 7A (Figure 3)	Holding broken covered conductor while the insulation touching the ground	Phase B – Line Side	9.67 mV	9.67 µA	9.67 mV	193.5 µA
Case 7B (Figure 3)	Holding broken covered conductor while the conductor touching the ground	Phase B – Line Side	198.1 mV	198.1 µA	7.00 kV	140.1 A
Case 8 (Figure 4)	Holding broken covered conductor hanging in air	Phase B – Line Side	203.2 mV	203.2 µA	-	-
Case 9A (Figure 5)	Holding broken covered conductor while the insulation touching the ground	Phase B – Load Side	7.61 mV	7.61 µA	7.61 mV	152.3 µA
Case 9B (Figure 5)	Holding broken covered conductor while the conductor touching the ground	Phase B – Load Side	10.88 mV	10.88 µA	384.8 V	7.695 A
Case 10 (Figure 6)	Holding broken covered conductor hanging in air	Phase B – Load Side	159.9 mV	159.9 µA	-	-

Note:
1. Capacitance of the covered conductor with two hand contact: 75 pF
2. Calculated reactance value using the measured capacitance = $1/(2\pi fC)$ = 35.37 MΩ
3. Short Conductor – Small portion of the conductor touching the ground in parallel with the person holding the conductor.

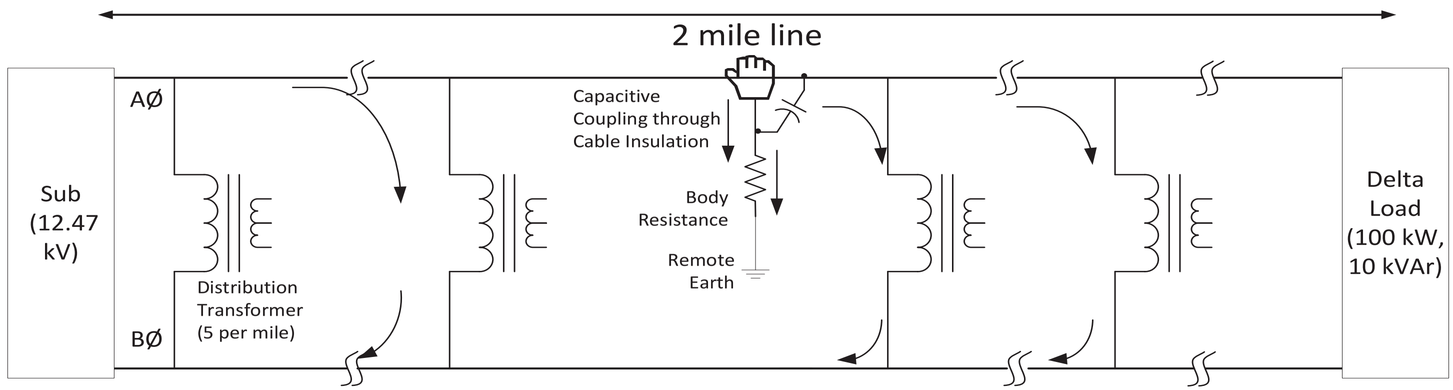


Figure 2: Simulation Scenario for Test Cases 1 & 2

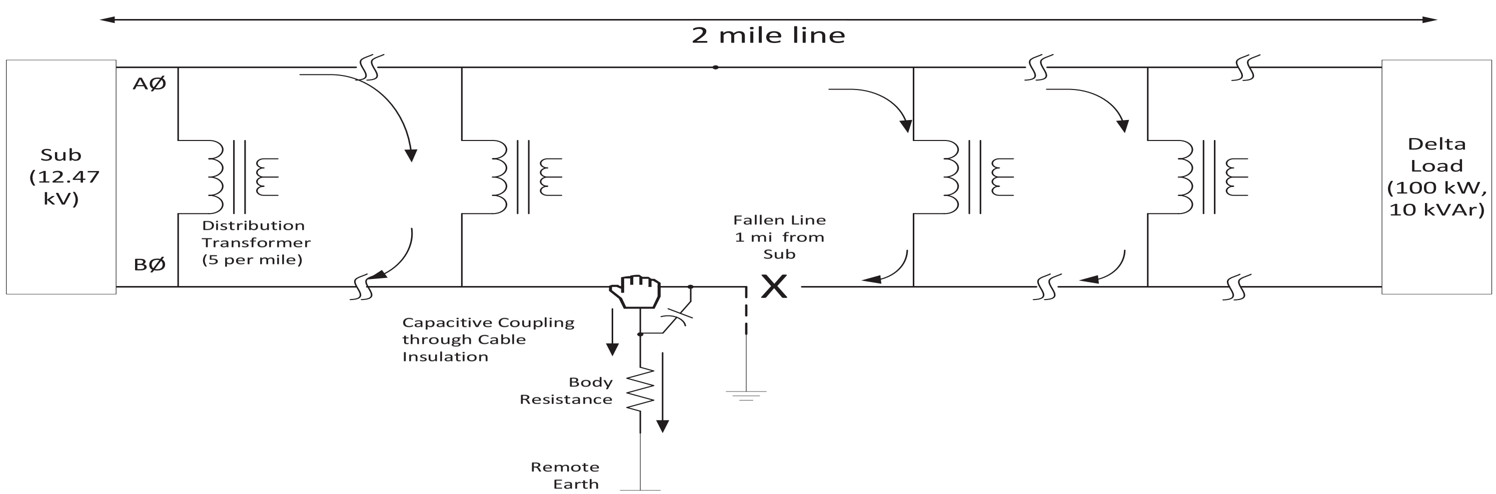


Figure 3: Simulation Scenario for Test Cases 3 & 7

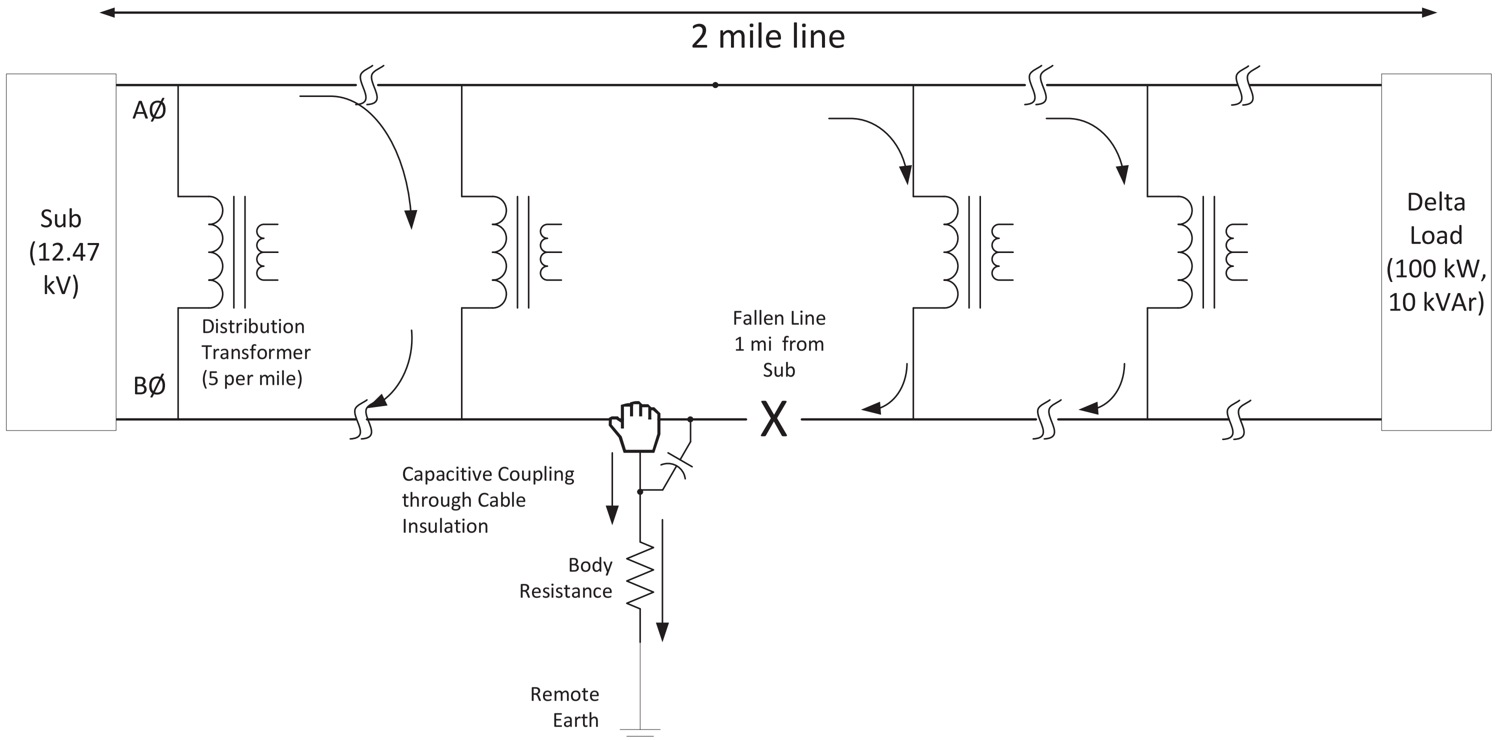


Figure 4: Simulation Scenario for Test Cases 4 & 8

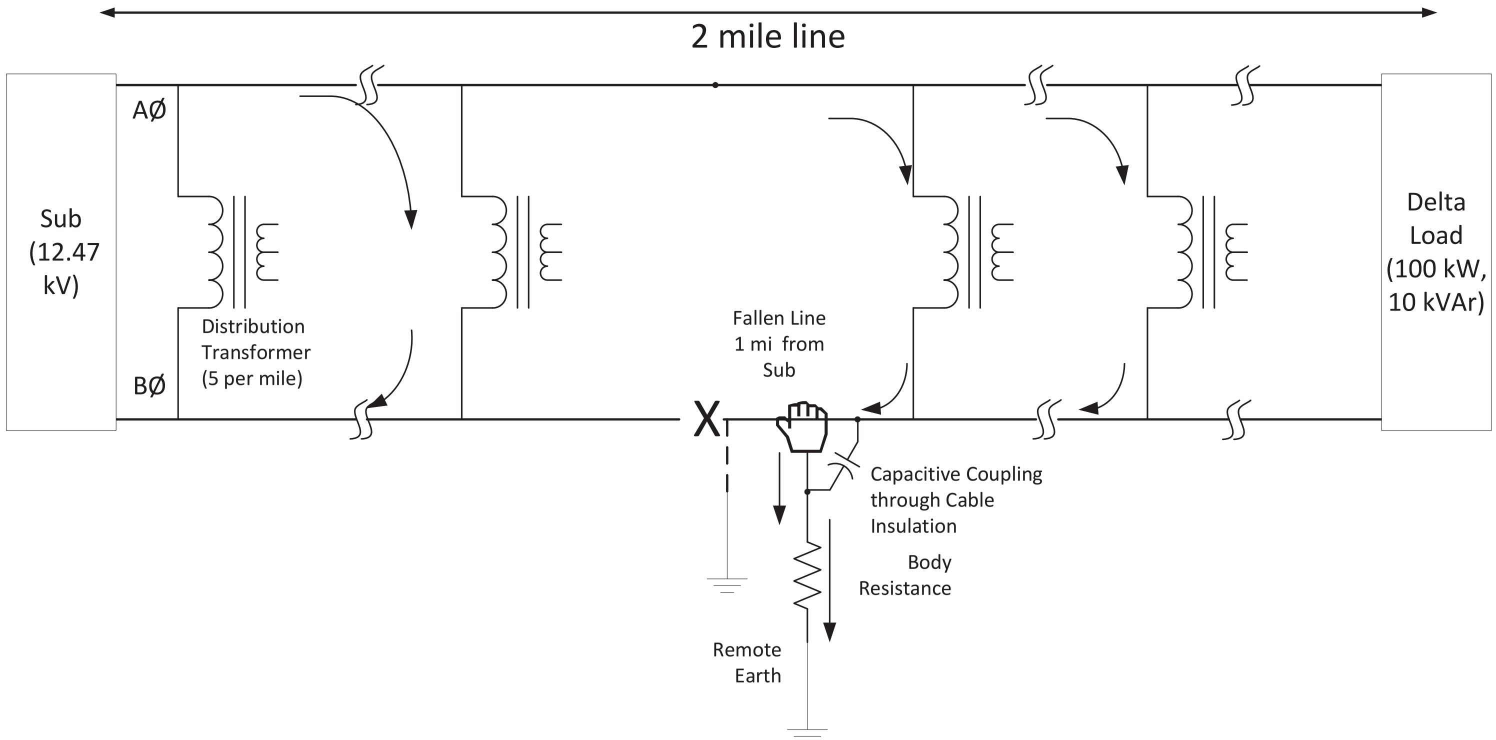


Figure 5: Simulation Scenario for Test Cases 5 & 9

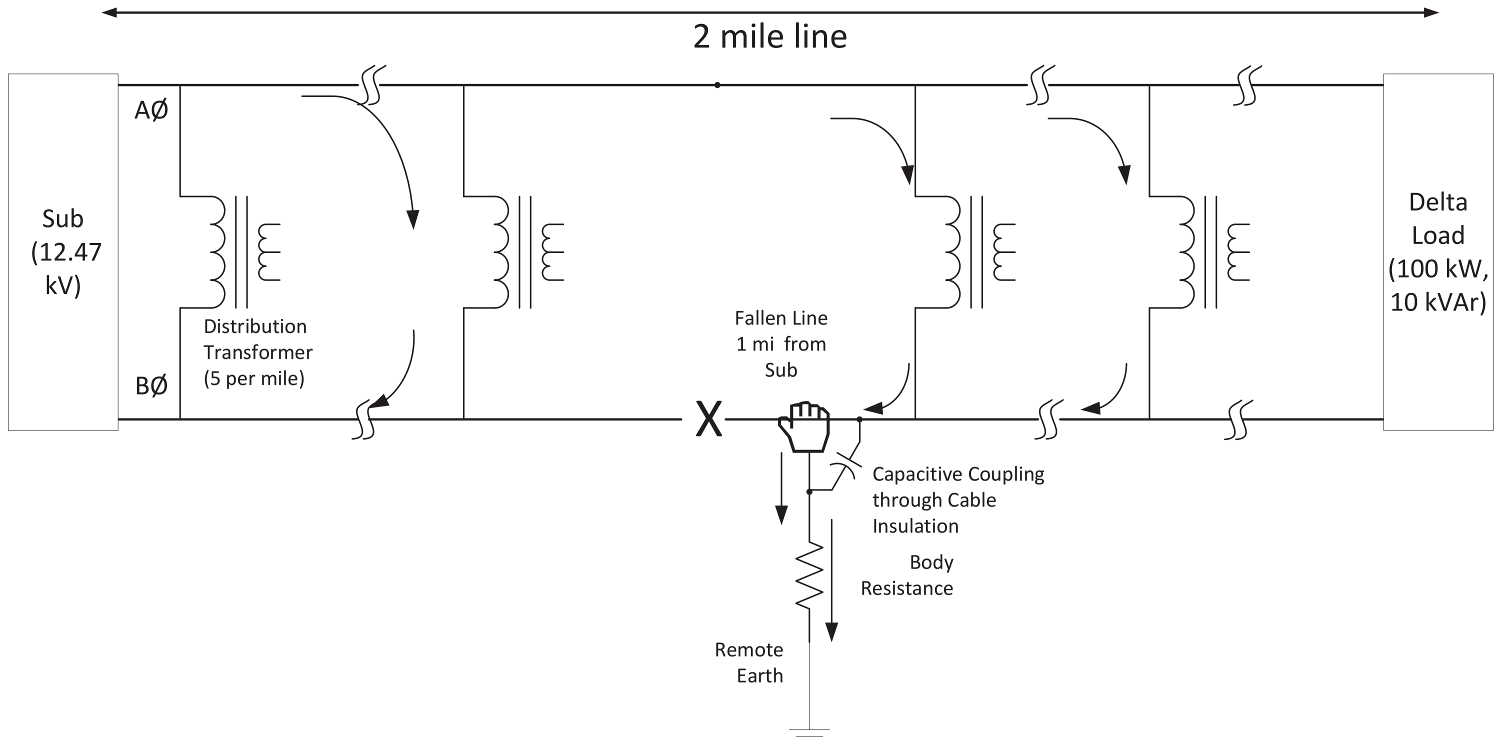


Figure 6: Simulation Scenario for Test Cases 6 & 10

4.0 LABORATORY SYSTEM TEST CASES

The below test cases were simulated in WinIGS software and the results are compared with actual laboratory test results.

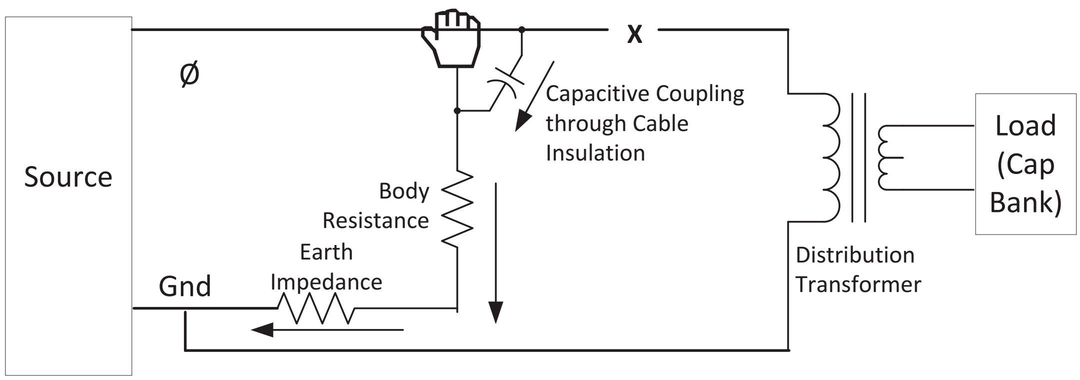


Figure 7: Simulation Scenario for Test Cases 11 & 12

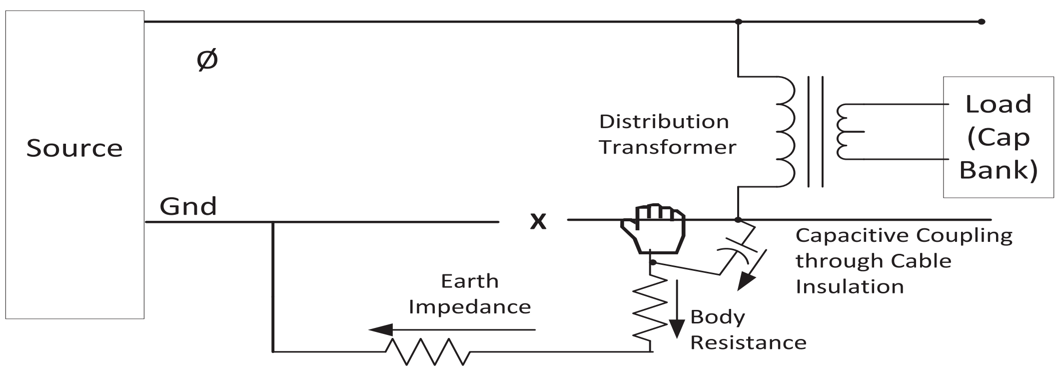


Figure 8: Simulation Scenario for Test Cases 13 & 14

Test Case 11: Person holding *broken bare* conductor on line side (Figure 7)

Test Case 12: Person holding *broken insulated* conductor on line side (Figure 7)

Test Case 13: Person holding *broken bare* ground wire on load side (Figure 8)

Test Case 14: Person holding *broken insulated* ground wire on load side (Figure 8)

***Note:** ground wire – return neutral conductor connected between the distribution transformer and source ground in air for the lab test case. In the field (SCE system), this would be another phase conductor since the line leaving the SCE substation is a delta.

