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Witnesses:	T. Fee C. Fernandez-Pello G. Fowler N. Lareau D. Russell R. Schroeder

SOUTHERN CALIFORNIA EDISON®

(U 338-E)

Thomas Fire and Debris Flow Cost Recovery Application – Rebuttal Ignitions Testimony

Before the

Public Utilities Commission of the State of California

Rosemead, California
July 11, 2024

SCE-13: Thomas Fire and Debris Flow Cost Recovery Application – Rebuttal Ignitions Testimony

Table Of Contents

SCE-13: Thomas Fire and Debris Flow Cost Recovery Application – Rebuttal Ignitions Testimony

Table Of Contents (Continued)

I.

INTRODUCTION

This chapter presents SCE's rebuttal to Cal Advocates' testimony on ignition-related issues. With respect to the Anlauf ignition, Cal Advocates takes the position that the Commission should adopt the findings of the Anlauf fire agency report, but offers little additional information to support those flawed findings. Cal Advocates' analysis suffers from multiple errors, including speculating about evidence that does not exist, misinterpreting evidence in ways contrary to science, and ignoring compelling evidence that it cannot otherwise explain away. Cal Advocates' scattershot effort to discredit expert conclusions with its own unfounded critiques does not undermine or raise doubt as to the key findings and conclusions of SCE's investigation and expert analysis that the Anlauf ignition likely was not caused by SCE's equipment. With respect to the Koenigstein ignition, Cal Advocates' testimony ultimately supports SCE's showing that the ignition was not attributable to any imprudence on the part of SCE. Most notably, Cal Advocates acknowledges that SCE had no prior indication of damage to the conductor that separated and fell to the ground on December 4, 2017. SCE's testimony demonstrates that the conductor separation was unexpected and extremely unusual, and Cal Advocates' testimony does not show otherwise. Lacking any evidence suggesting imprudence, Cal Advocates raises a handful of speculative theories and vague criticisms that do not withstand scrutiny, including because they have no causal connection to the ignition and therefore no relevance to the Commission's decision here.

II.

THE ANLAUF IGNITION

SCE-02 set forth the detailed factual showing and expert analysis establishing that the origin area of the Anlauf ignition was near the private residence, that the origin area near the CP Rectifier identified by the flawed Anlauf fire agency report is inconsistent with the evidence, and that SCE's facilities likely were not the cause of the Anlauf ignition. Although Cal Advocates attempts to undermine this showing, none of Cal Advocates' critiques withstands scrutiny.

Cal Advocates endorses the theory of the Anlauf fire agency report that SCE facilities near the CP Rectifier caused the fire—a theory so inconsistent with the evidence that plaintiffs in the civil litigation changed course and abandoned it. The clear physical evidence disproves this theory. And, as discussed further in SCE-02, Anlauf fire agency investigators should have followed standard investigatory practice and instead reached a "cause undetermined" conclusion since they were unable to identify a Specific Origin Area for the ignition.[1]

The metallurgical analysis is conclusive that the arc marks on the conductors near the CP Rectifier were heavily oxidized, meaning they occurred long before December 4, 2017, and were unrelated to the Anlauf ignition. Cal Advocates attempts to explain away this fact by positing that perhaps the arc marks became oxidized during the time period between the ignition and the evidence examination performed by SCE's metallurgical expert in 2019. However, photographs clearly demonstrate that these arc marks were already heavily oxidized from the moment they were taken into evidence within just weeks of the ignition, in stark contrast to the "fresh" arc marks on conductors taken into evidence from another location outside of the ignition area but collected around the same time. Cal Advocates also ignores and leaves unrebutted SCE's analysis of the surveillance camera footage. Far from relying on a single eyewitness photograph (the Gamez photo) as Cal Advocates' suggests,[2] this surveillance camera footage shows that the fire did not start in the CP Rectifier area and that the western flashes—the supposed ignition event according to the Anlauf fire agency report and Cal Advocates—did not occur in the CP Rectifier area either. Indeed, Cal Advocates' suggestion that a change of only a few degrees in the line of sight for the Gamez photo can have a material impact on the analysis merely shows the fallibility of the fire agencies' analysis of the photographic evidence. Moreover, SCE's

[1] SCE-02, pp. 11-12, 57.

[2] CA-07, p. 11.

extensive analysis of the fire movement indicators in Anlauf Canyon was more robust and well-documented than the analysis by the Anlauf fire agency investigators, and Cal Advocates' attempts to undermine this compelling evidence are fruitless.

Cal Advocates' testimony also fails to address the electrical evidence that supports SCE's showing. Indeed, SCE's detailed investigation specifically focused on identifying the locations of the fault events that were recorded on the Castro Circuit on December 4, 2017. Through analyzing the electrical event records, developing a CYME model to support the fault analysis,[3] and examining the physical metallurgical evidence (i.e., SCE's conductors), SCE's investigation determined the locations of both the 6:17 p.m. and 6:41 p.m. fault events: Neither occurred in the CP Rectifier area.
Cal Advocates does not challenge SCE's conclusions in this regard, or point to any other electrical event recorded on SCE's system that could have been associated with the Anlauf ignition. Of course there were no other relevant electrical events recorded on SCE's system and Cal Advocates cannot escape the fact that its theory of ignition—arcing in the CP Rectifier area due to a phase-to-phase fault—would have produced an electrical event record on SCE's system.

Additionally, Cal Advocates' attempts to undermine the analysis by SCE's experts showing that the Anlauf ignition occurred prior to any electrical events on SCE's system are unsuccessful, reflecting a misunderstanding of the scientific methodologies employed and misapplication of the principles of fire propagation and development. Radar analysis of smoke plumes is well accepted in the field and the radar feature showing the plume is located exactly where one would expect for an ignition near the private residence in Anlauf Canyon based on the wind patterns in the area. Thus, radar data from the U.S. National Weather Service shows a wildfire ash plume as early as 6:07 p.m., confirming that the ignition occurred well before the earliest electrical event on SCE's system at 6:17 p.m. Furthermore, this aligns with the surveillance camera footage showing the early size of the fire and modeling of its early growth behavior. Cal Advocates' conclusory and speculative critiques do not refute this compelling evidence.

In sum, the weight of the evidence—including metallurgical, electrical, radar, photogrammetric, fire markers, and fire growth analysis—shows that the Anlauf ignition likely was not caused by SCE's equipment. Cal Advocates' testimony relies on hypothetical conjecture to try to undermine SCE's expert

[3] *See* SCE-02, pp. 43-45, 65 & App. A.

analyses, rather than affirmative evidence showing any causal connection between SCE's equipment and the ignition. For the reasons set forth below, Cal Advocates' criticisms are without merit.

A. The Anlauf Ignition Did Not Occur in the CP Rectifier Area

1. Cal Advocates Fails to Refute the Clear Metallurgical Evidence Showing the Anlauf Ignition Was Not Caused By SCE Electrical Facilities in the CP Rectifier Area

Cal Advocates attempts to discredit my conclusion that the arc marks on the conductors in the CP Rectifier area were "old" and unrelated to the Anlauf ignition. Cal Advocates also advances various other arguments regarding the design and construction of SCE's electrical facilities in the CP Rectifier area, which I understand are addressed in SCE-14. In criticizing my findings, Cal Advocates does not dispute (nor could it) that oxidation is a time-dependent reaction between the environment and metal that is used by metallurgical experts to provide information regarding the age of physical arc marks on a metal conductor relative to a certain event, such as the ignition of a fire. Specifically, the degree of oxidation is useful to an investigation for determining whether evidence of prior arcing is related to a particular ignition event. Yet without factual substantiation, Cal Advocates hypothesizes that "[b]oth heat from the Anlauf fire and the time before SCE's examination of the conductor could have contributed to make the arc marks appear old."[4] Of course, Cal Advocates is correct as a theoretical matter that passage of time and "exposure to fire or smoke *can* influence oxidation."[5] But the physical evidence unambiguously disproves both of Cal Advocates' attempts to explain away the fact that the arc marks on the conductors from the CP Rectifier area already were heavily oxidized and old when they were collected just weeks after the ignition, indicating that they occurred long before December 4, 2017.