Table 3: Person Contact Current measured using Laboratory test Setup

Test Case (Reference)	Person contact W.r.to conductor Description	Person Contact Phase (1 mile from Sub)	Person Contact Current measured in Lab	Person Contact Current measured through WinIGS Simulation Software
Case 11 (Figure 7)	Holding *broken bare* conductor	Line Side	-*	5.3 A
Case 12 (Figure 7)	Holding *broken covered* conductor	Line Side	227 µA	220 µA
Case 13 (Figure 8)	Holding *broken bare* ground wire connected through transformer primary	Load Side	-*	34.2 mA
Case 14 (Figure 8)	Holding *broken covered* ground wire connected through transformer primary	Load Side	227 µA	218 µA

Note: * - Bare conductor test cases were not performed in the Laboratory.

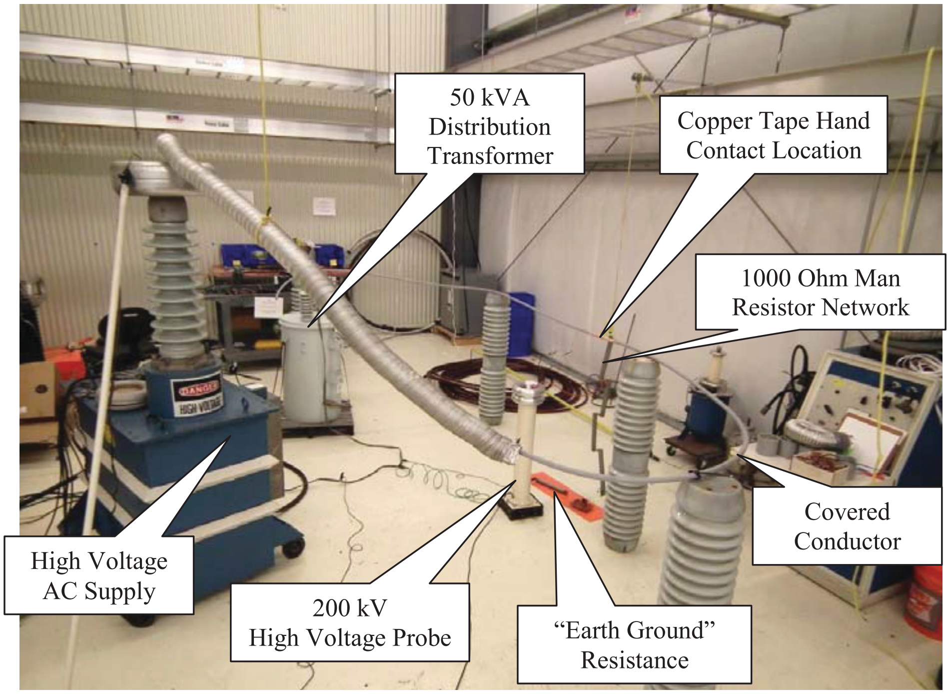


Figure 9: Laboratory Test Setup

5.0 ASSUMPTIONS

For the purpose of computer modeling, the following general assumptions are made. Additional assumptions or changes specific to individual simulations are as noted in the figures and tables.

- The 12.47 kV source substation is represented with positive sequence impedance - R1=0.018 pu & X1=0.311 pu, Negative sequence impedance - R1=0.008 pu & X1=0.221 pu, $R_{ground\ grid}$ = 1 Ω and $Z_{1TL+1feeder}$ = 0.15+j 0.65Ω.

- All of the line configurations and dimensions were used based SCE's suggestion of having a "Horizontal Cross-arm Distribution Pole without Neutral" configuration.

- Phase conductor sizes for the three phase circuit are AWG #1/0 ACSR.

- Approximately five transformers per mile are installed. The secondary side of the transformer is connected to three different housing loads (A-N @ 10 kW,1 kVAR, B-N @ 10kW, 1 kVAR and A-B @ 20 kW, 2 kVAR) through an insulated copper wire.

- Person Body Resistance = 1000 Ω (two hand grip)
- For laboratory test cases, earth impedance = 250 Ω.

6.0 EQUIPMENT

100 kV Biddle Transformer Set	CN-4022
Phenix 200 kV AC/DC KVM Probe	CQ-2251
Hewlett Packard LCR Meter	CQ-2195
Fluke Multi-meter	CQ-6806

Workpaper Title:

SCE Summary of NEETRAC Test Report for Covered Conductor Touch Current

SCE Summary of NEETRAC Test Report for Covered Conductor Touch Current

This document summarizes the results of the Covered Conductor Touch Current NEETRAC Report.

Prepared by Southern California Edison, Apparatus and Standards Engineering

I. Introduction

This document was prepared by SCE to summarize a SCE commissioned test performed by the National Electric Energy Testing, Research and Applications Center (NEETRAC) on covered conductor touch current to validate that covered conductor reduces charging current. This summary supports representations regarding human contact with covered conductors. In particular, the insulating cover on covered conductor reduces the charging current enough to be generally not perceptible during human contact with the cover of energized covered conductor; contact with energized bare conductor wire can result in electrocution.[1]

II. Effects of Electrical Current on the Human Body

The charging current test results can be compared to generally accepted benchmarks on the effects of human contact with different current levels:

Table 1: Effects of Electrical Current (Center for Disease Control, 2009)

Current	Effect
Below 1 mA	Generally not Perceptible
1 mA	Faint Tingle
5 mA	Slight Shock; Not painful but disturbing. Average individual can let go
6-25 mA (women) **9-30 mA (men)**	Painful shock, loss of muscular control. The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated
50-150 mA	Extreme pain, respiratory arrest (breathing stops), severe muscular contractions. Death is possible

III. Covered Conductor vs. Bare Conductor Touch Currents

A. Test Cases

The following are covered conductor test cases that were simulated and laboratory tested by NEETRAC:

- Person holding broken covered conductor on **line side**[2]
- Person holding broken covered conductor on **load side**[3]

The following are bare conductor test cases that were simulated by NEETRAC:

[1] See Table 2: NEETRAC Results
[2] Test Case 12 on NEETRAC Report
[3] Test Case 14 on NEETRAC Report

- Person holding broken bare conductor on **line side**[4]
- Person holding broken bare conductor on **load side**[5]

Note that bare conductor test cases were not performed in the laboratory.

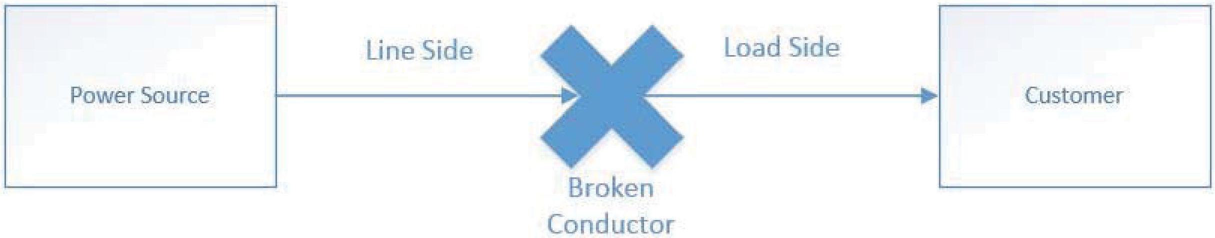


Figure 1: Line side and Load side Diagram

B. Test Results

Test Information:

- Conductor: 1/0 Covered Conductor
- Source: 12.447 kV
- Test Results: Human contact current measured

Table 2: NEETRAC Test Results (See NEETRAC Report, page 15)

	Covered Conductor		**Bare Conductor**
	Simulation Results (Theoretical Value)	Lab Test Results (Actual Values)	Simulation Results (Theoretical Value)
Line Side	0.220 mA	0.227 mA	5,300 mA
Load Side	0.218 mA	0.227 mA	34.2 mA

Table 2 summarizes the results for test cases 11 through 14 in the NEETRAC report. The small difference between the simulation and laboratory test values demonstrate the accuracy of the simulation. Although the bare conductor test cases were not laboratory tested, the results of the simulation are comparable to real-world values.

For additional details, refer to the appended NEETRAC Report. Note that covered conductor current values in the report are provided in microamps (µA). To convert microamps to milliamps (mA), the values must be multiplied by 0.001. Additionally, bare conductor current values may be denoted in Amps (A). To convert Amps to milliamps, the values must be multiplied by 1000.

[4] Test Case 11 on NEETRAC Report
[5] Test Case 13 on NEETRAC Report

IV. Summary

The data show that charging currents on covered conductors are below 1 mA as represented within Section (IV)(B)(1)(e) at page 58. Human contact with this current is generally not perceptible whereas human contact with the charging current of bare wire can result in electrocution.

V. References

Center for Disease Control. (2009). Electrical Safety, Safety and Health for Electrical Trades Student Manual. Retrieved from CDC: https://www.cdc.gov/niosh/docs/2009-113/pdfs/2009-113.pdf

NEETRAC. (2018). SCE Covered Conductor Touch Current. Georgia Tech Research Corporation.

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

Proceeding Number: A.19-08-013
Proceeding Name: SCE's 2021 GRC
Exhibit Reference: TURN-02 Wildfire Poles

Date: May 19, 2020

Responses Due: May 26, 2020 (requested expedited response date)

Witness: Eric Borden

Originated by:
Martin Collette
Southern California Edison Company
8631 Rush Street
Rosemead, CA 91770
(626-302-5328), (310-880-4070)
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Cc:
Douglas.Snow@sce.com
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scegrc@sce.com

Data Request No: **SCE-TURN-012-MC**

Please note that we are requesting an expedited response. We apologize for the inconvenience, but with the short turn around for rebuttal, and we have attempted to pose a limited scope in the requests, we hope that it will be feasible.
Please provide the following items:

Questions:

1. Regarding TURN's testimony in Exhibit TURN-02 at page 24, please provide all data, calculations, analysis, and worksheets supporting its proposal's assumption that SCE can utilize fire retardant wrapping instead of composite poles 75% of the time.

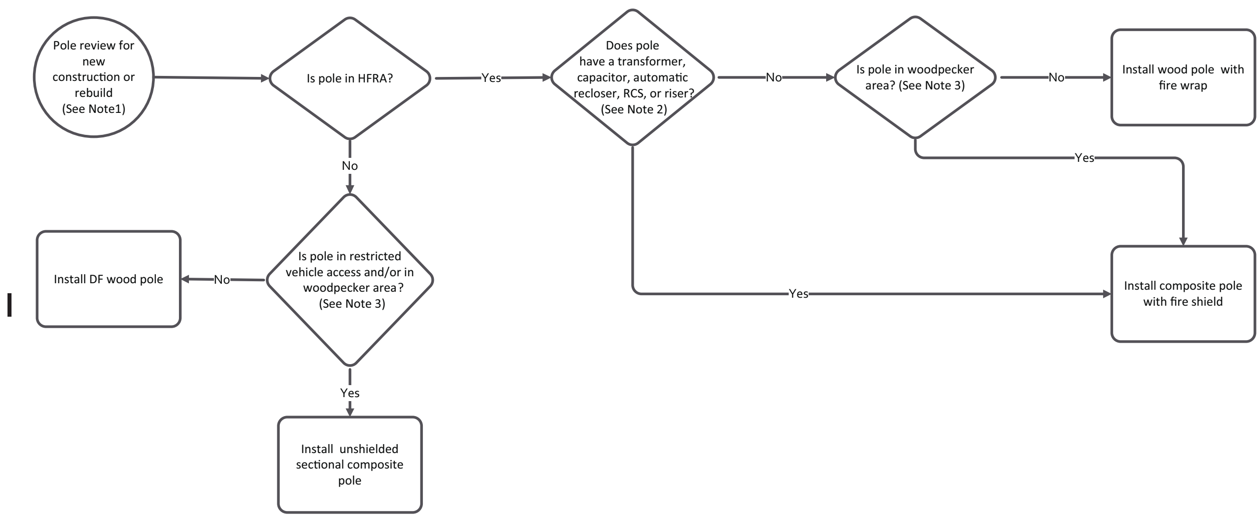
Provide electronic responses if possible. All data responses need to have each page numbered, referenced, and indexed so worksheets can be followed. If any number is calculated, include a copy of all electronic files so the formula and their sources can be reviewed.

If you have any questions regarding this DR, please call originator at above phone number.

Response:

SCE stated in its Wildfire Mitigation Plan at page 5-4 that "fire-resistant pole-wrapping technology is a cost-effective alternative to installing fire-resistant composite poles when the probability of an ignition at the pole is low (i.e., no electrical equipment on the pole and/or not a woodpecker area). In 2020, SCE will continue installing the fire-resistant wrap/barrier on new treated wood poles in HFRA when these criteria are met." TURN does not have any additional calculations or workpapers that have not already been provided to SCE.

Figure 10–2: Pole Decision Tree for New Construction and Rebuilds in HFRAs



Note(s):

1. The decision tree applies to new primary pole lines and pole replacements only.
2. Equipment that do not have ground attachments to the pole will be installed on wood pole with fire wrap.
3. This decision box is also applicable to animals, insects, fungus, moisture, and other severe environmental conditions.

Forecast - Covered Conductor (Capital)

SCE's Rebuttal Position

(Constant 2018 $000s)

	2019	2020	2021	2022	2023	Total
Covered Conductor cost per Circuit Mile	$ 421	$ 421	$ 421	$ 421	$ 421	
Covered Conductor Circuit Miles	291	1,000	1,400	1,600	1,900	6,191
Covered Conductor	$ 122,733	$ 421,185	$ 589,659	$ 673,896	$ 800,252	$ 2,607,725
Escalation	*1.04*	*1.08*	*1.11*	*1.15*	*1.18*	
Covered Conductor (Nominal $000s)	**$ 127,465**	**$ 454,369**	**$ 656,353**	**$ 771,815**	**$ 942,892**	**$ 2,952,893**
Fire Resistant Poles Unit Cost	$ 3	$ 3	$ 3	$ 3	$ 3	
# of Fire Resistant Poles	3,410	11,700	16,381	18,721	22,231	72,442
Fire Resistant Poles	$ 10,236	$ 35,126	$ 49,177	$ 56,202	$ 66,740	$ 217,481
Escalation	*1.04*	*1.08*	*1.11*	*1.15*	*1.18*	
Fire Resistant Poles (Nominal $000s)	**$ 10,630**	**$ 37,894**	**$ 54,739**	**$ 64,368**	**$ 78,636**	**$ 246,268**
Total CC and FR Poles	$ 132,969	$ 456,311	$ 638,836	$ 730,098	$ 866,991	$ 2,825,206
Total Covered Conductor (Nominal $000s)	**$ 138,096**	**$ 492,262**	**$ 711,092**	**$ 836,183**	**$ 1,021,528**	**$ 3,199,161**

Fire Resistant Wrap Unit Cost (2018$ 000s)	1.610
Fire Resistant Composite Poles Unit Cost (2018$ 000s)	5.090

Forecast Summary- Wildfire Covered Conductor Program (Capital)

SCE's Rebuttal Position

(Nominal $000s)

	2019	2020	2021	2022	2023	Total
Total Tree Attachment Remediation Costs	10,847	15,183	21,932	25,790	31,507	105,260
Total Covered Conductor Costs[1]	138,096	492,262	711,092	836,183	1,021,528	3,199,161
Total (CAP)	**148,943**	**507,445**	**733,024**	**861,973**	**1,053,035**	**3,304,421**

1. See "Forecast - Covered Conductor (Capital)"

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET C U E - S C E - 0 0 1

To: CUE
Prepared by: Brent Fielder
Job Title: Principle Manager
Received Date: 3/25/2020

Response Date: 4/8/2020

Question 01.a-b:
Regarding the statement (Ex. SCE-01, Vol. 1, p. 11:17-19):
"We have effectively managed our processes to work more efficiently and we face real-world resource constraints driven by the need to address and mitigate emergent risks related to wildfires."

a. Please provide any and all support for: "…we face real-world resource constraints driven by the need to address and mitigate emergent risks related to wildfires." Please include any quantitative studies or estimates along with back up for those quantitative estimates that support this statement.
b. What has SCE done to address these "resource constraints" including but not limited to multi-year or multi-GRC planning, apprenticeship programs, employee recruitment and retention efforts, and more efficient deployment of existing resources.

Response to Question 01.a-b:

a. Please provide any and all support for: "…we face real-world resource constraints driven by the need to address and mitigate emergent risks related to wildfires." Please include any quantitative studies or estimates along with back up for those quantitative estimates that support this statement.

Considering the work required to maintain and operate the electric system, and the need to immediately and substantially address wildfire risk, SCE undertook an effort to examine how SCE could modify the allocation of available resources to rapidly and effectively deploy wildfire mitigation programs. SCE found that, in many cases, the same resources that are required to support wildfire mitigation activities are responsible for implementing SCE's traditional infrastructure replacement work. These resources are finite, and SCE faces real resource constraints. SCE evaluated these constraints by estimating the potential increase in execution capacity associated with adding additional SCE and contract resources to the extent possible. SCE assumed that we could grow the execution workforce by ~10%-20% per year in 2019 and 2020. For example, this translated to a potential increase of up to 100 electrical crews in 2019 alone. However, it is important to note that other resources (e.g., engineers, planners, support personnel) were a comparable problem. SCE assumed these growth rates would diminish over time and would stabilize to between 5%-7.5% per year in 2021-2023. SCE notes that these assumptions were developed based on historical experience and subject matter expertise. Through this evaluation, SCE recognized that it couldn't grow the workforce fast enough to meet the demands of the wildfire program.

As such, and in light of assessing overall grid and societal needs, SCE made a conscious decision to pursue important system augmentation, infrastructure replacement, and load growth activities at a slower pace for the near future in order to divert necessary resources to implement higher safety risk reduction wildfire mitigation work. SCE is mindful of its responsibility as stewards of customer funding and has put forward a request in this 2021 GRC that provides significant immediate and longer-term value while maintaining affordability for customers. SCE performed a risk analysis to evaluate the public safety impacts of shifting resources from traditional infrastructure replacement programs to wildfire mitigation work. This analysis shows the safety benefit gained through the enhanced portfolio of wildfire mitigation exceeds the safety reduction in other risk initiatives, specifically contact with overhead conductor and underground equipment failure risks (which are further described in SCE's 2018 RAMP Report).

For additional discussion on SCE's resource constraints and the allocation from traditional IR programs to wildfire see SCE-02 Volume 1, Part 1 Distribution Infrastructure Replacement, SCE-01 Volume 2 pp. 24-25 Risk-Informed Strategy & Business Plan, and SCE-04 Volume 5 Wildfire Management.

b. What has SCE done to address these "resource constraints" including but not limited to multi-year or multi-GRC planning, apprenticeship programs, employee recruitment and retention efforts, and more efficient deployment of existing resources.

SCE has and is continuing to analyze operational data and modify its planning and deployment approaches to help improve performance in 2020 and beyond through multi-year planning. SCE will continue to realign existing resources to support heavily impacted work areas. SCE plans to add additional crews beginning in 2021 to increase SCE crew capacity across various work types through hiring groundman and other entry level positions and continues to have an active apprenticeship program. SCE will continue to keep its crews fully scheduled with work, which may include covered conductor work. Scope of work exceeding regional capacity of SCE crews are generally completed by contractors.

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET P u b A d v - S C E - 0 7 0 - T L G

To: Public Advocates Office
Prepared by: Kristi Gardner
Job Title: Manager
Received Date: 1/10/2020

Response Date: 1/27/2020

Question 01.d.1-3:
Referring to Exhibit SCE-04, Vol. 5A, page 5, SCE forecasts $105.447 million for its Wildfire Management O&M expenses for TY 2021.

d. Referring to page 53, Figure II-18, SCE forecasts $3.354 million for its Organizational Change Management (OCM) O&M expenses in the TY.

1) Referring to page 52, lines 4-6, SCE states its OCM "is a program focused on helping to identify and manage the effect of necessary changes to business processes, systems and tools, job roles, policies and procedures, and other areas that may have a corresponding impact to resources." SCE does not show any recorded expenses for 2014-2018.

Provide documentation that explains in detail and demonstrates specifically why SCE's management was unable to successfully utilize authorized funding to effectively and efficiently establish "a program focused on helping to identify and manage the effect of necessary changes to business processes, systems and tools, job roles, policies and procedures, and other areas that may have a corresponding impact to resources" during 2014-2018.

2) If SCE's management requested funding during 2014-2018 for Organizational Change Management activities that included the same or similar programs to help it focus "on helping to identify and manage the effect of necessary changes to business processes, systems and tools, job roles, policies and procedures, and other areas that may have a corresponding impact to resources," provide the number of employees working on this activity, the number of business units/GRC Activity, recorded expenses and the accounts were the costs were recorded.

3) Provide documentation that explains in detail and demonstrates specifically why SCE's management is unable to reallocate funding already included in rates for its OCM activities in the TY associated with "employee and other stakeholder communications, engagement, training coaching, development, feedback, monitoring, and advocacy."

Response to Question 01.d.1-3:

QUESTION 01.d.1 RESPONSE: SCE did not have authorized funding for 2014-2018 as Wildfire Management was a new program in 2018. When the program was initiated in 2018, SCE started its OCM efforts using internal resources and 1 external OCM consultant which was funded through 2018 GRC-authorized funding (approx. $173,400).

QUESTION 01.d.2 RESPONSE: SCE's management did not request funding during 2014-2018 for the same or similar OCM activities as described in response to question 01.d.1 above.

QUESTION 01.d.3 RESPONSE: Unless specifically prohibited by Commission precedent, statute, or other applicable restriction, SCE management has discretion to allocate authorized funds to programs and activities that are most important to effectively serve customers, including to adapt to emergent needs or react to unforeseen exogenous events. It has not been SCE's typical practice to trace funds that it re-allocated. SCE manages its budgets based on the authorized revenue requirement which follows the Commission's adopted forecast of capital expenditures, O&M expenses, depreciation, escalation rates, etc. Actual costs incurred in any particular program or project may vary from what was forecast because the 2018 GRC forecasts were developed in 2016, several years before the Commission authorized SCE's forecast in D.19-05-020. Moreover, SCE's programs necessarily adapt when emergent needs arise, new or better data becomes available, external factors impact SCE, unforeseen changes to the system occur, new or modified compliance requirements are introduced, etc. Please see SCE-06, Volume 2, for additional detail on SCE's capital allocation process.

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET PubAdv-SCE-014-TLG

To: Public Advocates Office
Prepared by: Martin Collette
Job Title: Principal Advisor
Received Date: 3/11/2020

Response Date: 3/19/2020

Question 03 Supplemental:
Referring to Exhibit SCE-02, Vol. 6, page 11, lines 4-8, SCE states that it "encountered operational challenges associated with the performance of existing contractor resources" which resulted in additional expenses. Provide documentation that demonstrates the detailed calculation and breakdown of all line item costs associated with the increased costs (i.e., moving work crews, retaining incremental contractor trimmers, etc.) associated with the operational challenges for 2018 and 2019 (as of October 2019)..

Response to Question 03 Supplemental:
SCE responded to this question on November 13, 2019 with an explanation that the requested documentation showing the breakdown of recorded costs into a specified set of line items could not be provided as a result of SCE's accounting systems not recording costs in that manner. This response remains accurate.

The Public Advocates Analyst responsible for this data request (PubAdv-SCE-014-TLG) recently initiated a conversation with the SCE Senior Manager listed as the Preparer for the original response. SCE understands that this was a request for additional information on two questions in the data set, both of which pertain to recorded costs in 2018. SCE provides in this supplemental response additional material on 2018 activities and costs incurred in 2018 and 2019 and is germane to the general topic of recorded costs for Routine Vegetation Management.

With regards to these 2018 recorded costs for Vegetation Management, SCE recently filed its 2021 GRC Track 2 supplemental testimony ("Track 2 Testimony"). This testimony seeks recovery of incremental costs incurred in 2018 and 2019 for various Fire Hazard Prevention/Wildfire activities, including Vegetation Management. SCE has attached the Track 2 Testimony to this supplemental response and points specifically to the discussion of Vegetation Management in pages 28-43 (see "Attachment Supplemental Question 3 PubAdv-014-TLG Track 2 Testimony"). The discussion found in these pages elaborates more on the activities and increased scope resulting from new regulations leading to operational enhancements, the changes in the supplier market for vegetation management activities (i.e. vegetation assessment/trim/removal activities), and the management challenges SCE faced in rapidly escalating and enhancing its Vegetation Management Program in 2018 and 2019. This material is pertinent to, and supports, the discussion of recorded costs found in

SCE-02, Volume 6A.

PUBLIC ADVOCATES OFFICE
DATA RESPONSE
Southern California Edison Company Test Year 2021 General Rate Case
A.19-08-013

Date: 5 May 2020

Origination Date: 27 April 2020

Response Due: **5 May 2020**

To: Martin Collette, Martin.collette@sce.com

cc: Douglas.Snow@sce.com
Russell.Archer@sce.com
scegrc@sce.com

From: Truman Burns, Project Coordinator
Public Advocates Office
505 Van Ness Avenue, Room 4104
San Francisco, CA 94102 txb@cpuc.ca.gov

Response by: Tamera Godfrey
Phone: 415-703-1367
Email: tamera.godfrey@cpuc.ca.gov

Data Request No: SCE-PubAdv-010-MC

SCE Questions:

1. At page 64 of PAO, Cal Advocate state "The Public Advocates Office removed the following sub-activities from its Wildfire Management TY recommendation: EOI Inspections – Distribution of $9.626 million, EOI Repairs – Transmission of $6.648 million, and EOI – Repairs of $14.554 million". The remainder of the testimony discusses Distribution Overhead Inspections and Distribution Preventive and Breakdown Maintenance expenses, but does not mention EOI Repairs- Transmission..

    a. Please identify which sections of the testimony provide an explanation and basis for Cal Advocates proposal to remove the EOI Repairs – Transmission sub-activity. If there is no explanation included in Cal Advocates testimony for setting test year funding for the EOI Repairs – Transmission sub-activity at zero, please explain the omission. If some material was inadvertently left out, please provide the missing testimony.
    b. Is it Cal Advocates position that Transmission repairs for EOI are identified through Distribution Inspections? If the answer is no, please explain where Cal Advocates believe how Transmission Repairs are identified.
    c. At page 67 of PAO-6 in discussing EOI, Cal Advocates state that it "also considers

SCE's TY forecasts in other areas of its T&D organization for the same proposed TY activities,".Iis it Cal Advocates assertion that SCE has requested funding in other parts of its GRC request to perform repairs on the Transmission system resulting from EOI? If so, please state which activity within SCE's request Cal Advocates is referring to.

2. Regarding the statement on POA-6, page 63, lines 21-24 "SCE's rates also include costs for its Program Management Office that was created in 2018 that can be reallocated or activities consolidated, this program provides "oversight for all wildfire mitigation activities." Please provide what specific costs that can be reallocated with all additional analysis supporting Cal Advocates' position.
3. Regarding the statement on POA-6, page 63, lines 19-20 "SCE's rates include costs incurred for IT projects that have been completed, closed or eliminated…". Please provide what specific projects that Cal Advocates is referring to for completed projects, closed projects, and eliminated projects. Please also identify the years the projects were completed, closed, or eliminated.
4. Prior to filing the testimony on Enhanced Overhead Inspections, did Cal Advocates review Advice Letter 4031-E (cited at page 56, SCE-04, Vol. 5A)?
    a. If the answer is yes, please explain how this informed the conclusion Cal Advocate draws at pages 64-65 of PAO-6 that "SCE's historical expense (2014-2018) for its Distribution Preventive and Breakdown O&M Maintenance and its Distribution Overhead Detailed Inspections organizations have cost embedded in rates for performing the same inspection and maintenance activities as proposed by SCE's newly organized Wildfire Management Program".
    b. If the answer is no. please explain why Cal Advocates determined that the material in Advice Letter 4031-E was not pertinent to the analysis they were conducting in review of SCE's EOI proposals.

Public Advocates Office Response:

Q.1.a-c
As discussed on page 27 of Exhibit PAO-6, the Public Advocates Office mentions that SCE's Transmission Grid is responsible for "performing annual patrols, planned and unplanned inspections and maintenance on overhead and underground transmission lines, insulator washing, road and rights-of-way maintenance and maintenance on its telecommunication network." On page 28, the Public Advocates Office mentions the activities included in SCE's TY forecast and its recommendation of $29.169 million.

SCE's sub-activities for Transmission Line Patrols and Transmission O&M Maintenance include recorded expenses and forecasts for activities associated with Enhanced Overhead Inspections (EOI). In SCE's data response to PubAdv-SCE-073-TLG, Q.1.e.2.a, it provided costs incurred for Transmission and Distribution inspections and repairs during 2014-2018 for EOI. Note that this data request is also mentioned in footnote 170 on page 65 in Exhibit PAO-6. In footnote 165 on page 64 of Exhibit PAO-6, the Public Advocates Office mentions that SCE's Transmission Line Patrols and its Transmission O&M Maintenance TY forecasts include the same activities as proposed by SCE's Wildfire Management Program.

Q.2.
The Public Advocates Office is unable to "provide what specific costs that can be reallocated" because SCE did not provide this type of detailed information for review and analysis and states it

“has not been SCE’s typical practice to trace funds that it re-allocated” (SCE’s data response to PubAdv-SCE-070-TLG, Q.1.d.1.3.).

Q.3.
The projects that the Public Advocates Office was “referring to for completed projects, closed projects, and eliminated projects” and the “years the projects were completed, closed, or eliminated” are associated with Information Technology projects for revisions, upgrades and enhancements SCE requested funding for in its 2012, 2015 and 2018 GRCs and have costs embedded in rates (i.e., Distribution Control Management System/Distribution Management System, Business Process and Technology Integration, Information Technology and Business Integration, Market Redesign and Technology Upgrade).

As stated on page 63 of Exhibit PAO-6, SCE’s EOI Program Management Office TY forecast includes Information Technology (IT) projects with lump sum numbers that lack a detailed breakdown of the calculation of the individual line item estimates.

Q.4.a-b.

Prior to serving the Public Advocates Office’s Exhibit PAO-6, on SCE’s Wildfire Management TY O&M expense forecast, including TY proposals and forecasts associated with Enhanced Overhead Inspections, the following information, “pertinent to the analysis” was reviewed and analyzed: SCE-04, Vol. 5 – Wildfire Management, SCE-02, Vol. 6A – Vegetation Management, SCE-02, Vol. 2A – Transmission Grid, SCE-02, Vol. 1, Part 2 – Capital-Related Expense, and SCE’s data request responses to PubAdv-SCE-066-TLG, PubAdv-SCE-069-TLG, PubAdv-SCE-070-TLG, PubAdv-SCE-073-TLG, PubAdv-SCE-078-TLG, and PubAdv-SCE-081-TLG. Also see response to Q.1.a-c.

The Public Advocates Office’s Exhibit PAO-6 did not make a determination that “the material in Advice Letter 4031-E was not pertinent to the analysis they were conducting in review of SCE’s EOI proposals.”

END OF RESPONSE

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET P u b A d v - S C E - 0 9 1 - G A W

To: Public Advocates Office
Prepared by: Nancy Foehner
Job Title: Senior Project Manager
Received Date: 1/28/2020

Response Date: 2/11/2020

Question 01.a:
On page 22 of Ex. SCE-02, Vol. 1, Part 2, SCE states the following beginning on line 5:
"In the last quarter of 2018, SCE accelerated wildfire mitigation efforts that impacted capital maintenance work performed by both SCE and contractor personnel. Some work previously scheduled to be completed in 2018 was rescheduled to 2019."
SCE then goes on to explain that because of the 2018 wildfire issues, 2018 was not a normal operating year, and should be excluded from forecasting averages.

a. It appears to the Public Advocates Office that inherent in the above discussions is the assumption that the forecast years 2019 and beyond will be "normal" operating years, meaning that wildfire mitigation efforts will no longer impact capital maintenance work to the extent that 2018 was impacted. Please discuss and explain why SCE has concluded that wildfire mitigation work will no longer have a major impact on capital maintenance work for the years 2019 and beyond.

Response to Question 01.a:
For years 2019-2023, SCE-02, Vol. 1, Pt. 2 includes the forecast costs for Distribution Overhead Detailed Inspections, Distribution Preventive & Breakdown O&M Maintenance, and Distribution Preventive & Breakdown Capital Maintenance. These forecasts include only the costs to perform these activities in non-HFRAs. The Enhanced Overhead Inspection (EOI) SCE performed at the end of 2018, which required the redeployment of resources away from Distribution Preventive & Breakdown (capital and O&M) Maintenance, was a one-time effort. SCE continues to perform Wildfire mitigation and has presented the costs to perform this work in SCE-04, Vol. 5A – Wildfire Management, and therefore, EOI financial impacts in SCE-02, Vol. 1, Pt. 2 have been removed from the forecast.

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET T U R N - S C E - 0 0 2

To: TURN
Prepared by: Raymond Fugere
Job Title: Senior Manager
Received Date: 10/17/2019

Response Date: 10/30/2019

Question 09:
Please explain the difference between the Enhanced Overhead Inspection program and inspections and remediations conducted pursuant to General Order (GO) 165 and GO 95 for distribution and transmission facilities. Please provide all supporting documentation related to this response.

Response to Question 09:
The attached document titled *Distribution Inspection and Maintenance Program (DIMP).pdf* contains the procedures related to performing distribution overhead detail inspections. The attached document titled *Transmission I&M procedures.pdf* contains the procedures related to performing transmission overhead detail inspections.

The inspections ordered by General Orders (GO) 95 and 165 differ from those performed as part of the Enhanced Overhead Inspection (EOI) program primarily by the following:

- The GO Inspections only documented conditions needing repair; whereas EOI documented conditions needing repairs and collected data
- EOI focused on fire mitigation efforts; whereas the GO inspections focused on compliance matters

Please also see SCE's Advice 4031-E filing (attached) that describes SCE's EOI and clarifies the differences from SCE's existing inspection programs.

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET T U R N - S C E - 0 0 3

To: TURN
Prepared by: Raymond Fugere
Job Title: Principle Manager
Received Date: 11/7/2019

Response Date: 11/22/2019

Question 08:
For SCE’s Tier 2 and 3 HFTDs, please provide a list of circuits in these areas and the dates the circuits were last inspected under the Overhead Distribution Inspection program.
List separately for ODI and EOI

Response to Question 08:
SCE's Overhead Detailed Inspection program is scheduled and performed on a grid basis rather than a circuit basis. Under SCE's Overhead Detail Inspection (ODI) program, all overhead equipment located within a grid is inspected regardless of the circuit. A grid may include poles identified as Tier 2, Tier 3, or non-high fire. Overhead equipment located in either a Tier 2 or Tier 3, will be inspected through its EOI program (or future high fire inspection program). High fire structures will be removed from the non-high fire grid-based ODIs. Overhead equipment located in Tier 2/3 areas will instead be inspected under SCE's proposed EOI program.

Pursuant to General Order No. 165 and Decision No. 97-03-070 issued by the Commission, SCE submits its Annual Report of distribution inspections completed on an annual basis. This report is in accordance with D.12-01-032, issued in R. 08-11-005.

The attached spreadsheet titled TURN-SCE-003 Q.8_Inspection Dates.xlsx shows all active equipment in SCE's service territory that has had an ODI, the startup date of the pole, the date of the ODI, and the date of the EOI. SCE tracks ODI records by equipment, and a pole may not have had an inspection if a pole is less than five years old. SCE is only producing poles that have had an ODI inspection and are currently active in its system of record.

SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL® Company

Gary A. Stern, Ph.D.
Managing Director, State Regulatory Operations

July 5, 2019

ADVICE 4031-E
(U 338-E)

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA
ENERGY DIVISION

SUBJECT: Description of Southern California Edison Company's Enhanced Overhead Inspections Program that Clarifies Differences from SCE's Existing Inspections, what the Enhanced Inspections Involve, Specific Activities that will be Performed, and Data that will be Collected as well as Databases Related to These Inspections

In compliance with Decision (D.)19-05-038, Southern California Edison (SCE) hereby further describes its Enhanced Overhead Inspections (EOI) initiative by clarifying the differences from SCE's existing inspections, explaining what the EOI involve, the specific activities that will be performed, the data that will be collected as well as databases related to EOI.