First, photos taken in the field at the time the conductors were removed on December 28, 2017 show the same dull, fully oxidized arc marks as when the conductors were examined during an evidence inspection on April 9-10, 2019. If these arc marks had been associated with the Anlauf ignition on December 4, 2017, they would have appeared shiny and reflective when taken into evidence less than

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[4] CA-07, p. 33. I understand that Cal Advocates witness sponsoring CA-07 has no training or experience in metallurgy, evidence storage, or oxidation processes, and has not previously examined electrical conductors with arc marks or to evaluate oxidation. *See* SCE-14, Appendix A, Cal Advocates Response to SCE-PubAdv-01, Questions 17-20.

[5] CA-07, p. 33 (emphasis added).

a month after the Anlauf ignition.[6] The photos shown in Figure II-1 disprove that the passage of time in evidence storage had any impact on the appearance of the arc marks. Removing a conductor from service, taking it into evidence, and storing it in an evidence locker means the conductor no longer has continued outdoor exposure to the elements and the environment.[7] This substantially slows the oxidation process such that arc marks that appear "fresh" at the time the conductor is taken into evidence will maintain that appearance for a long period of time (i.e., multiple years). It is clear from Figure II-1 that the arc marks in the CP Rectifier area did not appear "fresh," even when taken into evidence shortly after the Anlauf ignition.

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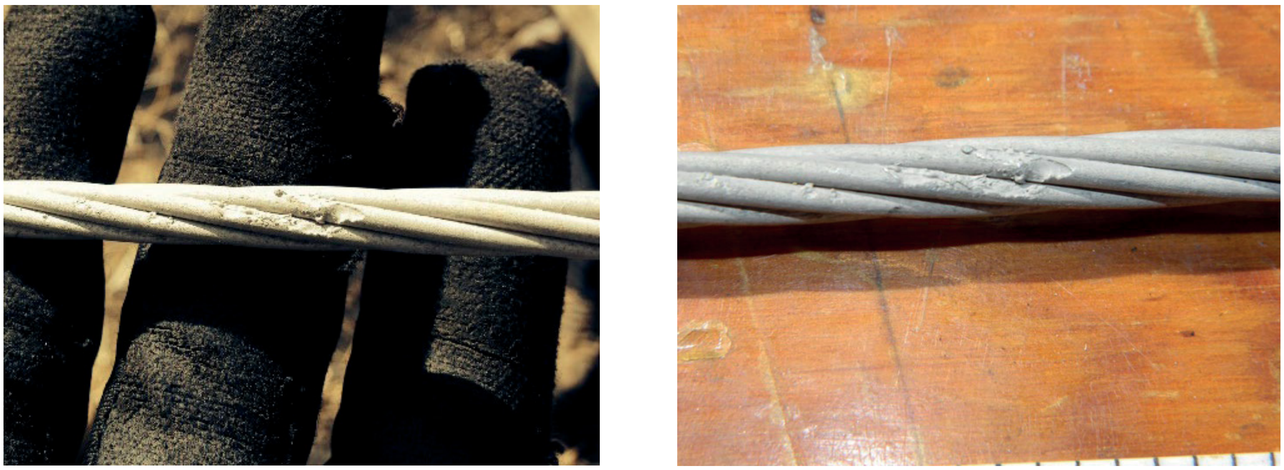
[6] The Anlauf fire agency report states that the conductors in the CP Rectifier area were collected and taken into evidence by Cal Fire on December 28, 2017. Once collected, these conductors were transferred to the Cal Fire evidence locker at the Southern Region Headquarters in Fresno, CA and placed into the evidence locker on January 2, 2018. *See* SCE-02, Appendix B (Anlauf fire agency report), pp. B39–B40.

[7] Cal Advocates selectively quotes from a data request response I prepared stating that "I would expect it to take 9-18 months following the event, and possibly even longer" for an arc mark to appear old. CA-07, p. 33, n.157. The full context of my response makes clear that oxidation "occurs over time and is influenced by such factors as . . . the environment [and] storage conditions," among other factors, and that this timeline for an arc mark to oxidize and appear old referred to conductors that remained in the field subject to the environmental conditions of Anlauf Canon: "***In conditions such as those in Anlauf Canyon***, it is possible that the initial stages of oxidation could be visible on an arc mark within approximately 3-6 months following the event. I would expect it to take 9-18 months following the event, and possibly even longer, for the surface of an arc mark to become fully oxidized to a similar extent as the adjacent conductor wire such that I would consider it 'old.'" CA-07-SA, SCE Response to CalAdvocates-SCE-A2308013-16, Question 5(a) (emphasis added). Cal Advocates even asked me to clarify what "conditions such as those in Anlauf Canyon" meant, which further clarified that I was referring to "the environmental conditions in Anlauf Canyon to which an in-service conductor would be exposed" (CA-07-SA, SCE Response to CalAdvcoates-SCE-A2308013-25, Question 6(a)), yet entirely omits this important context from its testimony.

Figure II-1
Oxidized Arc Marks in CP Rectifier Area: December 2017 and April 2019

December 2017 Photo	April 2019 Photo



Second, if the conductors from the CP Rectifier area had experienced exposure to fire or smoke sufficient to alter the appearance of the arc marks on the conductors as Cal Advocates suggests, I would expect to see physical evidence of that exposure on the conductors. Yet I saw no indication of smoke and/or flame exposure or heat-related damage during my detailed metallurgical examination of the conductors. Smoke and/or flame exposure leaves a dark soot deposit on the surface of a conductor and heat exposure also can cause melting or other heat-related damage to the conductor. Evidence of soot deposits and discoloration on the separated conductor that contacted the ground in connection with the Koenigstein ignition is shown in Figure II-2. In contrast, my evidence examination confirmed that no such evidence is visible on the conductors in the CP Rectifier area.[8] This accords with the fact that the conductors in the CP Rectifier area were still in the air and were not in contact with the ground at the time they were taken into evidence by Cal Fire, making it unlikely they sustained significant exposure to smoke or flames.[9]

[8] Although not the case for the conductors from the CP Rectifier area, even when there is evidence of a conductor sustaining smoke and/or flame exposure, in my experience this only partially obscures the appearance of an arc mark. Through my examination, I am able to identify areas that are either unaffected or less affected by the smoke and/or flame exposure such that I can reach a conclusion regarding the approximate age of the arc mark.

[9] *See* SCE-02, Appendix B (Anlauf fire agency report), pp. B39–B40.

Figure II-2
#4 ACSR Conductor from Koenigstein with Soot Deposits

Finally, a comparison between the conductors collected from the CP Rectifier area and from the Oil Field Area further disproves both of Cal Advocates' attempts to explain away the clear metallurgical evidence that the arc marks on the conductors in the CP Rectifier area did *not* occur on December 4, 2017. The conductors in the Oil Field Area were collected from the field shortly after the conductors from the CP Rectifier area were collected.[10] I examined both sets of conductors at Cal Fire's facility in Fresno, California during the same evidence inspection, which occurred on April 9-10, 2019. The difference in appearance between the two is self-evident in photos taken during my evidence inspection as shown in Figure II-3.[11]

[10] *See* SCE-02, Appendix B (Anlauf fire agency report), pp. B39–B42 (stating that the conductors from the Oil Field Area were collected and taken into evidence on January 5, 2018 and placed into the evidence locker on January 6, 2018).

[11] *See* SCE-02, p. 44 (discussing that the electrical, photogrammetric, and metallurgical evidence shows that the 6:17 p.m. fault occurred in the Oil Field Area).

Figure II-3
(SCE-02, Figure III-36)
Illustrative Examples of Arc Marks on #4 ACSR Conductor

Dull, fully-oxidized appearance; similar to rest of conductor	Shiny and reflective appearance indicating recent contact; contrasts with oxidized conductor

Example from CP Rectifier Area **Example from Oil Field Area**

The conductors from both areas are #4 ACSR conductor, were taken into evidence only days apart, and were stored in the same Cal Fire evidence locker in the same conditions. Thus, their oxidation process would have been slowed to the same degree. Moreover, in contrast to the conductors in the CP Rectifier area that were still in the air, the Anlauf fire agency report states that some of the conductors in the Oil Field Area—specifically the one shown in Figure II-3 with a fresh arc mark—were in contact with the ground at the time they were taken into evidence. Thus, these conductors were more likely to experience smoke and/or flame exposure than the conductors in the CP Rectifier area. If Cal Advocates' hypotheses were correct, the arc marks on the conductors from the Oil Field area would appear "old"—either because of smoke and/or flame exposure or passage of time in an evidence locker. But they do not. This is entirely consistent with the fact that removing a conductor from service and storing it in evidence preserves its condition. Thus, the physical metallurgical evidence disproves both of Cal Advocates' theories.

2. <u>Cal Advocates Ignores SCE's Analysis of Surveillance Camera Footage, which Unambiguously Shows the Anlauf Ignition Did Not Occur in the CP Rectifier Area</u>

Cal Advocates suggests the Garcia and Brock photos were taken too late to demonstrate where the fire originated and that analysis of the Gamez photo is inconclusive because the fire agency investigators estimated a different line of sight than I did. They claim that a change of only a few degrees "can appear to implicate either the CP rectifier (Figure 2) or the Dollar residence."[12] Cal Advocates concludes that "analysis of this single photo is insufficient to determine the origin location of the Anlauf ignition."[13]

Yet Cal Advocates ignores entirely my analysis of the StorHouse surveillance camera footage shown in Figure III-14 of SCE-02.[14] If Cal Advocates dismisses the Garcia and Brock photos as too late, Cal Advocates cannot dismiss the StorHouse surveillance camera footage, which captured the first images of when the fire became visible from these locations. This analysis unequivocally shows that the early fire ***did not*** originate near the CP Rectifier. This footage clearly shows the fire beginning on the ***left side*** of the "Tall Tree," and the CP Rectifier area, which is visible and unobstructed, is located on the ***right side*** of the Tall Tree when viewed from StorHouse.

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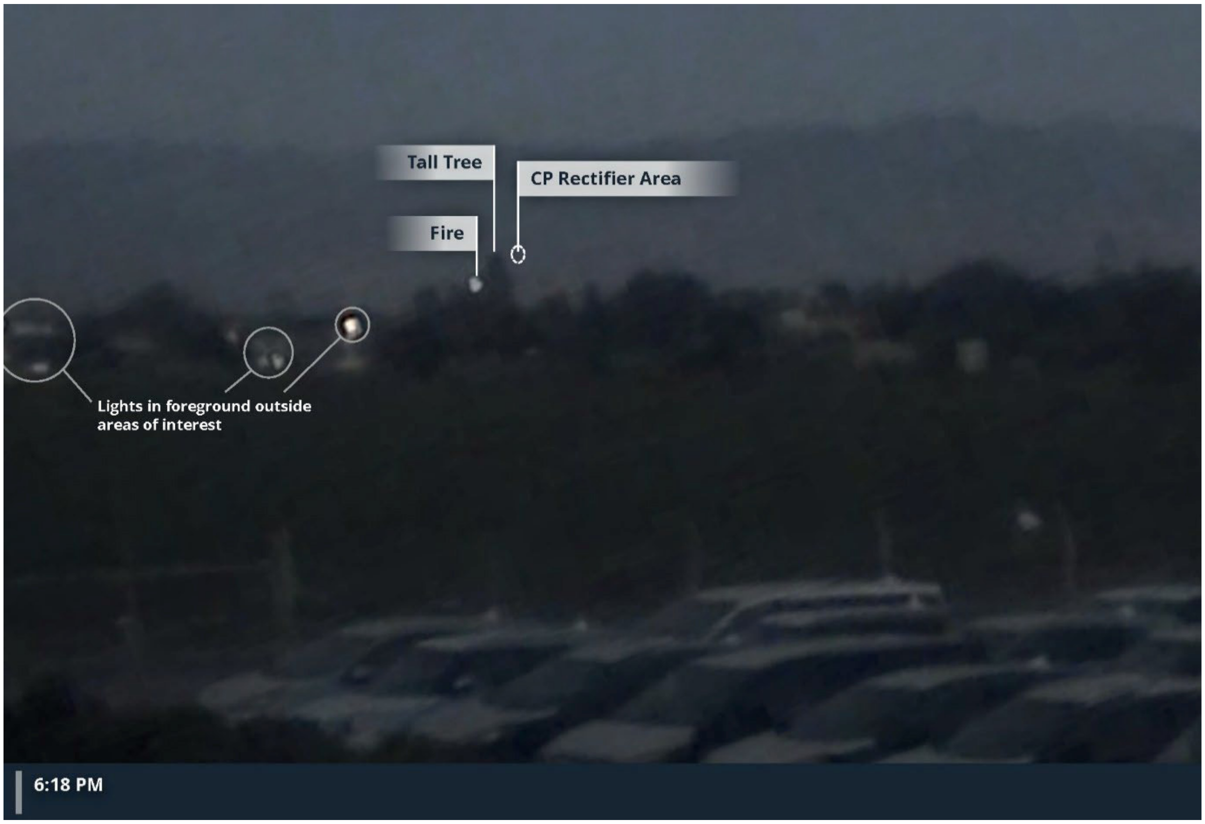
[12] CA-07, p. 11.

[13] CA-07, p. 11. Cal Advocates' concession that there are competing analyses of the Gamez photo and that a change of only a few degrees in the line of sight can have a material impact on the analysis merely confirms that the evidence relied on in the fire agency investigation is not clear cut and there are legitimate questions regarding the fire agency's interpretation of the evidence such that, as the testimony of Tom Fee discusses, the investigation should have reached a cause undetermined conclusion. *See* SCE-02, pp. 10-12, 57.

[14] *See* SCE-02, p. 27. My analysis is entirely independent from and unrelated to High Impact's estimates of the fire's size based on the footage from the StorHouse and Topa surveillance cameras, which Cal Advocates separately criticizes and is discussed in Section II.B.2.a).