PURPOSE

This advice letter provides the Commission with further description of SCE's EOI program as required by Ordering Paragraph (OP) 2 of D.19-05-038.

BACKGROUND

As described in its 2019 Wildfire Mitigation Plan (WMP), SCE commenced its EOI initiative in late 2018 to help address evolving wildfire risks. The primary focus of SCE's EOI is to inspect, assess and remediate SCE's infrastructure in its high fire risk areas (HFRA) to reduce ignition risk. Historically, SCE's inspection and maintenance programs have been focused on regulatory compliance. SCE's EOI initiative continues to evolve, as further described below, centered on a risk-based approach that addresses the evolving wildfire threat. In D.19-05-038, the Commission ordered SCE to file a Tier 1 Advice Letter further describing its EOI to clarify (in more detail than provided in the WMP) how it differs from SCE's existing inspections, what the enhanced inspections involve, including a description of the specific activities that will be performed, data that will be collected, and any databases that will be created or supplemented as part of these inspections. SCE addresses these requirements below.

ENHANCED OVERHEAD INSPECTIONS INITIATIVE OVERVIEW

SCE's ongoing commitment to safety and supporting California's fight against wildfire risk remains a top priority. Inspections of SCE's infrastructure, particularly in its HFRA, have been an ongoing part of regular operations for SCE for many years. In light of what has been called "the new abnormal" wildfire climate in California, SCE is conducting additional, enhanced inspections of its infrastructure in HFRA.
SCE has long taken substantial steps to reduce the risk of wildfires, and SCE continues to proactively enhance its operational practices and infrastructure through its comprehensive wildfire mitigation strategy.

SCE has developed and improved its various maintenance and inspection programs to further protect the safety of the general public, its customers, and its workers, as well as to continue to provide reliable service to customers. In SCE's efforts to consistently and continually improve the safety in HFRA, additional criteria inform the enhanced inspections. The EOI initiative is being implemented in addition to SCE's regular compliance and safety inspections as an added measure to further strengthen the safety and reliability of SCE assets. SCE dedicated enormous amounts of resources and effort to the EOI initiative to expeditiously finish a vast scope of work in advance of the 2019 wildfire season.

DISTRIBUTION ENHANCED OVERHEAD INSPECTIONS

How EOI Differs From Existing Programs

The distribution EOI initiative was designed to identify and rectify immediate and/or probable wildfire risk on the distribution system - including an emphasis on SCE historical ignition data to ensure the EOI criteria identified a wide range of potential ignition risk. However, for the 2019 WMP cycle, the EOI initiative was not designed to identify or replace SCE's legacy compliance inspection programs; EOI was primarily designed for a risk-based approach and not designed to identify the full spectrum of distribution compliance infractions.

What the Enhanced Inspections Involve

The distribution EOI scope consists of approximately 300,000 overhead primary distribution structures within all SCE HFRA (Zone 1, Tier 2, Tier 3, and non-CPUC HFRA). The aggregate EOI scope was implemented through a phased approach based on probability risk using historical data. Each phase was assigned a completion date to ensure an effective operational strategy, maximize risk buy-down, and complete inspections of all HFRA overhead structures prior to the traditional start of the California fire season in 2019. As of the filing of this advice letter, SCE has completed the vast majority of distribution EOI with few remaining exceptions due to limited access issues. Some aspects of EOI (including certain remediations and aerial inspections) are expected to continue into 2020.

The primary activities involved in SCE's distribution EOI initiative include inspecting all approximately 300,000 distribution primary-level structures[1] based on specifically-designed ignition risk reduction criteria. Additionally, all items that need to be remediated identified during EOI are scheduled and remediated based on existing maintenance priority timelines. During an EOI, there is a physical visit to the structure being inspected followed by a thorough visual inspection from the ground at the actual location. EOI are not conducted in vehicles.

SCE designed a Distribution Inspection Reference Guide to optimize inspection results and provide additional instructions to field crews. The reference guide consists of a description of each question on the inspection form, details on the intent of the question and expected outcome of the inspection, and instructions on mitigation of findings for each question.

In addition to the Distribution Inspection Reference Guide, a specialized project team with various areas of expertise throughout SCE designed a specific distribution EOI criteria form for qualified electrical workers to conduct the enhanced field inspections of SCE's distribution infrastructure in HFRA. The inspection form was designed to ensure effective ignition-focused mitigation, consistent EOI throughout SCE's HFRA, and implement construction standard changes and hardware projects to prevent and mitigate future ignition sources. The specially-designed inspection form is comprised of several ignition-focused questions not covered in General Order 95 compliance requirements, and posed as "yes" or "no" and "true" or "false" to ensure accuracy.[2] Based on field inspection responses to each individual question, the type of response results in an additional action to rectify all potential ignition risk issues discovered during the inspections. For example, based on the inspection discovery in the field, a response may result in an immediate notification creation on the digital form with the notification classification determined based on the severity of the discovered issue.

To ensure optimal inspection effectiveness during EOI, SCE utilizes specialized resources to perform field inspections. In contrast to traditional compliance inspections, all EOI is conducted by SCE Journey Lineman to further provide distribution expertise and improve ignition risk reduction effectiveness.

To further improve these enhanced inspections and minimize the probability of missing a potential ignition risk, SCE has recently launched a comprehensive aerial inspection function as part of its EOI program. Whereas the ground-based enhanced inspections described above have detected issues with SCE's infrastructure that are seen in-person from qualified electrical workers, the aerial inspections provide improved visuals for infrastructure that is located above the ground such as pole tops that may not be easily visible from the ground. This function is performed by helicopters and/or drones

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1 The EOI inspectors are not precluded from inspecting secondary-level structures, but the EOI initiative does not specifically mandate such inspections.

2 For example, the specialized form asks the following question: "Are jumper wires adequately separated and supported to avoid contact or fatigue during high wind events (N/A if no jumpers)?"

hovering and taking high-quality digital photos of each HFRA distribution overhead structure. Subsequently, each photo is then examined by a team of qualified resources (e.g., Journeymen Lineman and Distribution Engineers) and a specialized aerial inspection form is completed for each HFRA structure captured by the aerial inspections. Upon discovery of issues identified during the aerial inspections, the team submits repair notifications based on the severity of the findings. The aerial inspections are generally in addition to – not in lieu of – the ground-based inspections.[3]

Several EOI (both ground-based and aerial) have resulted in a remediation notification to repair or replace the identified distribution infrastructure issue. The remediation plan has been designed to rectify notifications based on compliance requirements, ignition and consequence risk, and for specific findings as a result of these enhanced inspections. The plan emphasizes a risk-based approach focused on ignition (type of notification) and consequence (potential effects of an ignition) to ensure the risk of an identified issue is prioritized to rectify the issue based on its severity.

Existing and New Databases

Generally, SCE has leveraged existing information systems for its EOI initiative. In addition, SCE used the "Survey123" application, which is an application that the EOI inspectors now use on newly deployed iPads in the field with full utilization of SCE's ArcGIS database to collect and store the inspection data during an EOI. Additionally, SCE designed several internal automated features within existing technologies to transition data and automate processes. SCE also deployed new technology during these enhanced inspections. For distribution EOI, about 500 iPads were provided to the inspectors to document and track inspections.

TRANSMISSION ENHANCED OVERHEAD INSPECTIONS

How EOI Differs From Existing Programs

In general, SCE's EOI for transmission-level infrastructure is similar in scope and work activities to the distribution initiative described above. Similar to the distribution EOI, transmission EOI take into consideration a more conservative risk-based approach than historical inspection practices, which are compliance-based. Although transmission inspections in the past required detailed assessments, transmission personnel, as part of the transmission EOI, were directed to focus specifically on potential ignition sources. All transmission overhead structures (approximately 50,000) in SCE's HFRA have been inspected through the EOI initiative as of the filing of this advice letter. Although these structures would have been inspected over the course of the year through traditional inspection programs, these enhanced inspections were accomplished in a shorter span

[3] Except in areas where access issues made it infeasible, SCE inspected all primary distribution and transmission infrastructure in HFRA via ground-based inspections. For those limited exceptions, SCE used aerial inspections instead of ground-based inspections. In general, however, SCE's aerial inspections are being conducted on assets that have already been inspected from the ground.

of 5 months with greater focus on ignition risk. The purpose of transmission EOI was to remediate high priority notifications as soon as possible and before the traditional fire season started. The volume of work and inspections completed was unlike anything the Transmission organization had done historically.

What the Enhanced Inspections Involve

A new interim group was formed within SCE's Transmission organization for this new initiative. Members from all parts of the Transmission organization formed a strike team to mobilize and execute the transmission EOI. The team planned, designed, and executed these enhanced inspections.

The approach to these inspections was also new. As opposed to having these structures inspected by only patrolman, teams were formed under patrolman supervision to inspect all the structures in HFRA. A new inspection checklist was created with the help of Transmission Engineering, Transmission Patrolman and Transmission Management to specifically assess fire threats. The typical inspection checklist that Patrolman used was incorporated, but many more ignition-specific questions above and beyond what they would normally inspect for were added.

Work that was remediated was also prioritized in a different way. Compliance timeframes in HFRA are much shorter than other non-HFRA and remediation in highest-risk areas take priority. The approach on using risk to determine priority was also new. Transmission leveraged a risk-based approach to determine prioritization of remediation work. SCE's risk-based approach will continue to evolve in order for SCE to continually improve its efforts to focus its mitigation efforts on the highest-risk items.

Additionally, and similar to distribution EOI, the Transmission organization has started to conduct aerial enhanced inspections via helicopters. These aerial inspections are an enhanced version of Transmission's traditional line patrols. Under SCE's traditional, compliance-based programs, SCE does not aerially inspect every transmission area. Historically, detailed aerial patrols have been conducted only when a ground-based inspection could not be safely conducted, or when a ground-based inspection finding indicated that an aerial inspection was warranted. Aerial patrols would be continuous and visual-only until a potential notification was identified, at which point the patrol resources would stop to further assess the condition and write an associated notification. While conducting enhanced ground inspections, SCE found that an aerial view of SCE's overhead assets would provide a more comprehensive inspection of the pole top, the wooden crossarms, the steel structures, and all conductor/hardware. Closer inspection has revealed additional ignition risks in Transmission's infrastructure. In an aerial EOI, every pole/tower that was assessed from the ground will be assessed in the air. Each structure will now have an HD video accompanied by individual still frames (photos) of each connection point on the pole or tower. These visuals allow the Transmission Patrolman, engineers, etc. to perform a deeper dive inspection of the asset.

A specialized inspection form was created to inspect overhead assets from an aerial perspective. This too was loaded into Survey123 and the software was used in a similar fashion as ground inspections. A team was formed from members outside of the Transmission organization (to supplement Transmission employees that were already spread thin) to support this effort. This team was not only in charge of project managing this enhanced aerial inspection, but were also tasked with creating the inspection groups (or pods) that would be used once the video/photos were available. These inspection pods consist of contract engineers and Transmission Patrolman. SCE plans to expand these pods to include additional analytical support, contract inspectors, and supervision.

New and Existing Databases

SCE also deployed new technology during these enhanced inspections. For transmission EOI, almost 100 iPads were released to the inspectors to document and track inspections. Automation of inspections in the iPads allowed the inspection checklist to be filled out real time (versus using paper inspections), the ability to capture longitude/latitude with the GPS monitor, the ability to take pictures of every structure and issue (regardless of whether it had an issue), and the ability to track metrics associated to inspections in the Survey 123 software application. Dashboards were created and introduced for the first time to track inspection progress in real-time. The employment of this new technology also required user and other employee training.

For transmission EOI, SCE also had to implement a partially new “gatekeeping” process (i.e., the process from reviewing, classifying, and approving/modify/rejecting the notifications that were created in Survey123 to be stored in SCE’s existing SAP databases). Although SCE used the same existing employee gatekeepers (approximately 20), the forum to gatekeep was different. Survey123 was used for gatekeeping to reduce the amount of time that would usually be needed in SCE’s maintenance software (SAP) to navigate through multiple screens to gather the necessary information and validate a notification. Gatekeepers can now visually see the notifications identified on each structure in a map and assign themselves a group to validate and confirm in the new software. The software, the visuals, the maps, and the grouping on the notifications was all new information that required new training. Additionally, SCE set up an internal site to store all photos from the inspection phase. This made it easier for the gatekeeper to reference material needed to validate the priority assigned to the notification.

Remediation planning and design was similarly done in Survey123. This is also different than historical Transmission practices. Previously, transmission estimators would search the associated notifications on one structure to determine the remediation that needed to be completed. In the enhanced remediation process, estimators can see all associated notifications on each structure in each circuit. This improved the planning and design process. For example, associated notifications on the structures can now be seen from EOI-related work and other inspection programs that need to be remediated on the same circuit. Bundling of these notifications in one area (using the Survey123 tool) proved to be very efficient.

GENERATION ENHANCED OVERHEAD INSPECTIONS

The generation EOI work stream was initiated after SCE's distribution and transmission EOI programs and subsequent to SCE's submittal of its 2019 WMP. The generation EOI was able to take advantage of the processes, training materials and systems described above. Generation facilities are unique in their application, age, variety, and how and where they are situated along with other overlapping regulatory requirements such as FERC licensing requirements; therefore, the tools and processes described above were modified to suit Generation assets and work flow processes.

How EOI Differs From Existing Programs

Standard inspections for generation assets include a large variety of routine inspections including, for example, NERC clearance requirements, CPUC clearance requirements (GO 95, etc.), substation inspections and testing, dam safety inspections, a variety of facility-based inspections, environmental inspections (hazardous materials storage, inspections of pressurized vessels, etc.) and surveys. However, historically, there have not been specific inspection routines focusing on potential sources of ignition for generation assets.

What the Enhanced Inspections Involve

Under the generation EOI, SCE scoped enhanced inspections of approximately 450 generation assets in its HFRA. These inspections are ongoing and include ignition-focused assessments of low-voltage ancillary assets and their associated overhead lines, supporting structures, any exposed wiring and/or threats from vegetation that require additional mitigation, high-voltage facilities to ensure all overhead connections from the last transmission and distribution inspected structures have been evaluated (using the same applicable questions asked on the transmission and distribution enhanced inspection forms), and confirmation of appropriate vegetation-free buffers around high-voltage facilities, especially in heavily forested locations with older facility set-back requirements. Similar to the transmission and distribution EOI described above, photographs are collected and documentation of findings regardless of whether issues are identified.

New and Existing Databases

Generation is also using the new Survey123 software to classify and remediate issues (with approximately 20 new iPads).

No cost information is required for this advice letter.

This advice letter will not increase any rate or charge, cause the withdrawal of service, or conflict with any other schedule or rule.

TIER DESIGNATION

Pursuant to OP 2 of D.19-05-038, this advice letter is submitted with a Tier 1 designation.

EFFECTIVE DATE

This advice letter will become effective on July 5, 2019, the same day as submitted.

NOTICE

Anyone wishing to protest this advice letter may do so by letter via U.S. Mail, facsimile, or electronically, any of which must be received no later than 20 days after the date of this advice letter. Protests should be submitted to:

CPUC, Energy Division
Attention: Tariff Unit
505 Van Ness Avenue
San Francisco, California 94102
E-mail: EDTariffUnit@cpuc.ca.gov

Copies should also be mailed to the attention of the Director, Energy Division, Room 4004 (same address above).

In addition, protests and all other correspondence regarding this advice letter should also be sent by letter and transmitted via facsimile or electronically to the attention of:

Gary A. Stern, Ph.D.
Managing Director, State Regulatory Operations
Southern California Edison Company
8631 Rush Street
Rosemead, California 91770
Telephone: (626) 302-9645
Facsimile: (626) 302-6396
E-mail: AdviceTariffManager@sce.com

Laura Genao
Managing Director, State Regulatory Affairs
c/o Karyn Gansecki
Southern California Edison Company
601 Van Ness Avenue, Suite 2030
San Francisco, California 94102
Facsimile: (415) 929-5544
E-mail: Karyn.Gansecki@sce.com

There are no restrictions on who may submit a protest, but the protest shall set forth specifically the grounds upon which it is based and must be received by the deadline shown above.

In accordance with General Rule 4 of GO 96-B, SCE is serving copies of this advice letter to the interested parties shown on the attached GO 96-B and Rulemaking (R.)18-10-007 service lists. Address change requests to the GO 96-B service list should be directed by electronic mail to AdviceTariffManager@sce.com or at (626) 302-4039. For changes to all other service lists, please contact the Commission's Process Office at (415) 703-2021 or by electronic mail at Process_Office@cpuc.ca.gov.

Further, in accordance with Public Utilities Code Section 491, notice to the public is hereby given by submitting and keeping the advice letter at SCE's corporate headquarters. To view other SCE advice letters submitted with the Commission, log on to SCE's web site at https://www.sce.com/wps/portal/home/regulatory/advice-letters.

For questions, please contact Ryan Stevenson at (626) 302-3613 or by electronic mail at ryan.stevenson@sce.com.

Southern California Edison Company

/s/ Gary A. Stern, Ph.D.
Gary A. Stern, Ph.D.

GAS:rs/kc:jm

ADVICE LETTER SUMMARY
ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No.: Southern California Edison Company (U 338-E)

Utility type:
- [x] ELC
- [ ] GAS
- [ ] WATER
- [ ] PLC
- [ ] HEAT

Contact Person: Darrah Morgan
Phone #: (626) 302-2086
E-mail: AdviceTariffManager@sce.com
E-mail Disposition Notice to: AdviceTariffManager@sce.com

EXPLANATION OF UTILITY TYPE

ELC = Electric | GAS = Gas | WATER = Water
PLC = Pipeline | HEAT = Heat

(Date Submitted / Received Stamp by CPUC)

Advice Letter (AL) #: 4031-E   Tier Designation: 1

Subject of AL: Description of Southern California Edison Company's Enhanced Overhead Inspections Program that Clarifies Differences from SCE's Existing Inspections, what the Enhanced Inspections Involve, Specific Activities that will be Performed, and Data that will be Collected as well as Databases Related to These...

Keywords (choose from CPUC listing): Compliance

AL Type: [ ] Monthly [ ] Quarterly [ ] Annual [x] One-Time [ ] Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #:
Decision 19-05-038

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL:

Summarize differences between the AL and the prior withdrawn or rejected AL:

Confidential treatment requested? [ ] Yes [x] No

If yes, specification of confidential information:
Confidential information will be made available to appropriate parties who execute a nondisclosure agreement. Name and contact information to request nondisclosure agreement/ access to confidential information:

Resolution required? [ ] Yes [x] No

Requested effective date: 7/5/19   No. of tariff sheets: -0-

Estimated system annual revenue effect (%):

Estimated system average rate effect (%):

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: None

Service affected and changes proposed[1]:

Pending advice letters that revise the same tariff sheets: None

[1]Discuss in AL if more space is needed.