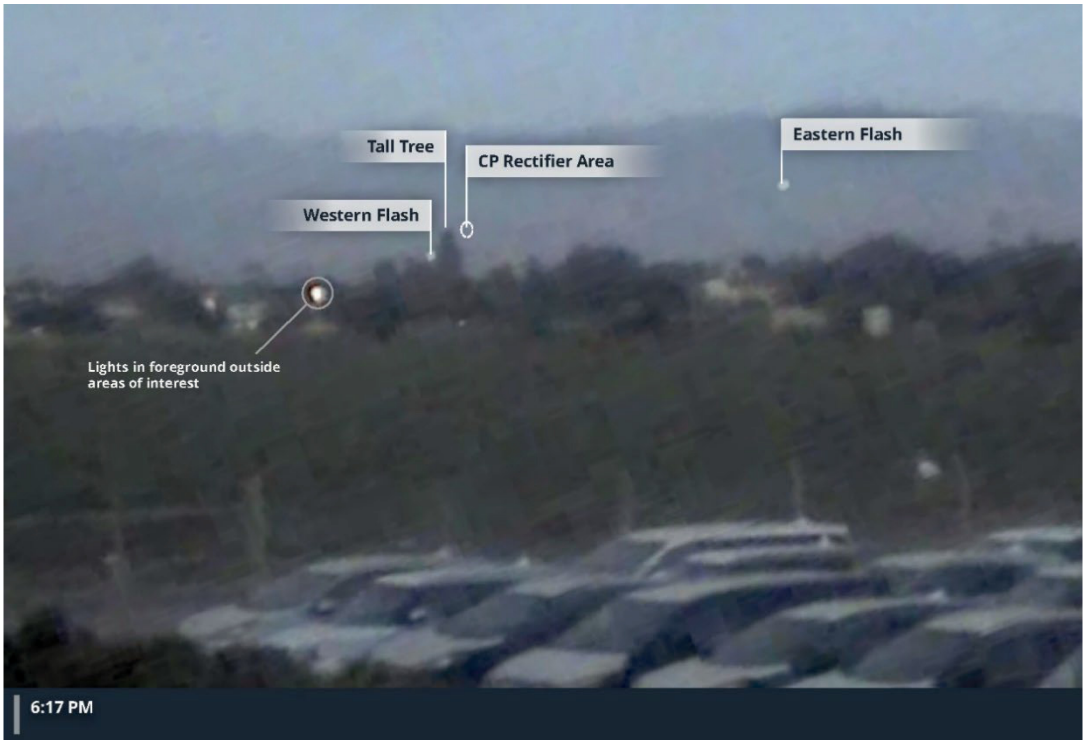
Figure II-4
(SCE-02, Figure III-14)
StorHouse Composite Image Showing Fire

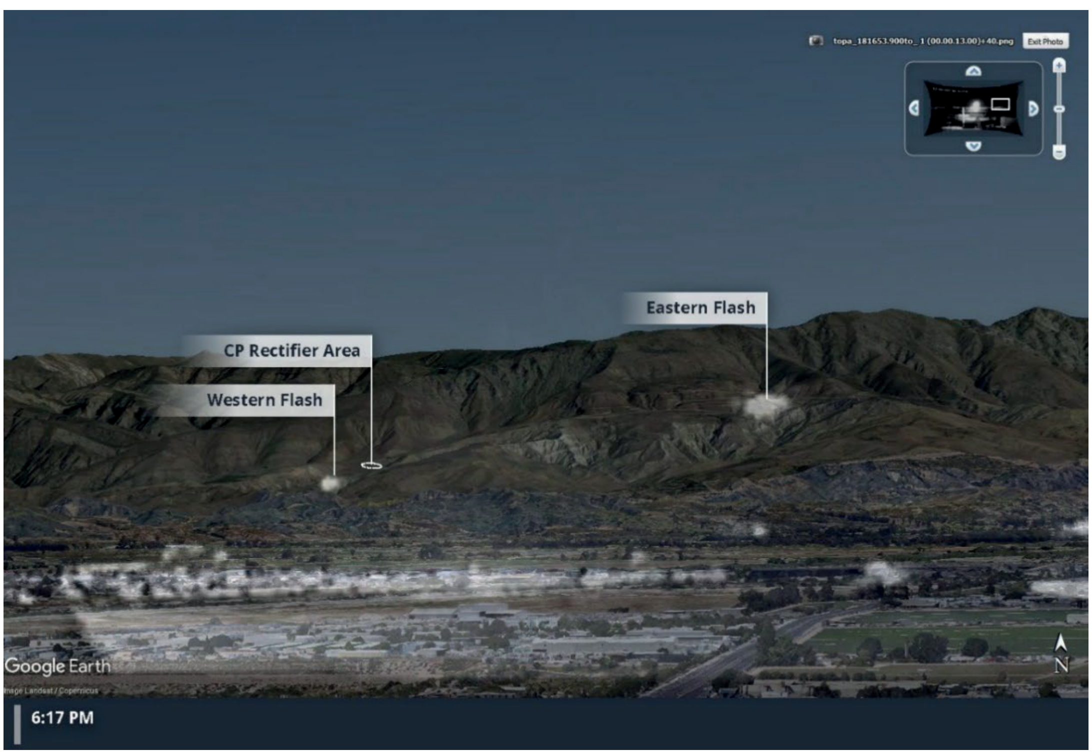


Cal Advocates also ignores entirely my analysis of the flashes—which is what the fire agency investigation report, and apparently Cal Advocates, identifies as the ignition event in the CP Rectifier area.[15] Again, this analysis shows that the western flashes—the supposed ignition event—are visible on the left side of the Tall Tree when viewed from the StorHouse camera. Indeed, both the StorHouse and Topa cameras show that the western flashes were not located in the CP Rectifier area and thus could not have been the cause of an ignition in that area as the Anlauf fire agency report concludes. In fact, the fire agency investigators' own lines of sight to the western flashes do not go through the CP Rectifier area.

[15] *See* SCE-02, pp. 31–34, Figs. III-20–III-22.

Figure III-5
(SCE-02, Figures III-20 & III-21)
Analysis StorHouse and Topa Showing Location of Flashes





Far from relying on a single photograph as Cal Advocates suggests, I have done robust analysis of the corroborating surveillance camera footage from ***two separate cameras*** (Topa and Storhouse) clearly showing both that (a) the fire did not start in the CP Rectifier area; and (b) the western flashes—the supposed ignition event—also did not occur in the CP Rectifier area. This analysis stands unrebutted in the record.

3. <u>SCE's Extensive Fire Marker Analysis Is Valid and Shows the Ignition Occurred Near the Private Residence, Not in the CP Rectifier Area</u>

I disagree with Cal Advocates' criticism of SCE's detailed fire marker analysis in Anlauf Canyon. Cal Advocates' only critique is that because my investigation primarily took place after the Anlauf fire agency investigators released the site, my fire marker analysis is unreliable due to potential disturbances of the area, including rainfall in January 2018.[16] This misunderstands the investigative process, what I look for when identifying and documenting fire movement indicators, and how passage of time affects fire movement indicators.

Natural environmental conditions and other factors can *always* cause disturbances to the scene of a wildland fire investigation. And even when public access to a site is restricted, there is still the potential for human disturbances. Thus, as a wildland fire investigator, an essential part of my job is assessing *whether* there have been any disturbances that would impact the reliability of the indicator, which is the first thing we do when we identify an indicator.[17] In my experience, a well-trained wildland fire investigator can reliably assess whether an item has been moved or otherwise disturbed from its original location at the time of the fire. For instance, it may be apparent that a rock has been moved because its contours are misaligned with the natural indentation or imprint in the earth where it was previously resting, indicating that it was dislodged from its original location. Likewise, a tree, fence post, or other wood item may indicate natural change over time (e.g., from rotting or other deterioration) that affects its appearance or otherwise show signs that it was moved or otherwise altered by humans.

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16 Cal Advocates incorrectly states that "SCE asserts that the Anlauf Fire Agencies' investigation disturbed the scene prior to releasing the general origin area on January 5, 2018." CA-07, p. 6 & n.41. The language in SCE-02 quoted by Cal Advocates in footnote 41 merely states that there were debris removal and other clean-up activities by the County in *February 2018*, not disturbances by fire agency investigators before January 5, 2018 as Cal Advocates suggests. I note that Cal Advocates' witness sponsoring CA-07 has no training or experience collecting and/or analyzing fire movement indicators in connection with wildland fire investigations and has no training, experience, or certifications in conducting wildland fire investigations. *See* SCE-14, Appendix A, Cal Advocates Response to SCE-PubAdv-01, Questions 8-10.