Clear Form

Protests and all other correspondence regarding this AL are due no later than 20 days after the date of this submittal, unless otherwise authorized by the Commission, and shall be sent to:

CPUC, Energy Division
Attention: Tariff Unit
505 Van Ness Avenue
San Francisco, CA 94102
Email: EDTariffUnit@cpuc.ca.gov

Name: Gary A. Stern, Ph.D.
Title: Managing Director, State Regulatory Operations
Utility Name: Southern California Edison Company
Address: 8631 Rush Street
City: Rosemead
State: California Zip: 91770
Telephone (xxx) xxx-xxxx: (626) 302-9645
Facsimile (xxx) xxx-xxxx: (626) 302-6396
Email: advicetariffmanager@sce.com

Name: Laura Genao c/o Karyn Gansecki
Title: Managing Director, State Regulatory Affairs
Utility Name: Southern California Edison Company
Address: 601 Van Ness Avenue, Suite 2030
City: San Francisco
State: California Zip: 94102
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Email: karyn.gansecki@sce.com

Clear Form

ENERGY Advice Letter Keywords

Affiliate	Direct Access	Preliminary Statement
Agreements	Disconnect Service	Procurement
Agriculture	ECAC / Energy Cost Adjustment	Qualifying Facility
Avoided Cost	EOR / Enhanced Oil Recovery	Rebates
Balancing Account	Energy Charge	Refunds
Baseline	Energy Efficiency	Reliability
Bilingual	Establish Service	Re-MAT/Bio-MAT
Billings	Expand Service Area	Revenue Allocation
Bioenergy	Forms	Rule 21
Brokerage Fees	Franchise Fee / User Tax	Rules
CARE	G.O. 131-D	Section 851
CPUC Reimbursement Fee	GRC / General Rate Case	Self Generation
Capacity	Hazardous Waste	Service Area Map
Cogeneration	Increase Rates	Service Outage
Compliance	Interruptible Service	Solar
Conditions of Service	Interutility Transportation	Standby Service
Connection	LIEE / Low-Income Energy Efficiency	Storage
Conservation	LIRA / Low-Income Ratepayer Assistance	Street Lights
Consolidate Tariffs	Late Payment Charge	Surcharges
Contracts	Line Extensions	Tariffs
Core	Memorandum Account	Taxes
Credit	Metered Energy Efficiency	Text Changes
Curtailable Service	Metering	Transformer
Customer Charge	Mobile Home Parks	Transition Cost
Customer Owned Generation	Name Change	Transmission Lines
Decrease Rates	Non-Core	Transportation Electrification
Demand Charge	Non-firm Service Contracts	Transportation Rates
Demand Side Fund	Nuclear	Undergrounding
Demand Side Management	Oil Pipelines	Voltage Discount
Demand Side Response	PBR / Performance Based Ratemaking	Wind Power
Deposits	Portfolio	Withdrawal of Service
Depreciation	Power Lines	

Clear Form

Forecast Summary - Enhanced Overhead Inspections and Remediations (O&M)

(Constant 2018 $000s)

	2019	2020	2021	2022	2023	Total
EOI Inspections - T[1]	$ 8,961	$ -	$ -	$ -	$ -	$ 8,961
EOI Inspections - D[2]	$ 37,951	$ 9,626	$ 9,626	$ 9,626	$ 9,626	$ 76,456
Aerial Inspections - D[3]	$ 32,613	$ 12,691	$ 12,691	$ 12,691	$ 12,691	$ 83,379
EOI Repairs - T[4]	$ 21,966	$ 6,647	$ 6,647	$ 6,043	$ 6,043	$ 47,346
EOI Repairs - D[5]	$ 77,467	$ 97,167	$ 14,553	$ 13,657	$ 12,757	$ 215,601
Long Span Mitigation (O&M)[6]	$ 17,674	$ 33,497	$ -	$ -	$ -	$ 51,170
Vertical Switches (O&M)[7]	$ 110	$ 27	$ -	$ -	$ -	$ 137
EOI PMO (O&M)[8]	$ 17,422	$ 16,291	$ 15,395	$ 12,471	$ 12,993	$ 74,572
Total EOI O&M	**$ 214,163**	**$ 175,947**	**$ 58,913**	**$ 54,489**	**$ 54,110**	**$ 557,622**

1. Pulled from recorded SAP costs on 4/25/19
2. See "Forecast - EOI Inspection - Distribution"
3. See "Forecast - Aerial Inspections - Distribution"
4. See "Forecast - EOI Repairs - Transmission"
5. See "Forecast - EOI Repairs - Distribution"
6. See "Forecast - Long Span Mitigation (O&M)"
7. See "Forecast - Vertical Switches (O&M)"
8. See "Forecast - EOI PMO (O&M)"

Forecast - EOI Inspection - Distribution

EOI Inspections

(Constant 2018 $000s)

	2019	2020	2021	2022	2023
Number of Inspections[1]	379,016	117,995	117,995	117,995	117,995
Cost per Inspection[2]	$0.10	$0.08	$0.08	$0.08	$0.08
Total EOI Inspection - Distribution Cost	$ 37,951	$ 9,626	$ 9,626	$ 9,626	$ 9,626

1. 2019 units based on actual inspections, revised number of inspection units is calculated by removing the non-tiered assets from distribution system in HFAs from 2020+ only
2. 2019 Based on actual inspections and expenditures, 2020-2023 cost per reduced due to increased efficiency.

Forecast - Aerial Inspections - Distribution

Aerial Inspection Data Capture and Processing		**2019**
Number of Poles		379,016
Cost per Pole	$	40.08
Total Inspection Cost		$15,192,796

Qualified Electrical Worker (QEW) Review Team		**2019**
Hourly Rate [A]	$	113.95
Number of Qualified Electrical Workers [B]		130
Daily Hours [C]		8
Working days [D]		147
Total QEW Review Cost [=A*B*C*D]		17,420,060

2019 Total Cost (Constant 2018$)	32,612,857	
2020-2023 Cost Ratio	0.39	*Ratio based on HFRA update and inspection of half the system per year*

	2019	**2020**	**2021**	**2022**	**2023**
Total (Constant 2018 $000)	32,613	12,691	12,691	12,691	12,691

Forecast - EOI PMO IT Projects (O&M)

	(Constant 2019 $000s)				
IT Project Support	**2019**	**2020**	**2021**	**2022**	**2023**
Mobile Crew Management	$ 180	$ 180	$ 180	$ 180	$ 180
Remote Sensing Aerial Survey Inspection	$ 2,205	$ 4,433	$ 7,508	$ 4,626	$ 5,160
~~Remote Sensing Aerial Survey Inspection (ongoing)~~	~~$ 4,787~~	~~$ 4,787~~	~~$ 4,787~~	~~$ 4,787~~	~~$ 4,787~~
Portfolio Planning, Optimization and Resource Planning for Poles and Covered Conductor	$ 60	$ 60	$ 60	$ 60	$ 60
iPad Deployment & Support	$ 1,316	$ 1,316	$ 1,316	$ 1,316	$ 1,316
IMAC support to the Lay down yards (incl. in Contractor Mobile Solution)	$ -	$ -	$ -	$ -	$ -
EOI - Drone2Map - Application Support Only	$ 20	$ 20	$ 20	$ 20	$ 20
EOI - Notifications Automation - Distribution	$ 240	$ 240	$ 240	$ 240	$ 240
EOI - Notifications Automation - Transmission	$ 100	$ 100	$ 100	$ 100	$ 100
EOI - Additional ArcGIS/Winshuttle/CMS Mobile Licenses	$ 200	$ 200	$ 200	$ 200	$ 200
E1P1- CMS Notification form update for Safety Reporting	$ 10	$ 10	$ 10	$ 10	$ 10
EOI- Remediation process - Contractor Mobile solution to handle 270,000 Notification	$ 130	$ 130	$ 130	$ 130	$ 130
SMT Enhancement Requirements	$ 220	$ 220	$ 220	$ 220	$ 220
Click - Background Optimizer for auto scheduling and dispatching of EOI Notification	$ 55	$ 55	$ 55	$ 55	$ 55
Transitional Cost to Move to Longer Term Solutions	$ -	$ -	$ -	$ -	$ -
SurfacePro and Blue Beam for Planner	$ 618	$ 618	$ 618	$ 618	$ 618
Survey 123 for Distribution	$ 100	$ 100	$ 100	$ 100	$ 100
Situational Awareness Phase 2 -Visual Weather forecast Data and Reporting	$ 18	$ 18	$ 18	$ 18	$ 18
Asset Reliability & Risk Analytics (ARRA)	$ 114	$ 140	$ 72	$ 72	$ 72
EOI Support Adjustment	$ -	$ -	$ 109	$ -	$ -
IT Project Support (Constant 2019$)	$ 5,585	$ 7,839	$ 10,954	$ 7,964	$ 8,498
EOI PMO (O&M) (Constant 2018$)	**$ 5,462**	**$ 7,667**	**$ 10,714**	**$ 7,789**	**$ 8,312**

Escalation Index	**2019**	**2020**	**2021**	**2022**	**2023**
O&M - Distribution	1.0225	1.0350	1.0469	1.0617	1.0805
~~EOI PMO (O&M) (Constant 2018$)~~	~~$ 10,144~~	~~$ 12,349~~	~~15,395~~	~~12,471~~	~~12,993~~
~~EOI PMO (O&M) (Nominal$)~~	~~$ 10,371~~	~~$ 12,781~~	~~16,117~~	~~13,240~~	~~14,040~~

PUBLIC ADVOCATES OFFICE
DATA RESPONSE
Southern California Edison Company Test Year 2021 General Rate Case
A.19-08-013

Date: 24 April 2020

Origination Date: 16 April 2020

Response Due: **23 April 2020**

To: Martin Collette, Martin.collette@sce.com

cc: Douglas.Snow@sce.com
Russell.Archer@sce.com
scegrc@sce.com

From: Truman Burns, Project Coordinator
Public Advocates Office
505 Van Ness Avenue, Room 4104
San Francisco, CA 94102 txb@cpuc.ca.gov

Response by: Tamera Godfrey
Phone: 415-703-1367
Email: tamera.godfrey@cpuc.ca.gov

Data Request No: SCE-PubAdv-003-MC

SCE Questions:

1. At page 53, PAO-6 Cal Advocates state “SCE does not acknowledge its shareholders receive benefits when SCE’s customers with behind-the-meter distributed generation and storage supplies ‘power during an outage from their on-site distributed generation and storage devices’ and that its shareholders have provided funding in the past for various incentive programs and other projects in which they received benefit”. (lines 18-22).

    a. Please explain what is the benefit that SCE shareholders are receiving when “SCE’s customers with behind-the-meter distributed generation and storage supplies ‘power during an outage from their on-site distributed generation and storage devices’”. If Cal Advocates have specific material supporting this assertion, please provide that material or appropriate references. Please provide any quantification or analysis that Cal Advocates has conducted on the shareholder benefits identified in the quote. If the benefits are included as part of a regulatory proceeding, please identify relevant references.

    b. Please identify when SCE “shareholders have provided funding in the past for various incentive programs and other projects in which they received benefit”. Please identify the specific programs that are being referenced in the statement quoted on page 53 above.

Public Advocates Office Response:

1-a. On page 53 of Exhibit PAO-6, the Public Advocates Office was referring to benefits associated with the avoidance of negative public relations associated with outages, the tangible benefits SCE's shareholders receive in the form of dividends and higher stock prices when SCE's operations are running efficiently and it is not receiving negative press associated with outages, and the possibility that SCE's shareholders could be responsible for payments and/or refunds for outages. These are benefits SCE and its shareholders receive when "SCE's customers with behind-the-meter distributed generation and storage supplies 'power during an outage from their on-site distributed generation and storage devices.'"

1-b. On page 53 of Exhibit PAO-6, the Public Advocates Office was referring to SCE's Long Term- Incentive Program (see SCE Exhibit SCE-6, Vol. 3, Part 1, p. 62) and its Short-Term Incentive Program (STIP). Regarding STIP, in particular the Financial Performance goal, that is associated with tangible benefits to SCE's shareholders in the form of dividends and higher stock prices, but provides no benefit to ratepayers and no ratepayer funding was authorized for this goal (see D.14-08-032, p. 520, D.16-06-054, D.17-05-013, and D.19-05-020, p. 186).

In regards to other projects in which SCE's "shareholders have provided funding in the past," the Public Advocates Office was referring to SCE's data response to PubAdv-SCE-073-TLG, Q.1-d, 3 a-d. In that response, SCE stated it "performed infrared inspections on its distribution system at shareholder expense and these costs are not included in the historical costs presented in this GRC."

END OF RESPONSE

Southern California Edison
A.19-08-013 – SCE 2021 General Rate Case

DATA REQUEST SET P u b A d v - S C E - 0 7 3 - T L G

To: Public Advocates OfficePublic Advocates Office
Prepared by: Eghosa Obasohan
Job Title: Senior Advisor
Received Date: 1/13/2020

Response Date: 1/28/2020

Question 01.b.1-6:
Referring to Exhibit SCE-04, Vol. 5A, page 5, SCE forecasts $105.447 million for its Wildfire Management O&M expenses for TY 2021.

b. Referring to page 91, Figure II-27, SCE forecasts $3.594 million for its Enhanced Situational Awareness O&M expenses in the TY. SCE does not show any recorded expenses for 2014-2017 for its Enhanced Situational Awareness activities.

1) Referring to page 88, lines 8-9, SCE states "Comprehensive situational awareness is fundamental to SCE's operational decision-making, service delivery and all-hazard emergency response." Provide documentation that explains and demonstrates specifically how SCE was able to perform its comprehensive situational awareness functions successfully during 2014-2017 without incurring any costs during this time period.

2) If SCE incurred costs during 2014-2017 for its situational awareness activities, provide the recorded expenses and the accounts where SCE recorded the costs.

3) Referring to page 90, lines 14-16, provide documentation that explains how SCE was able to effectively and efficiently forecast, track and monitor threats "to the grid which could cause issues to both public safety and power reliability" during 2014-2018 and prior to the creation of The Situational Awareness Center.

4) Provide documentation that explains where SCE's meteorologists (i.e., providing weather forecasts, analytics, and hazard advisories) were located and the accounts where SCE recorded the expenses during 2014-2018.

5) Provide documentation that shows the costs incurred between 2014-2018 for the ongoing and routine maintenance of SCE's weather stations.

6) Referring to page 89, line 26, provide the total number of weather stations installed as of December 31, 2019 and all associated expenses recorded in 2019.

Response to Question 01.b.1-6:

Q1.b1

As described in the GRC filing, in response to the significantly heightened threat of climate change and wildfire facing California, SCE is significantly enhancing its Situational Awareness capabilities to more fully understand the environmental landscape impacting the utility. This is requiring a substantial investment in a comprehensive Situational Awareness Program that includes advanced tools, technologies and applications. Prior to 2018, SCE relied on its expert meteorology, operational and emergency management staff to provide situational awareness.

Q1.b2

As stated previously, SCE is significantly expanding its Situational Awareness Program in response to new threats, so many of these costs are new. Prior to 2018, Situational Awareness costs were distributed across multiple organizations across the company. There is no practical way to capture these disparate costs.

Q1.b3

Prior to 2018, SCE relied on its expert meteorology, operational and emergency management staff to forecast, track and monitor threats to the grid. Although this was sufficient in prior years, SCE is expanding these capabilities to address the evolving threat of climate change and wildfire risk impacting California. This is requiring SCE to enhance its Situational Awareness programs with additional staff and technologies to effectively forecast and respond to these threats.

Q1.b4

SCE meteorologists were located with the Energy Procurement & Management department from 2014 – 2018 (refer to 2018 GRC SCE-05 Power Supply – Vol. 02 Energy Procurement). The expenses were recorded as part of SCE's O&M.

In April of 2018, SCE moved the existing meteorologists (3 employees) from the Energy Procurement & Management department to the Business Resiliency department. After establishing a comprehensive Situational Awareness Center, SCE hired 2 additional meteorologists to staff and support Enhanced Situational Awareness efforts for the mitigation of wildfire risk. The costs for the 2 additional meteorologists are being requested in the 2021 GRC under the Enhanced Situational Awareness work activity in the Wildfire Volume (SCE 04, V05).

Q1.b5

SCE's current weather station program was started in 2018, therefore no costs were recorded in 2014 - 2017. The 2018 maintenance costs are shown in the attached file "PubAdv-SCE-073-TLG Q1.b.5 Weather Station 2018 Recorded.xlsx"

Q1.b6

A total of 482 weather stations were installed as of 12/31/19. SCE will publish 2019 recorded expenses by 3/30/20.