17 SCE-02, p. 13.

Many indicators—such as the staining on a large rock embedded in the earth as shown in Figure II-6—are unlikely to be disturbed for months or years following a fire. Whenever there is evidence of potential disturbance, we do not use that fire movement indicator.

Figure II-6
(SCE-02, Figure III-5)
Example of Fire Movement Indicator in Anlauf Canyon

I also tailor each investigation to the specific facts of a case, which includes accounting for things like the passage of time since an ignition event and the potential for environmental and human disturbances of the site. For instance, my investigation of the Anlauf ignition began roughly a month after the ignition when the fire agency investigators released the General Origin Area (GOA) on January 5, 2018.[18] Whereas some fire movement indicators may be available to an investigator on scene within a

[18] SCE-02, Anlauf fire agency report, pp. B61-B62. After flying over Anlauf Canyon in a helicopter on December 14, 2017, I performed my initial site visits on January 5 and 8, 2018, during which I began surveying fire movement indicators in the canyon and generally assessed the conditions and evidence. I returned with a team to begin detailed documentation of fire movement indicators in Anlauf Canyon on February 8, 2018.

day or two of an ignition (e.g., a burned blade of grass or curled leaves) but disappear quickly within a week or two, other fire movement indicators (e.g., staining on a rock, a tree stump, or a fence post) can endure and fade only slowly over time. Thus, the investigative process of identifying and documenting fire markers necessarily focuses on those available at the time.

In conducting my investigation, I also was aware of the activities by the fire agency investigators, SCE's restoration work in the Anlauf Canyon area, as well as weather events in the area since December 4, 2017. For every fire marker we identified, my team and I first evaluated whether there was evidence of potential disturbance and if there was, we did not use that indicator in the investigation. Moreover, as part of our documentation process, we took photos of every fire movement indicator from multiple angles—as shown in Figure II-6. This detailed documentation allows for after-the-fact review by third parties. Apart from merely *speculating* about the potential for disturbance in an attempt to undermine my fire marker analysis, notably Cal Advocates has *not* pointed to any *specific evidence* of disturbance in the thousands of photos of fire markers in Anlauf Canyon that we documented. My fire marker documentation practice in this regard is different from the fire agency investigators, who did not do comparable documentation of the fire markers they relied on in their investigation. As a result, no one—not me or Cal Advocates—is in a position to validate their work, as Cal Advocates is able to do for my work here. Just because the fire agencies had "prompt access to the canyon" as Cal Advocates notes,[19] that does not mean their investigation is correct or more reliable than my fire marker analysis, especially when they did not document their investigative processes in a transparent, verifiable manner.

B. <u>The Anlauf Ignition Occurred Prior to Any Electrical Event on SCE's System</u>

As described in SCE-02, the Anlauf ignition likely occurred prior to any electrical events on SCE's system and thus was not caused by any SCE electrical facilities. Contrary to Cal Advocates' unfounded assertions, the radar data clearly support an ignition in Anlauf Canyon as early as 6:07 p.m. Moreover, analysis of the fire's size and initial growth based on footage captured by the Topa and StorHouse surveillance cameras further supports an ignition around this same time. Cal Advocates has not pointed to any electrical events on SCE's system or posited any other theory for how SCE's electrical facilities could have caused an ignition at this time.

[19] CA-07, p. 8.

1. **Contrary to Cal Advocates' Unfounded Assertions, the Radar Evidence Shows a Developing Smoke Plume from the Anlauf Ignition as Early as 6:07 p.m.**

As described in SCE-02, extensive radar analysis based on data from the Sulphur Mountain (KVTX) Next-Generation Weather Radar (NEXRAD) station shows the development of a wildfire smoke plume from the Anlauf ignition starting as early as 6:07 p.m. on December 4, 2017. Successive radar scans after 6:07 p.m. demonstrate this plume growing in size. Given the spatial and temporal consistency between the radar reflectivity at 6:07 p.m. and later radar scans, I conclude that the radar evidence shows a smoke plume associated with the Anlauf ignition as early as 6:07 p.m. Cal Advocates advances three arguments in an attempt to undermine my conclusion. None has merit.

First, Cal Advocates claims I did not confirm that the radar feature detected on December 4, 2017 was a smoke plume. In particular, Cal Advocates argues that I failed to analyze other known smoke plumes specifically detected by the KVTX radar station to determine the accuracy and validity of my methodology.[20] Yet it is not clear what Cal Advocates means to suggest in this regard or what would qualify as a "known smoke plume" in Cal Advocates' view. Even so, similar radar analysis I conducted for the Koenigstein ignition that occurred about 90 minutes after the Anlauf ignition and for which the time and location are not in question confirms and validates my analysis and conclusions from the radar data for the Anlauf ignition. Moreover, the best way to validate analysis of radar data is through a comparison to other means of observing the same phenomena. In this regard, it cannot reasonably be disputed that KVTX detected the ash plume from the Thomas Fire. For instance, at a time that is not in dispute (10:30 a.m. on December 5, 2017), there is clear alignment between satellite imagery[21] showing the observed plume of the Thomas Fire and the plume detected by KVTX. This is illustrated in Figure II-7.

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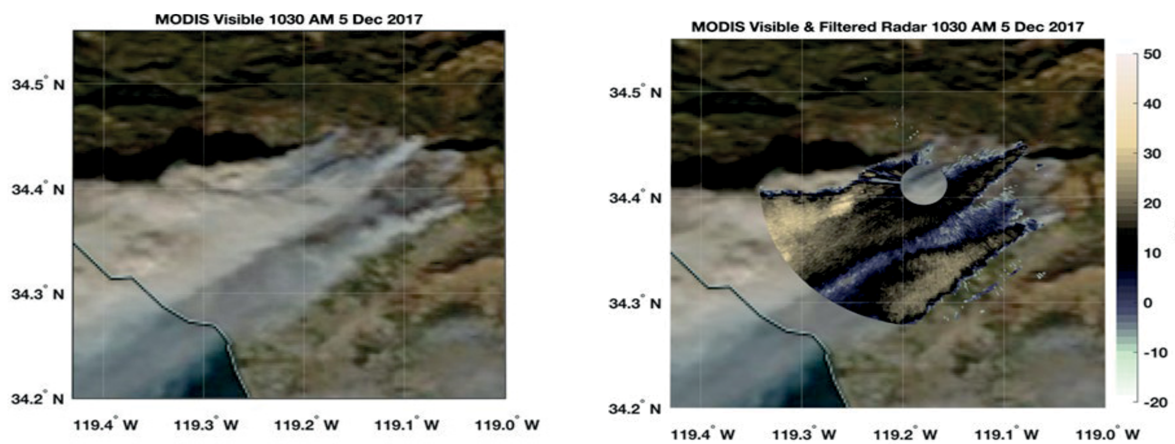
[20] CA-07, p. 12. Cal Advocates has acknowledged that the witness sponsoring CA-07 has no training or experience analyzing radar data. *See* SCE-14, Appendix A, Cal Advocates Response to SCE-PubAdv-01, Question 14.

[21] Moderate Resolution Imaging Spectroradiometer (MODIS), a NASA instrument, can view a 2,330 km wide swath and covers the entire Earth every 1-2 days. It measures 36 spectral bands from 0.405 to 14.385 µm and captures data at 250m, 500m, and 1,000m resolutions.

Figure II-7
Comparison between Sulphur Mountain (KVTX) Radar and MODIS Satellite Imagery at 10:30 AM PST on December 5, 2017

Satellite Image	Satellite Image with Radar Data Overlay



Cal Advocates offers no explanation for why, in its view, KVTX would so clearly and accurately detect the plume from the Thomas Fire at this time but not during the time in question—between 6:00 p.m. and 6:30 p.m. on December 4, 2017. To the contrary, Cal Advocates does not challenge the underlying radar data collected by KVTX in any meaningful way; nor could it. Using data from NEXRAD radars—like KVTX[22]—to analyze wildfire smoke plumes is well accepted in the field and in peer-reviewed scientific literature. For instance, I have authored eight peer-reviewed scientific articles that include detection and analysis of wildfire plumes with NEXRAD radars.[23] Moreover, the

[22] KVTX is one of 160 high-resolution NEXRAD radar stations that are owned, operated, and maintained by the National Weather Service (NWS) within the U.S. National Oceanographic and Atmosphere Administration (NOAA). NWS's network of NEXRAD radar stations is the backbone of the federal government's severe weather warning system. The data from KVTX are not unique or different from the radar data collected by NWS's other NEXRAD radar stations, all of which have almost identical operating parameters, including wavelength and scan rate.

[23] I also have relied on data from various NEXRAD radar stations to analyze smoke plumes for more than 50 wildfires across the United States. These include the Camp Fire near Pulga and Paradise, CA, the Bear Fire near Oroville, CA, and the King and Caldor Fires near Sacramento, CA. *See* N.P., Lareau et al., *Tracking Wildfires with Weather Radars*, 127 J. of Geophysical Rsch: Atmospheres 8-20 (2022). In my experience, NEXRAD radars are particularly reliable for determining wildfire ash plumes because of their unique specifications and consistency across the United States. NEXRAD radars use a 10-cm wavelength that is sensitive to pyrometeors (i.e., ash and debris lofted in the atmosphere). Like other weather radars, NEXRAD radars quantify changes in fire and plume processes—including changes in plume behavior, volume, and

(*Continued*)

Anlauf ignition is particularly well suited to radar data analysis in order to identify the first evidence of the ash plume. Whereas other fires may occur at much longer distances from a NEXRAD radar (where the radar beam can lose sensitivity and is higher above the surface), the Anlauf ignition is somewhat unique in that it developed in close proximity (~6 miles) to KVTX.

Second, Cal Advocates suggests that I did not validate the accuracy of the timestamps on the radar scans.[24] Yet the accuracy of the timestamp was never in question. The NEXRAD radar network is the state-of-the-art, real-time weather monitoring system for the federal government and is calibrated and maintained by the Radar Operations Center (ROC) of the NWS. Cal Advocates offers no basis to question the ROC's calibration of KVTX.[25] Moreover, the accuracy of the timestamps is further confirmed by the radar-satellite alignment shown in Figure II-7 above.

Finally, Cal Advocates asserts that, because the plume itself was not located directly in or over Anlauf Canyon, it does not match the origin areas as determined by the Anlauf fire agencies or SCE, and thus has less value in determining the origin of the fire.[26] Yet Cal Advocates' underlying assumption—that the smoke plume should be directly in or above Anlauf Canyon—is incorrect and ignores the fact that the plume appears generally where one would expect based on the complex topography of Anlauf Canyon and the conditions at that time. Whether the ignition occurred sometime before 6:07 p.m. near the private residence area or at 6:17 p.m. in the CP Rectifier area, Cal Advocates does not dispute that the Anlauf ignition occurred in Anlauf Canyon and the radar data clearly shows the ash plume from this fire moving laterally as it rose to the height of being detected by KVTX. Thus, for instance, even though the Gamez photo[27] clearly shows a fire in Anlauf Canyon at 6:24 p.m., radar data from around this same time shows that the plume from the fire was not located directly in or above Anlauf Canyon. Instead, it was located in a similar location and orientation as the plume feature first detected at 6:07 p.m., which was primarily south but also both slightly east and west from the origin area

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vertical extent—based on its sensitivity to pyrometers. This allows the radars to be most effective immediately above the fire, where the ash and debris are most concentrated. However, NEXRAD radars are unique in their ability to operate effectively at high temporal and spatial resolution. They can observe fire processes even under heavy smoke and cloud cover (which often obscure satellite and aircraft observations).

[24] CA-07, p. 12.

[25] I confirmed via email with the ROC that all of the 160 radars in the NEXRAD network reference a redundant network time server to ensure that all timestamps are both accurate and synchronized.

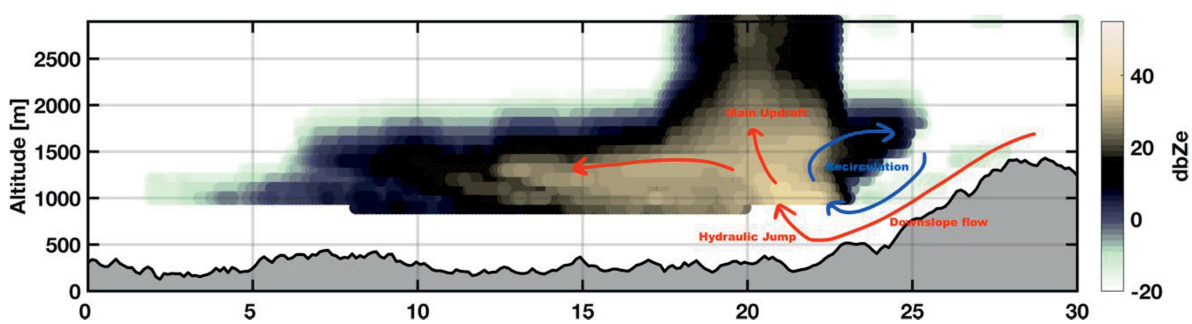
[26] CA-07, pp. 12, 14.

[27] *See* SCE-02, pp. 28–30 & Fig. III-16.

in Anlauf Canyon.[28] Thus Cal Advocates' suggestion that the smoke plume should be directly above Anlauf Canyon is wrong.

Contrary to Cal Advocates' suggestion that smoke would have been blown only southwest—not southeast—due to strong Santa Ana winds from the northeast, the observed lateral movement is unsurprising given the complex topography of the area.[29] Cal Advocates relies extensively on the wind study after the fire but conveniently ignores a key conclusion of this study that explains this lateral movement: "The Thomas fire ignition sites, especially the primary origin, were likely subjected to strong but quite localized near-surface winds due to the downsloping flow being elevated ***both farther upwind and downwind***, the latter having the form of a hydraulic jump."[30] This hydraulic jump or "recirculation" zone means that, as the ash plume was lofted vertically, it moved not just south but also both east and west. This phenomenon becomes even more apparent after around 6:45 p.m. on December 4, 2017, as shown in Figure II-8 with the blue marks depicting the recirculation zone and the red marks identifying the direction of the plume's drift.

Figure II-8
Radar Cross Section at 6:46-6:58 PM PST on December 4, 2017 Showing the Recirculation Zone



2. The Surveillance Camera Footage Indicates the Fire Ignited Before 6:17 p.m.

As described in SCE-02, I analyzed fire size data from the surveillance camera footage and used known fire growth behavior established in the scientific literature to show that the Anlauf

[28] This spatial and temporal alignment is clearly shown in the sequenced images in SCE-02, Fig. III-23.

[29] While the Santa Ana winds are predominantly from the northeast and plumes predominantly elongate to the southwest, the near-surface wind flow is strongly influenced by terrain features, turbulence, and wave dynamics.

[30] Fovell, R.G.; Gallagher, A. *Winds and Gusts during the Thomas Fire*. Fire 2018, 1, 47. https://doi.org/10.3390/fire1030047 (emphasis added).

ignition occurred well before 6:17 p.m.—likely around 6:03 to 6:06 p.m.—and prior to any electrical events recorded on SCE's system.[31] Cal Advocates attempts to undermine my analysis both by criticizing my methodology and by raising questions about the fire size data used in my analysis. Cal Advocates makes incorrect assumptions about my methodology and misapplies basic scientific principles of fire propagation and development. Cal Advocates' critiques of the fire size data likewise lack merit and are discussed further in Section II.B.2.a) and in Appendix B.