Southern California Edison Company Test Year 2021 General Rate Case
Data Request No: PubAdv-SCE-073-TLG Q1.b.5

Origination Date: 1/13/20
Responses Due: 1/28/20

Subject: Weather Stations 2018 Recorded O&M

Question Q1.b.5: Provide documentation that shows the costs incurred between 2014-2018 for the ongoing and routine maintenance of SCE's weather stations

Year	Sub_Work Activity	L_NL_DESC	CE_Description	Nominal $s
2018	Weather Stations	L	TECHNICIAN	$74,198
2018	Weather Stations	L	OH PAID ABSENCE	$1,628
2018	Weather Stations	L	ENGINEER	$60,938
2018	Weather Stations	L	SPECIALIST	$45,502
2018	Weather Stations	L	LABOR NT NOH CORRX	$27,712
2018	Weather Stations	L	FOREMAN	$500
2018	Weather Stations	L	LABOR OTH NOH CORRX	$6,374
2018	Weather Stations	L	LABOR ACCRUAL	$1,260
2018	Weather Stations	L	LINEMAN	$935
2018	Weather Stations	L	LABOR PT NOH CORRX	$1,860
2018	Weather Stations	L	GROUNDMAN	$267
2018	Weather Stations	L	LABOR-OTH-CORRECTION	$0
2018	Weather Stations	L	LABOR-PT-CORRECTION	($1,238)
2018	Weather Stations	L	LABOR-NT-CORRECTION	($36,015)
2018	Weather Stations	N	OFC&OFC SPRT PRDT DP	$762
2018	Weather Stations	N	MTRS, MONIT & WRN IN	$447,860.00
2018	Weather Stations	N	MATERIAL SALES TAX	$80,719.52
2018	Weather Stations	N	COMM SYST & EQUP DP	$13,993.00
2018	Weather Stations	N	BLD&IND PRDS/EQP DP	$6,398.00
2018	Weather Stations	N	LIGHTING, STREET & F	$988.86
2018	Weather Stations	N	HARDWARE, POLE LINE	$581.28
2018	Weather Stations	N	RADIO BASE, MOBILE	$405.70

2018	Weather Stations	N	CONDUIT & FITTINGS,	$78.78
2018	Weather Stations	N	METAL, FABRICATED, C	$66.29
2018	Weather Stations	N	MAT-DP-CORRECTION	$0.00
2018	Weather Stations	N	COMM EQUIP & SYS	-$496,804.70
2018	Weather Stations	N	IBM	$366,692.92
2018	Weather Stations	N	WESTERN WEATHER GROUP I	$72,190.85
2018	Weather Stations	N	PAR ELECTRICAL CONTRACTO	$60,944.52
2018	Weather Stations	N	SEVERSON CO INC	$4,465.12
2018	Weather Stations	N	GENERAL SUPPORT SVCS	$8,094.56
2018	Weather Stations	N	EDISON MATERIAL SUPPLY	$774.04
2018	Weather Stations	N	CELLCO PARTNERSHIP	$4,803.79
2018	Weather Stations	N	CONTR. BUS SVC-OTHER	-$40,964.74
2018	Weather Stations	N	SECURITY	$0.00
2018	Weather Stations	N	ENVIRN/SAFETY SVCS	-$344,832.97
2018	Weather Stations	N	OUTSD SVC-CORRECTION	$0.00
2018	Weather Stations	N	MEALS-MTG W NONEMP	$1,009.73
2018	Weather Stations	N	LODGING	$255.25
2018	Weather Stations	N	EMPLOYEE EXP - OTHER	$2,017.17
2018	Weather Stations	N	MEALS-BUS TRAV/SEM.	$1,175.99
2018	Weather Stations	N	MILEAGE	$75.22
2018	Weather Stations	N	FUEL COSTS	$0.00
2018	Weather Stations	N	OTHER GEN OPER EXP	$105,237.00
2018	Weather Stations	N	A/P ACCRUAL/REVERSAL	-$0.02
2018	Weather Stations	N	OTHER/GEN-CORRECTION	$0.00
Grand Total				**480,907**

Workpaper Title:

Enhanced Situational Awareness (O&M)

Forecast - HD Cameras O&M

2018 000's $

	2019	2020	2021	2022	2023
Total Dollars	$ 4,216	$ 1,553	$ 1,651	$ 1,651	$ 1,651
Total Units	160	160	160	160	160

	2019	**2020**	**2021**	**2022**	**2023**
Management Costs	$ 122	$ 125	$ 223	$ 223	$ 223
Maintenance	$ 1,751	$ 852	$ 852	$ 852	$ 852
Travel to tower sites	$ -	$ -	$ -	$ -	$ -
Equipment (Camera kits, routers, computer hardware)	$ 60	$ 20	$ 20	$ 20	$ 20
Installation, Maintenance, Operation	$ 528	$ 176	$ 176	$ 176	$ 176
Indirect Costs	$ 1,756	$ 380	$ 380	$ 380	$ 380
Total (2018$)	**$ 4,216**	**$ 1,553**	**$ 1,651**	**$ 1,651**	**$ 1,651**

Forecast - Weather Stations O&M

2018 000's $

		2019	2020	2021	2022	2023
A = AC	**Total Dollars**	$ 640	$ 1,240	$ 1,463	$ 1,463	$ 1,464
B = D	**Total Units**	475	850	850	850	850

	Forecast Details	**2019**	**2020**	**2021**	**2022**	**2023**
C	Number of new Weather Station Installations	350	375	0	0	0
D	Cumulative Weather Stations Installed	475	850	850	850	850
E	Data Collection and Reporting ($33/month cost per)	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03
F	Number of months for data collection	12	12	12	12	12
G	Deployment Ratio	0.7	0.8	1	1	1
H = D*E*F*G	Data Collection and Reporting Fees	$ 132	$ 269	$ 337	$ 337	$ 337
I	Contract Maintenance ($400/year cost per)	$ 0	$ 0	$ 0	$ 0	$ 0
J = D*I	Contract Maintenance Fees	$ 190	$ 340	$ 340	$ 340	$ 340
K = D*K	5% rate of breakfix per device installed	0.05	0.05	0.05	0.05	0.05
L	Estimated breakfixes	24	43	43	43	43
M	Contract Breakfix ($500 labor + $1000 parts)	$ 2	$ 2	$ 2	$ 2	$ 2
N	Number of months for breakfixes	12	12	12	12	12
O	Deployment Ratio	0.7	0.8	1.0	1.0	1.0
P = L*M*N*O	Breakfix fees	$ 299	$ 612	$ 765	$ 765	$ 765
R	Meso West ($1.5/month to send to MesoWest to make publicly available cost per)	$ 0.0015	$ 0.0015	$ 0.0015	$ 0.0015	$ 0.0015
S	Number of months for MesoWest	12	12	12	12	12
T	Deployment Ratio	0.7	0.8	1	1	1
U = D*R*S*T	MesoWest Fees	$ 6	$ 12	$ 15	$ 15	$ 15
V	Kestrels (hand held weather stations) cost pers	$ 0.14	$ 0.14	$ 0.14	$ 0.14	$ 0.14
W	Number of Kestrels	50	0	0	0	0
X = V*W	Kestrel fees	$ 7	$ -	$ -	$ -	$ -
Y	Replacement for lost/damaged Kestrels	$ 0.14	$ 0.14	$ 0.14	$ 0.14	$ 0.15
Z	Number of Kestrels	200	200	200	200	200
AA	Replacement ratio	0.23	0.23	0.23	0.23	0.23
AB = Y*Z*AA	Replacement for lost/damaged fees	$ 6	$ 6	$ 6	$ 6	$ 7
AC = H+J+P+U+X+AB	O&M Weather Station Total (2018 000's $)	$ 640	$ 1,240	$ 1,463	$ 1,463	$ 1,464

Forecast - Wildfire Response, Modeling, Analysis, & Weather Forecasting O&M

(Constant 2018 000's $)

	2019	2020	2021	2022	2023
Total Dollars	**$ 480**	**$ 480**	**$ 480**	**$ 480**	**$ 480**

Forecast Details - Labor	2019	2020	2021	2022	2023
Fire Manager	$ 110	$ 110	$ 110	$ 110	$ 110
Fire Science Forecasting	$ 130	$ 130	$ 130	$ 130	$ 130
Meteorology Forecasting	$ 220	$ 220	$ 220	$ 220	$ 220
Total	$ 460	$ 460	$ 460	$ 460	$ 460

Forecast Details - Non-Labor	2019	2020	2021	2022	2023
Fire Management Vehicle	$ 20	$ 20	$ 20	$ 20	$ 20
Total O&M	$ 480	$ 480	$ 480	$ 480	$ 480

Forecast Summary - Enhanced Situational Awareness (O&M)

	(Constant 2018 $000s)					
	2019	**2020**	**2021**	**2022**	**2023**	**Total**
HD Cameras O&M[1]	$4,216	$1,553	$1,651	$1,651	$1,651	$10,722
Weather Stations O&M[2]	$ 640	$ 1,240	$ 1,463	$ 1,463	$ 1,464	$ 6,270
Wildfire Response, Modeling, Analysis, & Weather Forecasting[3]	$ 480	$ 480	$ 480	$ 480	$ 480	$2,399
Enhanced Situational Awareness	$5,336	$ 3,272	$ 3,594	$ 3,594	$ 3,595	$ 19,391

Notes

[1] See "Forecast - HD Cameras O&M"

[2] See "Forecast - Weather Stations O&M"

[3] See "Forecast - Wildfire Response, Modeling, Analysis & Weather Forecasting"

Workpaper Title:

Capital Detail by WBS Element for Enhanced Situational Awareness

Southern California Edison
2021 GRC Capital Workpapers

Exhibit:	SCE-04 Resiliency
Volume:	Wildfire Management Volume 5
Business Plan Group:	Resiliency
Business Plan Element:	Wildfire Management
GRC Activity:	Enhanced Situational Awareness

1. Witness:	D. Daigler
2. Asset type:	Telecommunications
3. In-Service date:	Specific Blanket
4. RO Model ID:	828
5. Pin:	8159
6. CWBS Element:	COS-00-GR-BR-815900
CWBS Description:	Grid Resiliency - Weather stations & Cam
7. SRIIM Eligible:	No

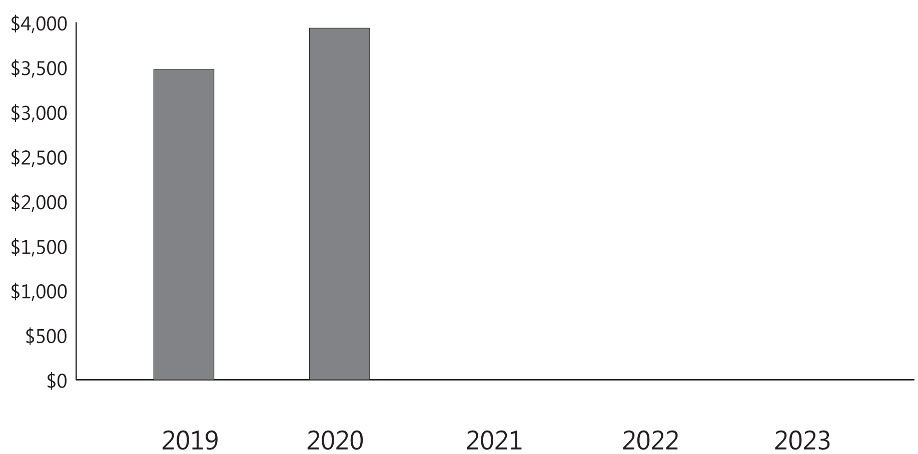
Cost Estimates - Nominal ($000)

2021 GRC - Capital Expenditures Forecast

Year	2019	2020	2021	2022	2023
SCE$	3,476	3,939	0	0	0

2019 - 2023 Total
7,415

Due to rounding, totals may not tie to individual items.



Southern California Edison
2021 GRC Capital Workpapers

Exhibit:	SCE-04 Resiliency
Volume:	Wildfire Management Volume 5
Business Plan Group:	Resiliency
Business Plan Element:	Wildfire Management
GRC Activity:	Enhanced Situational Awareness

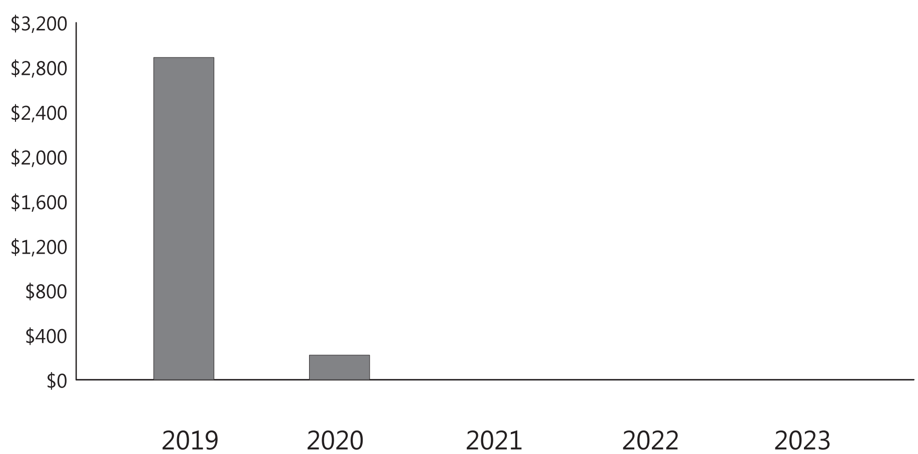
1. Witness:	D. Daigler
2. Asset type:	Furniture & Equipment
3. In-Service date:	12/01/2021
4. RO Model ID:	829
5. Pin:	8159
6. CWBS Element:	COS-00-GR-BR-815902
CWBS Description:	HD Cameras
7. SRIIM Eligible:	No

Cost Estimates - Nominal ($000)

2021 GRC - Capital Expenditures Forecast

Year	2019	2020	2021	2022	2023	2019 - 2023 Total
SCE$	2,888	220	0	0	0	3,108

Due to rounding, totals may not tie to individual items.



Workpaper Title:

Enhanced Situational Awareness (Capital)

Forecast Summary - Enhanced Situational Awareness (Capital)

	(Nominal $000s)					
	2019	2020	2021	2022	2023	Total
HD Cameras Capital[1]	$2,888	$220	$ -	$ -	$ -	$3,108
Weather Stations Capital[2]	$3,476	$3,939	$ -	$ -	$ -	$7,415
Enhanced Situational Awareness (Capital)	$6,364	$4,159	$ -	$ -	$ -	$10,523

Notes
[1] See "Forecast - HD Cameras Capital"
[2] See "Forecast - Weather Stations Capital"

Forecast - HD Cameras (Capital)

Nominal 000's $

	2019	2020	2021	2022	2023
Total Dollars	**$ 2,888**	**$ 220**	**$ -**	**$ -**	**$ -**
Total Units	120	0	0	0	0

	2019	2020	2021	2022	2023
Management Costs	$ 790	$ 191	$ -	$ -	$ -
Maintenance	$ -	$ -	$ -	$ -	$ -
Travel to tower sites	$ 143	$ 15	$ -	$ -	$ -
Equipment (Camera kits, routers, computer har	$ 1,613	$ -	$ -	$ -	$ -
Installation, Maintenance, Operation	$ -	$ -	$ -	$ -	$ -
Indirect Costs	$ 275	$ 7	$ -	$ -	$ -
UCSD Camera Fees (2018$)	$ 2,822	$ 213	$ -	$ -	$ -

Escalation Index	**2019**	**2020**	**2021**	**2021**	**2021**
CAP - GEN PLANT	1.0235	1.0338	1.0489	1.066455	1.083923
Cameras Capital (2018 000's$)	$ 2,822	$ 213	$ -	$ -	$ -
Cameras Capital (Nominal 000's $)	$ 2,888	$ 220	$ -	$ -	$ -
Planned Camera Units for Installation	120	0	0	0	0

Forecast - Weather Stations Capital

Nominal 000's $

		2019	2020	2021	2022	2023
A = T	**Total Dollars**	$ 3,558	$ 4,032	$ -	$ -	$ -
B = F + I	**Total Units**	350	375	-	-	-

		2019	2020	2021	2022	2023
	Installation					
C = F + I	# of Units	350	375	0	0	0
D	Cost Per	$ 2.0	$ 2.0	$ -	$ -	$ -
E = C*D	**Total Dollars**	**$ 700**	**$ 750**	**$ -**	**$ -**	**$ -**
	Weather Station Equipment (Satellite Enabled)					
F	# of Units	200	375	0	0	0
G	Cost Per	$ 7.6	$ 7.6	$ -	$ -	$ -
H = F*G	**Total Dollars**	**$ 1,517**	**$ 2,844**	**$ -**	**$ -**	**$ -**
	Weather Station Equipment (Cell Enabled)					
I	# of Units	150	0	0	0	0
J	Cost Per	$ 6.4	$ -	$ -	$ -	$ -
K = I*J	**Total Dollars**	**$ 960**	**$ -**	**$ -**	**$ -**	**$ -**
	B-Materials					
L	# of Units	400	400	0	0	0
M	B-Materials	$ 0.5	$ 0.5	$ -	$ -	$ -
N = L*M	**Total Dollars**	**$ 212**	**$ 212**	**$ -**	**$ -**	**$ -**
	Site Assessment					
O	# of Units	350	375	0	0	0
P	Site Assessment	$ 0.3	$ 0.3	$ -	$ -	$ -
Q = O*P	**Total Dollars**	**$ 88**	**$ 94**	**$ -**	**$ -**	**$ -**
R = E+H+K+N	Total Cost (2018 000$)	$ 3,476	$ 3,900	$ -	$ -	$ -
S	*Escalation Index*	1.02354	1.03378	1.04893	1.06645	1.08392
T = R*S	Weather Stations (Nominal 000's $)	$ 3,558	$ 4,032	$ -	$ -	$ -

Application No.: A.19-08-013
Exhibit No.: SCE-04 Vol. 5A E
Witnesses: ~~B. Chen~~ R. Roy
D. Daigler
K. Gardner
~~R. Sholler~~ R. Fugere

SOUTHERN CALIFORNIA
EDISON®
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(U 338-E)

2021 General Rate Case

Errata

Amended Testimony on Wildfire Management

Before the

Public Utilities Commission of the State of California

Rosemead, California
November 22, 2019

SCE-04, Volume 5A: E Amended Testimony on Wildfire Management

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A310

E

SCE-04, Volume 5A: Amended Testimony on Wildfire Management

Table Of Contents (Continued)

Table I-1
O&M Activities
(Constant 2018 $000)

	Recorded		Forecast	
	2018	2019	2020	2021
		$209,481	$171,266	$54,232
Asset Reliability Risk Analytics	$128			
Community Resiliency Incentives				$3,450
Distribution Fault Anticipation		$729	$205	$68
Enhanced Overhead Inspections and Remediations	$4,863	~~$214,163~~	~~$175,947~~	~~$58,914~~
Enhanced Situational Awareness	$382	$5,336	$3,272	$3,594
Fire Science and Advanced Modeling	$1,873	$2,110	$4,974	$3,948
Fusing Mitigation		$52	$7,409	$1,089
Grid Resiliency PMO	$57	$22,655	$12,271	
HFRA Sectionalizing Devices	$2,727	$1,231	$151	
Infrared Inspection Program	$0	$5,068	$3,797	$3,797
Organizational Support		$2,171	$3,354	$3,354
PSPS Customer Support	$852	$13,877	$13,365	$13,311
PSPS Execution	$169	$13,727	$14,030	$13,922
Weather Stations	$253			
Wildfire Covered Conductor Program		$50		
Totals	**$11,305**	**~~$281,168~~**	**~~$238,777~~**	**~~$105,447~~**
		$276,486	**$234,095**	**$100,765**

Table I-2
Capital Activities
(Total Company Nominal $000)[4]

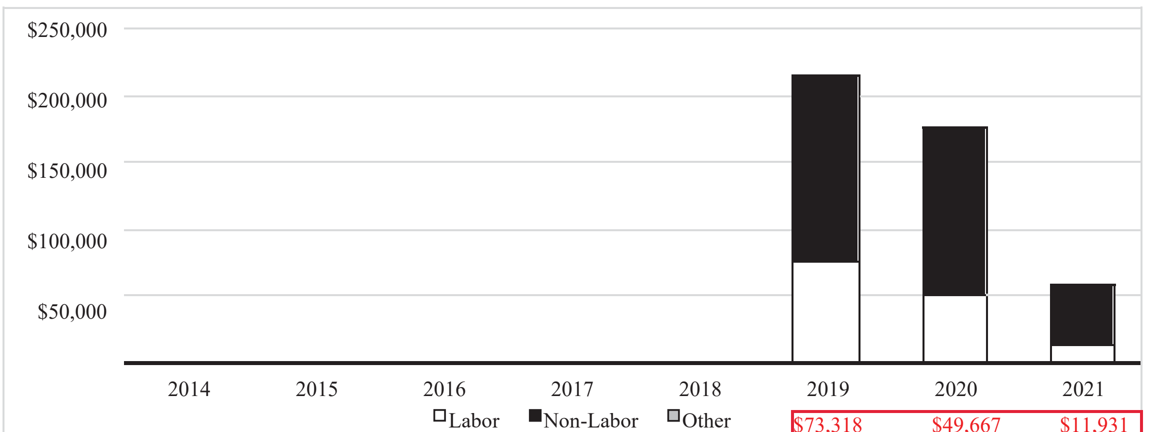
	Recorded			Forecast		
	2018	2019	2020	2021	2022	2023
HFRA Sectionalizing Devices		$6,292	$28,452	$5,209	$5,360	
Distribution Fault Anticipation		$2,340	$0	$6,270	$12,903	$13,274
Enhanced Overhead Inspections and Remediations	$100	$148,610 ~~$154,849~~	$148,312 ~~$149,695~~	$51,205 ~~$52,432~~	$45,216 ~~$46,310~~	$41,570 ~~$42,755~~
Enhanced Situational Awareness	$2,997	$6,364	$4,159			
Fire Science and Advanced Modeling		$12,953	$5,685	$1,102		
Fusing Mitigation		$54,795	$11,446			
PSPS Execution		$180	$1,212	$738		
Undergrounding				$22,507	$42,457	$43,678
Wildfire Covered Conductor Program		$156,337	$533,803	$771,099	$906,746	$1,107,732
Totals	**$3,097**	~~**$394,110**~~ $387,871	~~**$734,453**~~ $733,070	~~**$859,358**~~ $858,131	~~**$1,013,775**~~ $1,012,682	~~**$1,207,439**~~ $1,206,254

4 Refer to WP SCE-04 Vol. 05A, Part 1 pp. 1 - 2 - Capital Summary for Wildfire Management SCE-04, Volume 5A.

CPUC General Order 95 Rule 18 has designated adjusted compliance timeframes for issues identified in HFRA. In addition to the need to meet state compliance regulations, remediation is intended to minimize wildfire risk, increase public safety, and ensure optimal electrical reliability to SCE customers. Remediation efforts have been vetted through multiple subject matter experts and external consultants to ensure SCE's approach to wildfire mitigation takes into account risk associated to the tier level of a notification, types of notification found in the inspection process, and consequence of a wildfire threat as prioritized using latest wildfire modeling data.

(3) EOI O&M Forecast

Figure II-20
Enhanced Overhead Inspections O&M Expenses
(Constant 2018 $000)[54]



	Recorded					Forecast		
	2014	**201S**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Labor					$4,533	~~$76,012~~	~~$50,935~~	~~$12,868~~
Non-Labor		$1			$330	~~$138,151~~	~~$125,013~~	~~$46,046~~
Other						$136,163	$121,599	$42,301
Total Expenses		**$1**			**$4,863**	~~**$214,163**~~	~~**$175,947**~~	~~**$58,914**~~
Ratio of Labor to Total	-	0%	-	-	93%	35%	29%	22%

$209,481 $171,266 $54,232

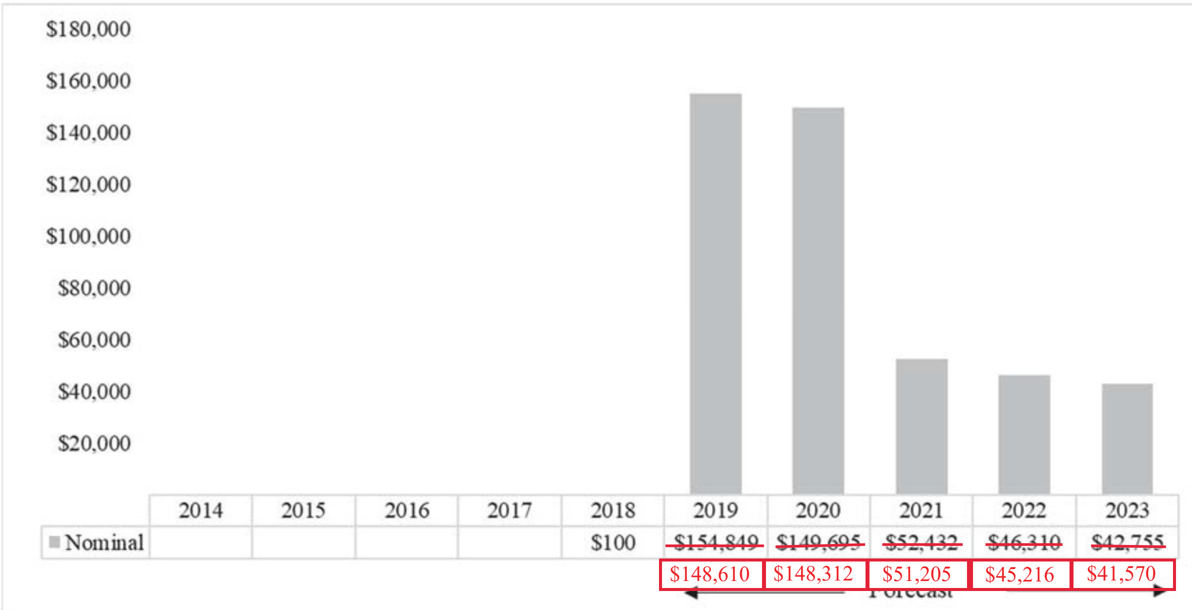
(a) Basis for O&M Cost Forecast

This forecast is composed of Transmission EOI, Distribution EOI, and Aerial inspections; Transmission and Distribution EOI repairs; long span mitigation; vertical switch

[54] Refer to WP SCE-04 Vol. 05A, Part 1 pp. 370 - 376 – O&M Detail for Enhanced Overhead Inspections and Remediation.

(4) EOI Capital Expenditures

Figure II-21
Enhanced Overhead Inspections
2019-2023 Forecast
(Total Company – Nominal $000)[56]



(a) Basis for Capital Expenditure Forecast

This forecast is composed of transmission EOI replacements, distribution EOI replacements, long span mitigations, vertical switch replacements, and EOI PMO. SCE summarizes the individual methods used to forecast each of these components below, and provides further detail in workpapers:[57]

- Transmission and distribution EOI replacement expenditures are based on a forecast of capital notifications identified from EOI inspections that require capital remediation, while cost per notification is based on previously completed notifications.

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56 Refer to WP SCE-04 Vol. 05A, Part 1 pp. 390 - 396 - Capital Detail by WBS Element for Enhanced Overhead Inspections and Remediation.

57 Refer to WP SCE-04 Vol. 05A, Part 1 pp. 397 - 405 - Enhanced Overhead Inspections (Capital).

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2021 General Rate Case
A.19-08-013

Workpapers

Amended

Errata

Wildfire Management
SCE-04 Volume 05A, Part 01E

June 2020

Forecast Summary - Enhanced Overhead Inspections and Remediations (O&M)

(Constant 2018 $000s)

	2019	2020	2021	2022	2023	Total
EOI Inspections - T[1]	$ 8,961	$ -	$ -	$ -	$ -	$ 8,961
EOI Inspections - D[2]	$ 37,951	$ 9,626	$ 9,626	$ 9,626	$ 9,626	$ 76,456
Aerial Inspections - D[3]	$ 32,613	$ 12,691	$ 12,691	$ 12,691	$ 12,691	$ 83,379
EOI Repairs - T[4]	$ 21,966	$ 6,647	$ 6,647	$ 6,043	$ 6,043	$ 47,346
EOI Repairs - D[5]	$ 77,467	$ 97,167	$ 14,553	$ 13,657	$ 12,757	$ 215,601
Long Span Mitigation (O&M)[6]	$ 17,674	$ 33,497	$ -	$ -	$ -	$ 51,170
Vertical Switches (O&M)[7]	$ 110	$ 27	$ -	$ -	$ -	$ 137
EOI PMO (O&M)[8]	$ 17,422	$ 16,291	$ 15,395	$ 12,471	$ 12,993	$ 74,572
Total EOI O&M	**$ 214,163**	**$ 175,947**	**$ 58,913**	**$ 54,489**	**$ 54,110**	**$ 557,622**

1. Pulled from recorded SAP costs on 4/25/19
2. See "Forecast - EOI Inspection - Distribution"
3. See "Forecast - Aerial Inspections - Distribution"
4. See "Forecast - EOI Repairs - Transmission"
5. See "Forecast - EOI Repairs - Distribution"
6. See "Forecast - Long Span Mitigation (O&M)"
7. See "Forecast - Vertical Switches (O&M)"
8. See "Forecast - EOI PMO (O&M)"

Forecast Summary - Enhanced Overhead Inspections and Remediations (O&M)

(Constant 2018 $000s)

	2019	2020	2021	2022	2023	Total
EOI Inspections - T[1]	$ 8,961	$ -	$ -	$ -	$ -	$ 8,961
EOI Inspections[4] - D[2]	$ 37,951	$ 9,626	$ 9,626	$ 9,626	$ 9,626	$ 76,456
Aerial Inspections - D[3]	$ 32,613	$ 12,691	$ 12,691	$ 12,691	$ 12,691	$ 83,379
EOI Repairs - T	$ 21,966	$ 6,647	$ 6,647	$ 6,043	$ 6,043	$ 47,346
EOI Repairs - D[5]	$ 77,467	$ 97,167	$ 14,553	$ 13,657	$ 12,757	$ 215,601
Long Span Mitigation (O&M)[6]	$ 17,674	$ 33,497	$ -	$ -	$ -	$ 51,170
Vertical Switches (O&M)[7]	$ 110	$ 27	$ -	$ -	$ -	$ 137
EOI PMO (O&M)[8]	$ 12,741	$ 11,610	$ 10,714	$ 7,789	$ 8,312	$ 51,165
Total EOI O&M	**$ 209,481**	**$ 171,266**	**$ 54,232**	**$ 49,807**	**$ 49,429**	**$ 534,215**

1. Pulled from recorded SAP costs on 4/25/19
2. See "Forecast - EOI Inspection - Distribution"
3. See "Forecast - Aerial Inspections - Distribution"
4. See "Forecast - EOI Repairs - Transmission"
5. See "Forecast - EOI Repairs - Distribution"
6. See "Forecast - Long Span Mitigation (O&M)"
7. See "Forecast - Vertical Switches (O&M)"
8. See "Forecast - EOI PMO (O&M)"

Forecast - EOI Repairs - Transmission

Transmission Inspection Notification Info (2019)

Notification Problem Statement	Frequency (A)	Total Inspection Notifications (B)	Problem Statement Count (A x B)	Adjusted Notifications[1]	Avg Cost/Notification	Total Cost	O&M
Pole Replacement	0.15	13,750	2,063	1444	$ 30,000	$ 43,312,500	
Pole Repair	0.3	13,750	4,125	N/A	$ 1,476 [2]	$ 6,088,500	x
Tower Repair	0.05	13,750	688	N/A	$ 5,606 [3]	$ 3,854,125	x
Veg Mgmt	0.3	13,750	4,125	N/A	$ 1,193 [4]	$ 4,921,125	x
Conductor Repair	0.15	13,750	2,063	N/A	$ 2,469 [5]	$ 5,092,313	x
Other O&M	0.05	13,750	688	N/A	$ 546 [6]	$ 375,375	x
	1.00				Preliminary	$ 63,643,938	$ 20,331,438
					EOI Notification Adder	$ 6,364,394	$ 2,033,144
					Total	**$ 70,008,331**	**$ 22,364,581**

Transmission Inspection Notification Info (2020-2021)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	O&M
Pole Replacement	0.15	4,850	728	509	$ 30,000	$ 15,277,500	
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	x
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	x
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	x
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	x
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	x
	1.00				Preliminary	$ 22,448,953	$ 7,171,453
					EOI Notification Adder	$ 2,244,895	$ 717,145
					Total	**$ 24,693,848**	**$ 7,888,598**

Transmission Inspection Notification Info (2022-2023)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	O&M
Pole Replacement	0.15	4,850	728	509	$ 30,000	$ 15,277,500	
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	x
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	x
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	x
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	x
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	x
	1.00				**Total**	**$ 22,448,953**	**$ 7,171,453**

NOTIFICATION RATE

	Structures	2019 - find rate	2020 - find rate	2021 - find rate	2022 - find rate	2023 - find rate
HFRA	48,500		10%	10%	10%	10%
EOI already performed	55,000	25%				
	Notifications	13,750	4,850	4,850	4,850	4,850

	2019	2020	2021	2022	2023
Units	11,688	4,123	4,123	4,123	4,123
EOI Repairs - T (2019 $000)	$ 22,365	$ 7,889	$ 7,889	$ 7,171	$ 7,171
EOI Repairs - T (2018 $000)	$ 21,966	$ 7,748	$ 7,748	$ 7,044	$ 7,044
HFRA Update Adjustment Factor	100%	86%	86%	86%	86%
Total EOI Repairs - T (2018 $000)	$21,966	$6,647	$6,647	$6,043	$6,043

Escalation Index	2019	2020	2021	2022	2023
O&M - Transmission	1.0181	1.0269	1.0357	1.0470	1.0606

Assumptions:
1. 30% reduction to account for poles completed by Deteriorated Pole Program
2. 2,506 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,476.
3. 1,310 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $5,606.
4. 93 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,123.
5. 1,486 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $2,469.
6. 2,542 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $546.

Forecast - EOI Repairs - Transmission

Transmission Inspection Notification Info (2019)

Notification Problem Statement	Frequency (A)	Total Inspection Notifications (B)	Problem Statement Count (A x B)	Adjusted Notifications[1]	Avg Cost/Notification	Total Cost	O&M
Pole Replacement	0.15	13,750	2,063	1444	$ 26,071	$ 37,640,463	
Pole Repair	0.3	13,750	4,125	N/A	$ 1,476 [2]	$ 6,088,500	x
Tower Repair	0.05	13,750	688	N/A	$ 5,606 [3]	$ 3,854,125	x
Veg Mgmt	0.3	13,750	4,125	N/A	$ 1,193 [4]	$ 4,921,125	x
Conductor Repair	0.15	13,750	2,063	N/A	$ 2,469 [5]	$ 5,092,313	x
Other O&M	0.05	13,750	688	N/A	$ 546 [6]	$ 375,375	x
	1.00				Preliminary	$ 57,971,900	$ 20,331,438
					EOI Notification Adder	$ 5,797,190	$ 2,033,144
					Total	**$ 63,769,090**	**$ 22,364,581**

Transmission Inspection Notification Info (2020-2021)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	O&M
Pole Replacement	0.15	4,850	728	509	$ 25,335	$ 12,901,940	
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	x
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	x
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	x
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	x
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	x
	1.00				Preliminary	$ 20,073,393	$ 7,171,453
					EOI Notification Adder	$ 2,007,339	$ 717,145
					Total	**$ 22,080,732**	**$ 7,888,598**

Transmission Inspection Notification Info (2022-2023)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	O&M
Pole Replacement	0.15	4,850	728	509	$ 25,335	$ 12,901,940	
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	x
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	x
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	x
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	x
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	x
	1.00				**Total**	**$ 20,073,393**	**$ 7,171,453**

NOTIFICATION RATE

	Structures	2019 - find rate	2020 - find rate	2021 - find rate	2022 - find rate	2023 - find rate
HFRA	48,500		10%	10%	10%	10%
EOI already performed	55,000	25%				
	Notifications	13,750	4,850	4,850	4,850	4,850

	2019	2020	2021	2022	2023
Units	11,688	4,123	4,123	4,123	4,123
EOI Repairs - T (2019 $000)	$ 22,365	$ 7,889	$ 7,889	$ 7,171	$ 7,171
EOI Repairs - T (2018 $000)	$ 21,966	$ 7,748	$ 7,748	$ 7,044	$ 7,044
HFRA Update Adjustment Factor	100%	86%	86%	86%	86%
Total EOI Repairs - T (2018 $000)	$21,966	$6,647	$6,647	$6,043	$6,043

Escalation Index	2019	2020	2021	2022	2023
O&M - Transmission	1.0181	1.0269	1.0357	1.0470	1.0606

Assumptions:

1. 30% reduction to account for poles completed by Deteriorated Pole Program
2. 2,506 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,476.
3. 1,310 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $5,606.
4. 93 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,123.
5. 1,486 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $2,469.
6. 2,542 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $546.