Cal Advocates primarily criticizes the exponential equation I used in concluding that the fire ignited before 6:17 p.m.[32] As described in SCE-02, I looked to the scientific literature on early fire growth behavior, specifically the experiments of McAlpine and Cheney, and the predictions from the FARSITE fire growth model in order to derive a generic fire growth equation.[33] I then used the fire size estimates from High Impact's analysis of the surveillance camera footage to fit this generic equation to the observed size of the fire.[34] Thus, I was able to model the fire's rate of growth and approximate ignition time. In other words, while I relied on the studies described in the scientific literature for the generic exponential equation, I derived the quantitative components of this equation from the real-world fire size data. I did not use these studies' unique quantitative parameters, e.g., rate of growth, in my analysis.[35]

Cal Advocates asserts that an exponential curve never reaches zero and I do not explain my assumption that the ignition began as a 0.1 foot diameter fire.[36] Cal Advocates fails to appreciate the distinction between a theoretical mathematical model of fire behavior and actual observed fire behavior. A fire never grows from a value of zero. The initial size of a fire depends on the type of ignition

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[31] SCE-02, p. 43.

[32] CA-07, pp. 21-22. Cal Advocates acknowledges that the witness sponsoring CA-07 has no training or experience conducting academic studies of or otherwise modeling wildland fire ignition, propagation, or initial growth behaviors. *See* SCE-14, Appendix A, Cal Advocates Response to SCE-PubAdv-01, Question 16.

[33] SCE-02, p. 40.

[34] SCE-02, p. 41.

[35] Cal Advocates attempts to criticize my reliance on the McAlpine and Cheney studies and the FARSITE model because these studies do not consider significant wind speeds over 60 mph or variable terrain with a steep slope. CA-07, pp. 27-28, 30. The precise wind conditions of these studies is not material to the basic conclusion that fires initially experience exponential growth. Because I fit the generic exponential growth equation to the observed fire size data, this incorporated the real-world wind and other conditions experienced at the ignition location on December 4, 2017.

[36] CA-07, p. 22.

source—which, in this case, is *small*. I conclude that, at the moment of ignition, the fire had a size of approximately 0.1-foot diameter. This is based on experimental observations of ignitions in a bed of pine needles by hot metal particles[37] and is consistent with scientific studies that consider wildland fires initiated by human intervention (e.g., hot metal fragments or burning biomass such as a cigarette).[38]

Cal Advocates suggests that exponential growth "does not comport with known fire behavior" because the fire would have transitioned to an equilibrium rate of spread that was linear—not exponential—by 6:17 p.m.[39] To support this assertion, Cal Advocates derives an equilibrium rate of spread by using Cal Fire data from many hours after the ignition, from 2:55 a.m. to 10:01 a.m. on December 5, 2017.[40] Cal Advocates' attempted extrapolation and associated conclusions are incorrect and unreliable. As an initial matter, the observed fire-size data from the surveillance camera footage clearly show exponential growth at 6:17 p.m. on December 4, 2017, not linear growth as Cal Advocates suggests. And this observed exponential growth behavior shows a growth rate that exceeds 47.3 feet per minute. Put differently, Cal Advocates' assertion is not only based on the wrong data extrapolation, it is inconsistent with the evidence.

Moreover, Cal Advocates' theory hinges on the assumption that there is a smooth transition from a fire's initial, accelerating growth behavior to equilibrium linear growth and that the rate of growth during the accelerating growth phase can never exceed an estimate of the fire's equilibrium linear rate of growth many hours after the ignition. That assumption is incorrect and not supported in the literature.[41] Since Cal Advocates begins their data approximately eight hours after the ignition,[42] it is not surprising that the overall trend reached equilibrium during that specific time period. In eight hours, the

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[37] *See* SCE-02, pp. 39-40.

[38] *See* Thomsen, M., Fernandez-Pello, A. C., & Williams, F. A. *On the Growth of Wildland Fires from a Small Ignition Source*. Combustion Science and Technology, 195(14), 3542–3556 (2023). https://doi.org/10.1080/00102202.2023.2239461.

[39] CA-07, pp. 25-26.

[40] CA-07, p. 24, Fig. 7.

[41] Cal Advocates' attempt to use the McAlpine study to predict quantitatively the growth of the fire and its transition to equilibrium is incorrect and flawed. The fuel type, topography, wind, weather, and other environmental conditions in the McAlpine study are completely different than the Thomas Fire. The McAlpine study simulated a single homogenous layer of fuel in a forest setting (explicitly ignoring multiple fuel layers), evaluated only four different wind speeds, and held constant temperature and relative humidity. Cal Advocates presents no evidence that the Thomas Fire shared any of these quantitative factors and they cannot assume both fires behaved equivalently.

[42] *See* CA-07, pp. 21-22, Figs. 5 and 6.

fire likely faced many changes due to weather, wind, topography, and other environmental conditions as well as fire suppression activities, all of which impact fire growth behavior—accelerating or decelerating its growth rate.[43] Because I focused my analysis on the initial spread of the fire from a small ignition source and used real-world data to map its trajectory, I was able to account for these factors.[44] There is no indication Cal Advocates even considered, let alone attempted to account for, these factors in their calculations.

Finally, Cal Advocates' assumptions (if they were correct) would actually indicate a much earlier ignition time. Cal Advocates' theory (relying on the Cal Fire data) is that the fire's equilibrium growth rate was around 47.3 ft/minute for the entire period after the accelerative growth phase following ignition until the morning on December 5, 2017. If Cal Advocates' theory were correct, then the Cal Fire data would show an ignition much earlier in the day than any party has alleged. As shown in the blue line in Figure II-9 below, extrapolating backward from the Cal Fire data using Cal Advocates' assumptions shows a fire over 10,000 feet in diameter at Cal Advocates' ostensible ignition time of 6:17 p.m. and indicates an ignition time prior to 1:10 p.m. in the afternoon on December 4, 2017. Conversely, as shown in the orange line in Figure II-9, even accepting Cal Advocates' theory that if the ignition had occurred around 6:03-6:06 p.m. it would have reached linear growth of 47.3 ft/minute by 6:17 p.m., extrapolating forward would result in estimates of the fire's size by the morning of December 5, 2017 that are substantially smaller than the Cal Fire data upon which Cal Advocates' relies. Thus, Cal Advocates' assumptions are disproven by the evidence it relies on.

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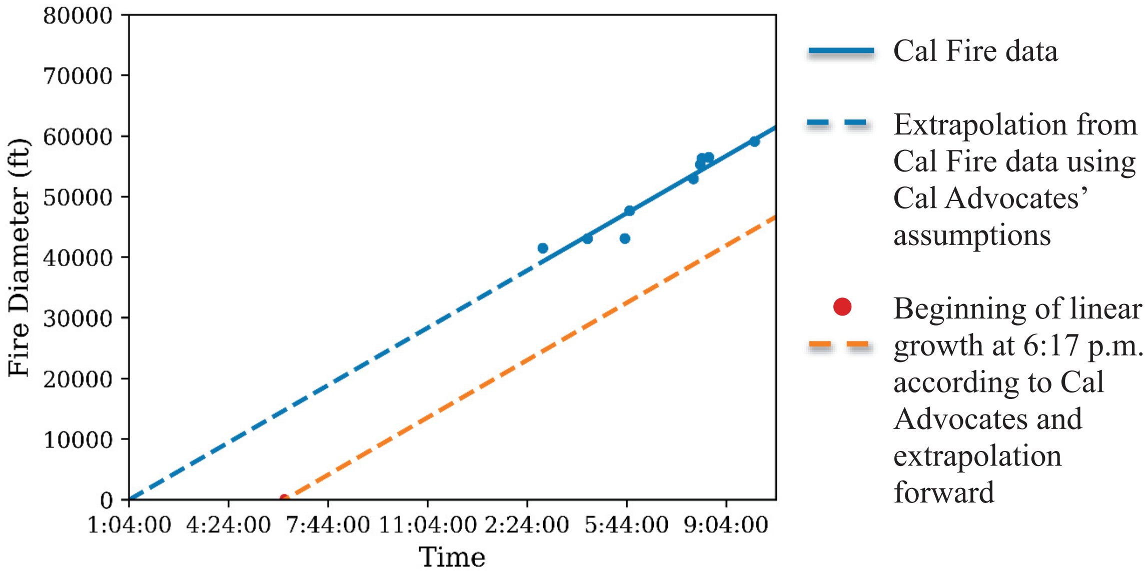
[43] These conditions build upon each other and lead to further modeling issues. For example, predictions may be complicated by turbulent wind patterns interacting with fire generated air currents, the presence of various forms of vegetation such as bushes and trees, as well as varying topography of meadows and canyons, which can all influence the rate and direction of the fire's spread. The fire's fuel load may also vary in "morphology, thermophysical properties, and moisture content," which "affect the heat and mass transfer mechanisms through the fuel bed, and the thermo-chemical pyrolysis of the woody fuel required to sustain the fire." *See* Thomsen et al., p. 7.