Forecast - EOI PMO (O&M)

	(Constant 2018 $000s)				
	2019	**2020**	**2021**	**2022**	**2023**
Cost of IT Projects[1]	$ 10,144	$ 12,349	$ 15,395	$ 12,471	$ 12,993
Cost of PMO Support[2]	$ 7,278	$ 3,942	$ -	$ -	$ -
Total EOI PMO O&M Constant 2018$)	**$ 17,422**	**$ 16,291**	**$ 15,395**	**$ 12,471**	**$ 12,993**

[1]See "Forecast - EOI PMO IT Projects (O&M)"

[2]See "Forecast - EOI PMO Support Detail (O&M)"

Forecast - EOI PMO (O&M)

	(Constant 2018 $000s)				
	2019	**2020**	**2021**	**2022**	**2023**
Cost of IT Projects[1]	$ 5,462	$ 7,667	$ 10,714	$ 7,789	$ 8,312
Cost of PMO Support[2]	$ 7,278	$ 3,942	$ -	$ -	$ -
Total EOI PMO O&M Constant 2018$)	**$ 12,741**	**$ 11,610**	**$ 10,714**	**$ 7,789**	**$ 8,312**

[1]See "Forecast - EOI PMO IT Projects (O&M)"

[2]See "Forecast - EOI PMO Support Detail (O&M)"

Forecast - EOI PMO IT Projects (O&M)

	(Constant 2019 $000s)				
IT Project Support	**2019**	**2020**	**2021**	**2022**	**2023**
Mobile Crew Management	$ 180	$ 180	$ 180	$ 180	$ 180
Remote Sensing Aerial Survey Inspection	$ 2,205	$ 4,433	$ 7,508	$ 4,626	$ 5,160
Remote Sensing Aerial Survey Inspection (ongoing)	$ 4,787	$ 4,787	$ 4,787	$ 4,787	$ 4,787
Portfolio Planning, Optimization and Resource Planning for Poles and Covered Conductor	$ 60	$ 60	$ 60	$ 60	$ 60
iPad Deployment & Support	$ 1,316	$ 1,316	$ 1,316	$ 1,316	$ 1,316
IMAC support to the Lay down yards (incl. in Contractor Mobile Solution)	$ -	$ -	$ -	$ -	$ -
EOI - Drone2Map - Application Support Only	$ 20	$ 20	$ 20	$ 20	$ 20
EOI - Notifications Automation - Distribution	$ 240	$ 240	$ 240	$ 240	$ 240
EOI - Notifications Automation - Transmission	$ 100	$ 100	$ 100	$ 100	$ 100
EOI - Additional ArcGIS/Winshuttle/CMS Mobile Licenses	$ 200	$ 200	$ 200	$ 200	$ 200
E1P1- CMS Notification form update for Safety Reporting	$ 10	$ 10	$ 10	$ 10	$ 10
EOI- Remediation process - Contractor Mobile solution to handle 270,000 Notification	$ 130	$ 130	$ 130	$ 130	$ 130
SMT Enhancement Requirements	$ 220	$ 220	$ 220	$ 220	$ 220
Click - Background Optimizer for auto scheduling and dispatching of EOI Notification	$ 55	$ 55	$ 55	$ 55	$ 55
Transitional Cost to Move to Longer Term Solutions	$ -	$ -	$ -	$ -	$ -
SurfacePro and Blue Beam for Planner	$ 618	$ 618	$ 618	$ 618	$ 618
Survey 123 for Distribution	$ 100	$ 100	$ 100	$ 100	$ 100
Situational Awareness Phase 2 -Visual Weather Forecast Data and Reporting	$ 18	$ 18	$ 18	$ 18	$ 18
Asset Reliability & Risk Analytics (ARRA)	$ 114	$ 140	$ 72	$ 72	$ 72
EOI Support Adjustment	$ -	$ -	$ 109	$ -	$ -
IT Project Support (Constant 2019$)	$ 10,371	$ 12,626	$ 15,741	$ 12,751	$ 13,285
EOI PMO (O&M) (Constant 2018$)	**$ 10,144**	**$ 12,349**	**$ 15,395**	**$ 12,471**	**$ 12,993**

Escalation Index	**2019**	**2020**	**2021**	**2022**	**2023**
O&M - Distribution	1.0225	1.0350	1.0469	1.0617	1.0805
EOI PMO (O&M) (Constant 2018$)	$ 10,144	$ 12,349	$ 15,395	$ 12,471	$ 12,993
EOI PMO (O&M) (Nominal$)	**$ 10,371**	**$ 12,781**	**$ 16,117**	**$ 13,240**	**$ 14,040**

Forecast - EOI PMO IT Projects (O&M)

	(Constant 2019 $000s)									
IT Project Support		**2019**		**2020**		**2021**		**2022**		**2023**
Mobile Crew Management	$	180	$	180	$	180	$	180	$	180
Remote Sensing Aerial Survey Inspection	$	2,205	$	4,433	$	7,508	$	4,626	$	5,160
~~Remote Sensing Aerial Survey Inspection (ongoing)~~	~~$~~	~~4,787~~	~~$~~	~~4,787~~	~~$~~	~~4,787~~	~~$~~	~~4,787~~	~~$~~	~~4,787~~
Portfolio Planning, Optimization and Resource Planning for Poles and Covered Conductor	$	60	$	60	$	60	$	60	$	60
iPad Deployment & Support	$	1,316	$	1,316	$	1,316	$	1,316	$	1,316
IMAC support to the Lay down yards (incl. in Contractor Mobile Solution)	$	-	$	-	$	-	$	-	$	-
EOI - Drone2Map - Application Support Only	$	20	$	20	$	20	$	20	$	20
EOI - Notifications Automation - Distribution	$	240	$	240	$	240	$	240	$	240
EOI - Notifications Automation - Transmission	$	100	$	100	$	100	$	100	$	100
EOI - Additional ArcGIS/Winshuttle/CMS Mobile Licenses	$	200	$	200	$	200	$	200	$	200
E1P1- CMS Notification form update for Safety Reporting	$	10	$	10	$	10	$	10	$	10
EOI- Remediation process - Contractor Mobile solution to handle 270,000 Notification	$	130	$	130	$	130	$	130	$	130
SMT Enhancement Requirements	$	220	$	220	$	220	$	220	$	220
Click - Background Optimizer for auto scheduling and dispatching of EOI Notification	$	55	$	55	$	55	$	55	$	55
Transitional Cost to Move to Longer Term Solutions	$	-	$	-	$	-	$	-	$	-
SurfacePro and Blue Beam for Planner	$	618	$	618	$	618	$	618	$	618
Survey 123 for Distribution	$	100	$	100	$	100	$	100	$	100
Situational Awareness Phase 2 -Visual Weather forecast Data and Reporting	$	18	$	18	$	18	$	18	$	18
Asset Reliability & Risk Analytics (ARRA)	$	114	$	140	$	72	$	72	$	72
EOI Support Adjustment	$	-	$	-	$	109	$	-	$	-
IT Project Support (Constant 2019$)	$	5,585	$	7,839	$	10,954	$	7,964	$	8,498
EOI PMO (O&M) (Constant 2018$)	**$**	**5,462**	**$**	**7,667**	**$**	**10,714**	**$**	**7,789**	**$**	**8,312**

Escalation Index		**2019**		**2020**		**2021**		**2022**		**2023**
O&M - Distribution		1.0225		1.0350		1.0469		1.0617		1.0805
~~EOI PMO (O&M) (Constant 2018$)~~	~~$~~	~~10,144~~	~~$~~	~~12,349~~		~~15,395~~		~~12,471~~		~~12,993~~
~~EOI PMO (O&M) (Nominal$)~~	~~$~~	~~10,371~~	~~$~~	~~12,781~~		~~16,117~~		~~13,240~~		~~14,040~~

Forecast Summary - Enhanced Overhead Inspections and Remediations (Capital)

(Nominal $000s)

	2019	2020	2021	2022	2023	Total
EOI Replacements - T[1]	$ 47,644	$ 14,816	$ 15,133	$ 14,020	$ 14,341	$ 105,953
EOI Replacements - D[2]	$ 67,201	$ 81,257	$ 27,931	$ 26,960	$ 25,910	$ 229,259
Long Span Mitigation (Capital)[3]	$ 9,344	$ 29,119	$ -	$ -	$ -	$ 38,463
Vertical Switches (Capital)[4]	$ 750	$ 1,558	$ 2,813	$ 2,895	$ -	$ 8,016
EOI PMO (Capital)[5]	$ 29,910	$ 22,946	$ 6,555	$ 2,435	$ 2,505	$ 64,351
Total EOI Capital (Nominal $)	**$ 154,849**	**$ 149,695**	**$ 52,432**	**$ 46,309**	**$ 42,756**	**$ 446,042**

1. See "Forecast - EOI Replacements - Transmission"
2. See "Forecast - EOI Replacements - Distribution"
3. See "Forecast - Long Span Mitigation (Capital)"
4. See "Forecast - Vertical Switches (Capital)"
5. See "Forecast - EOI PMO (Capital)"

Forecast Summary - Enhanced Overhead Inspections and Remediations (Capital)

(Nominal $000s)

	2019	2020	2021	2022	2023	Total
EOI Replacements - T[1]	$ 41,405	$ 12,512	$ 12,780	$ 11,840	$ 12,111	$ 90,647
EOI Replacements - D[2]	$ 67,201	$ 82,178	$ 29,057	$ 28,046	$ 26,954	$ 233,436
Long Span Mitigation (Capital)[3]	$ 9,344	$ 29,119	$ -	$ -	$ -	$ 38,463
Vertical Switches (Capital)[4]	$ 750	$ 1,558	$ 2,813	$ 2,895	$ -	$ 8,016
EOI PMO (Capital)[5]	$ 29,910	$ 22,946	$ 6,555	$ 2,435	$ 2,505	$ 64,351
Total EOI Capital (Nominal $)	**$ 148,610**	**$ 148,312**	**$ 51,205**	**$ 45,216**	**$ 41,570**	**$ 434,913**

1. See "Forecast - EOI Replacements - Transmission"
2. See "Forecast - EOI Replacements - Distribution"
3. See "Forecast - Long Span Mitigation (Capital)"
4. See "Forecast - Vertical Switches (Capital)"
5. See "Forecast - EOI PMO (Capital)"

Forecast - EOI Replacements - Transmission

Transmission Inspection Notification Info (2019)

Notification Problem Statement	Frequency (A)	Total Inspection Notifications (B)	Problem Statement Count (A x B)	Adjusted Notifications[1]	Avg Cost/Notification	Total Cost	Capital
Pole Replacement	0.15	13,750	2,063	1,444	$ 30,000	$ 43,312,500	x
Pole Repair	0.3	13,750	4,125	N/A	$ 14,761 [2]	$ 60,889,125	
Tower Repair	0.05	13,750	688	N/A	$ 5,606 [3]	$ 3,854,125	
Veg Mgmt	0.3	13,750	4,125	N/A	$ 1,193 [4]	$ 4,921,125	
Conductor Repair	0.15	13,750	2,063	N/A	$ 2,469 [5]	$ 5,092,313	
Other O&M	0.05	13,750	688	N/A	$ 546 [6]	$ 375,375	
	1.00				Preliminary	$ 118,444,563	$ 43,312,500
					EOI Notification Increase	$ 11,844,456	$ 4,331,250
					Total	**$ 130,289,019**	**$ 47,643,750**

Transmission Inspection Notification Info (2020-2021)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	Capital
Pole Replacement	0.15	4,850	728	509	$ 30,000	$ 15,277,500	x
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	
	1.00				Preliminary	$ 22,448,953	$ 15,277,500
					EOI Notification Increase	$ 2,244,895	$ 1,527,750
					Total	**$ 24,693,848**	**$ 16,805,250**

Transmission Inspection Notification Info (2022-2023)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	Capital
Pole Replacement	0.15	4,850	728	509	$ 30,000	$ 15,277,500	x
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	
	1.00				**Total**	**$ 22,448,953**	**$ 15,277,500**

NOTIFICATION RATE

	Structures	2019 - find rate	2020 - find rate	2021 - find rate	2022 - find rate	2023 - find rate
HFRA	48,500		10%	10%	10%	10%
EOI already performed	55,000	25%				
	Notifications	13,750	4,850	4,850	4,850	4,850

	2019	2020	2021	2022	2023
Units	1,444	509	509	509	509
EOI Replacement - T (Nominal $000)	$ 47,644	$ 16,805	$ 16,805	$ 15,278	$ 15,278
EOI Replacement - T (Constant 2018 $000)	$ 46,376	$ 16,358	$ 16,358	$ 14,871	$ 14,871

Escalation Index	2019	2020	2021	2022	2023
Capital - Transmission	1.0273	1.0557	1.0784	1.0989	1.1241
EOI Replacement - T (Constant 2018 $000)	$ 46,376	$ 16,358	$ 16,358	$ 14,871	$ 14,871
EOI Replacement - T (Nominal $000)	$ 47,644	$ 17,270	$ 17,640	$ 16,342	$ 16,716
HFRA Update Adjustment Factor	100%	86%	86%	86%	86%
Total EOI Replacements - T (Nominal $000)	**$ 47,644**	**$ 14,816**	**$ 15,133**	**$ 14,020**	**$ 14,341**

Assumptions:
1. 30% reduction to account for poles completed by Deteriorated Pole Program
2. 2,506 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,476.
3. 1,310 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $5,606.
4. 93 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,123.
5. 1,486 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $2,469.
6. 2,542 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $546.

Forecast - EOI Replacements - Transmission

Transmission Inspection Notification Info (2019)

Notification Problem Statement	Frequency (A)	Total Inspection Notifications (B)	Problem Statement Count (A x B)	Adjusted Notifications[1]	Avg Cost/Notification	Total Cost	Capital
Pole Replacement	0.15	13,750	2,063	1,444	$ 26,071	$ 37,640,463	x
Pole Repair	0.3	13,750	4,125	N/A	$ 1,476 [2]	$ 6,088,500	
Tower Repair	0.05	13,750	688	N/A	$ 5,606 [3]	$ 3,854,125	
Veg Mgmt	0.3	13,750	4,125	N/A	$ 1,193 [4]	$ 4,921,125	
Conductor Repair	0.15	13,750	2,063	N/A	$ 2,469 [5]	$ 5,092,313	
Other O&M	0.05	13,750	688	N/A	$ 546 [6]	$ 375,375	
	1.00				Preliminary	$ 57,971,900	$ 37,640,463
					EOI Notification Increase	$ 5,797,190	$ 3,764,046
					Total	**$ 63,769,090**	**$ 41,404,509**

Transmission Inspection Notification Info (2020-2021)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	Capital
Pole Replacement	0.15	4,850	728	509	$ 25,335	$ 12,901,940	x
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	
	1.00				Preliminary	$ 20,073,393	$ 12,901,940
					EOI Notification Increase	$ 2,007,339	$ 1,290,194
					Total	**$ 22,080,732**	**$ 14,192,134**

Transmission Inspection Notification Info (2022-2023)

Notification Problem Statement	Frequency	Total Inspection Notifications	Problem Statement Count	Adjusted Notifications	Avg Cost/Notification	Total Cost	Capital
Pole Replacement	0.15	4,850	728	509	$ 25,335	$ 12,901,940	x
Pole Repair	0.3	4,850	1,455	N/A	$ 1,476	$ 2,147,580	
Tower Repair	0.05	4,850	243	N/A	$ 5,606	$ 1,359,455	
Veg Mgmt	0.3	4,850	1,455	N/A	$ 1,193	$ 1,735,815	
Conductor Repair	0.15	4,850	728	N/A	$ 2,469	$ 1,796,198	
Other O&M	0.05	4,850	243	N/A	$ 546	$ 132,405	
	1.00				**Total**	**$ 20,073,393**	**$ 12,901,940**

NOTIFICATION RATE

	Structures	2019 - find rate	2020 - find rate	2021 - find rate	2022 - find rate	2023 - find rate
HFRA	48,500		10%	10%	10%	10%
EOI already performed	55,000	25%				
	Notifications	13,750	4,850	4,850	4,850	4,850

	2019	2020	2021	2022	2023
Units	1,444	509	509	509	509
EOI Replacement - T (2019 $)	$ 41,405	$ 14,192	$ 14,192	$ 12,902	$ 12,902
EOI Replacement - T (Constant 2018 $)	$ 40,302	$ 13,814	$ 13,814	$ 12,559	$ 12,559

Escalation Index	2019	2020	2021	2022	2023
Capital - Transmission	1.0273	1.0557	1.0784	1.0989	1.1241
EOI Replacement - T (Constant 2018 $)	$ 40,302	$ 13,814	$ 13,814	$ 12,559	$ 12,559
EOI Replacement - T (Nominal $)	$ 41,405	$ 14,584	$ 14,897	$ 13,801	$ 14,117
HFRA Update Adjustment Factor	100%	86%	86%	86%	86%
Total EOI Replacements - T (Nominal $000)	**$ 41,405**	**$ 12,512**	**$ 12,780**	**$ 11,840**	**$ 12,111**

Assumptions:

1. 30% reduction to account for poles completed by Deteriorated Pole Program
2. 2,506 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,476.
3. 1,310 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $5,606.
4. 93 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $1,123.
5. 1,486 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $2,469.
6. 2,542 work orders from 2014-today represent 90% of our volume in this category. Average cost comes out to $546.

Forecast - EOI Replacements - Distribution

(Constant $000s)

	2019	2020	2021	2022	2023
Number of Priority 1 Notifications[1]	0	1	2	2	2
Priority 1 Notification Cost per Unit[2]	$10	$10	$10	$10	$10
Priority 1 Subtotal (2018$)	$ -	$ 8	$ 16	$ 16	$ 16
Number of Priority 2/3 Notifications[1]	6,191	6,643	807	757	707
Priority 2/3 Notification Cost per Unit[2]	$10	$10	$10	$10	$10
Priority 2/3 Subtotal (2018$)	$ 62,282	$ 66,827	$ 8,118	$ 7,620	$ 7,113
Number of Pole Replacements[1]	0	787	1,203	1,128	1,054
Pole Replacement Cost per Unit[2]	$0	$15	$15	$15	$15
Pole Replacement Subtotal (2018$)	$ -	$ 11,817	$ 18,067	$ 16,944	$ 15,833
EOI Replacements (Constant 2018$)	$ 62,282	$ 78,652	$ 26,202	$ 24,580	$ 22,962
Escalation Factor	1.04	1.08	1.11	1.15	1.18
Total EOI Replacements (Nominal)	$ 64,683	$ 84,849	$ 29,165	$ 28,151	$ 27,055
HFRA Update Adjustment Factor	104%	96%	96%	96%	96%
Total EOI Replacements (Nominal)	**$ 67,201**	**$ 81,257**	**$ 27,931**	**$ 26,960**	**$ 25,910**

1 See "Scope - EOI Replacements - Distribution"
2 Cost per Unit calculated based on completed EOI notifications through May 2019.

Forecast - EOI Replacements - Distribution

(Constant $000s)

	2019	2020	2021	2022	2023
Number of Priority 1 Notifications[1]	0	1	2	2	2
Priority 1 Notification Cost per Unit[2]	$10	$10	$10	$10	$10
Priority 1 Subtotal (2018$)	$ -	$ 8	$ 16	$ 16	$ 16
Number of Priority 2/3 Notifications[1]	6,191	6,643	807	757	707
Priority 2/3 Notification Cost per Unit[2]	$10	$10	$10	$10	$10
Priority 2/3 Subtotal (2018$)	$ 62,282	$ 66,827	$ 8,118	$ 7,620	$ 7,113
Number of Pole Replacements[1]	0	787	1,203	1,128	1,054
Pole Replacement Cost per Unit[2]	$16	$16	$16	$16	$16
Pole Replacement Subtotal (2018$)	$ -	$ 12,707	$ 19,123	$ 17,935	$ 16,759
Total EOI Replacements (Constant 2018$)	$ 62,282	$ 79,543	$ 27,258	$ 25,571	$ 23,888
Escalation Factor	1.04	1.08	1.11	1.15	1.18
Total EOI Replacements (Nominal)	**$ 64,683**	**$ 85,810**	**$ 30,341**	**$ 29,286**	**$ 28,146**
HFRA Update Adjustment Factor	104%	96%	96%	96%	96%
Total EOI Replacements (Nominal)	**$ 67,201**	**$ 82,178**	**$ 29,057**	**$ 28,046**	**$ 26,954**

1 See "Scope - EOI Replacements - Distribution"

2 Cost per Unit calculated based on completed EOI notifications through May 2019. However, Pole Replacement Cost per Unit is based on 2018 PLP/Det Pole closed work orders. See Exhibit SCE-02, Vol. 5 Poles, for more details.