[44] Thomsen et al., p. 8 ("In the initial spread of wildland fire from a small ignition source, the problem [of modeling wildfire development] is somewhat simpler.").

Figure II-9
Extrapolations Using Cal Advocates' Assumptions



a) <u>Cal Advocates' Criticisms of High Impact's Fire Size Data Are Baseless</u>

Cal Advocates questions High Impact's estimates of fire size using the surveillance camera footage that I relied on for my analysis. High Impact prepared a technical appendix to its report that further explains the methodology and processes employed in its analysis.[45] I understand that this technical appendix addresses the two main critiques raised by Cal Advocates.[46]

First, Cal Advocates suggests that the fire size estimates are unreliable because of perceived differences between the surrogate camera and the Topa and StorHouse surveillance cameras. Specifically, Cal Advocates states that the surrogate camera has "a higher resolution, a different field of view, and a generally clearer image" than the Topa camera and points generally to different lens distortion between the two.[47] Cal Advocates' critique assumes that High Impact's 3D computer

[45] This technical appendix is attached as Appendix B.

[46] Many of Cal Advocates' critiques appear to be based on a misunderstanding of the photogrammetric analyses that were performed. I understand that Cal Advocates' witness sponsoring CA-07 has some experience in photogrammetry related to the commercial aerospace industry, but that experience is limited to constructing "computer models of satellite components from numerous photographs" and does not include estimating fire size from surveillance camera footage. *See* SCE-14, Appendix A, Cal Advocates Response to SCE-PubAdv-01, Questions 11-13.

[47] CA-07, pp. 17-20. Contrary to Cal Advocates suggestion (CA-07 at 20), the technical appendix states that a similar comparison with the surrogate camera was performed for the StorHouse camera.

modeling was based on the resolution, field of view, and lens specifications of the surrogate camera, *not* the specifications of the particular make and model of the Topa and StorHouse cameras. As explained in the technical appendix, that assumption is incorrect. High Impact's 3D computer model used virtual cameras with the *exact same specifications* (make, model, lens, etc.) as the Topa and StorHouse cameras. The technical appendix affirms that the surrogate camera was used only for the limited purpose of identifying the proper exposure parameters to use for the virtual cameras in the model to match the illumination conditions captured on December 4, 2017.[48] Thus, the differences identified by Cal Advocates are irrelevant in light of the limited purpose of the surrogate camera and Cal Advocates does not argue that there is not a proper exposure match between the surrogate camera and surveillance cameras.

Second, Cal Advocates criticizes the margin of error included in High Impact's fire size estimates as without justification. However, the technical appendix describes how High Impact calculated the appropriate margin of error based on its methodology for estimating fire size, which involved counting each pixel in the video images on a sliding scale of brightness. This led to a margin of error of plus or minus 10 meters based on the counting of half pixels. The technical appendix states that this margin of error is consistent with industry standards based on these calculations.

3. <u>The 911 Calls and Witness Statements Described by Cal Advocates Are Not Inconsistent with an Ignition Prior to 6:17 p.m.</u>

Cal Advocates points to records of 911 calls regarding the Anlauf ignition and other witness statements in an attempt to suggest that the timeline for these events is somehow inconsistent with the Anlauf ignition having occurred before 6:17 p.m., as the radar data and fire size evidence show.[49] Specifically, Cal Advocates criticizes SCE for not providing a rationale for the delay between the time of ignition and when the residents in Anlauf Canyon called 911 to report the fire near their home and suggests that this delay means the fire must not have started before 6:17 p.m. Yet, as Cal Advocates notes, at 6:24 p.m. "the fire was large enough to be seen from over two miles away"[50] and analysis of the Gamez photo shows the fire was located near the private residence area at this time.[51]

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[48] The technical appendix states that using surrogate cameras in this manner was necessary because of the automatic exposure adjustment features of the Topa and StorHouse cameras.

[49] CA-07, pp. 31–32.

[50] CA-07, p. 31.

[51] *See* SCE-02, pp. 29–30.

Cal Advocates concedes that the residents did not call 911 until 6:33 p.m.—16 minutes after the Anlauf fire agency report's ignition time which Cal Advocates adopts. Cal Advocates recognizes the most likely explanation for the residents' delay and general unawareness of the conditions outside in Anlauf Canyon at this time: the residents were inside their home watching Monday night football and were alerted to the fire outside their home only after receiving a phone call about the fire.[52] Thus, the delay between the time of ignition and when the residents in Anlauf Canyon called 911 has no evidentiary bearing on proving or disproving the fire's ignition time or location.

C. Cal Advocates' Criticism of SCE's Recloser Settings Has No Causal Connection to the Anlauf Ignition and Cal Advocates Does Not Dispute that SCE's Protective Devices Operated as Intended

Cal Advocates suggests that the Anlauf ignition could have been avoided if SCE had retained the pre-2014 settings on the branch line Remote Automatic Recloser at the base of Anlauf Canyon.[53] First and foremost, that suggestion is incorrect for the reasons set forth at length in SCE-02 and above, namely, that the Anlauf ignition was *not* the result of electrical contact between SCE conductors in the CP Rectifier area and occurred well *before* the earliest electrical event recorded on SCE's system at 6:17 p.m. Thus, the recloser settings are irrelevant to the cause of the Anlauf ignition.

In any event, Cal Advocates does not dispute that SCE's protective devices operated as intended on December 4, 2017. Electrical event records confirm that the phase-to-phase fault recorded at 6:17 p.m. self-cleared, meaning it was not of sufficient magnitude or duration to cause the recloser to operate. Cal Advocates criticizes SCE's adjustment of the phase and ground fault settings of the branch line Remote Automatic Recloser in 2014, but that criticism is without merit. I understand that the increases to the phase and ground fault settings in 2014 were to provide adequate coordination with downstream devices when SCE upgraded this recloser to a microprocessor-based relay. Cal Advocates cannot reasonably challenge this practice; in fact, having a process for analyzing and adjusting settings to improve coordination *is an industry best practice*. Cal Advocates' suggestion that the earlier settings should have been retained is nothing more than hindsight bias and misaligned with best practices at the time. Moreover, even if Cal Advocates' ignition theory were correct, Cal Advocates has not shown the

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[52] CA-07, p. 32.

[53] CA-10, p. 5. The Remote Automatic Recloser at the base of Anlauf Canyon is RAR 1228.

branch line Remote Automatic Recloser actually would have operated at 6:17 p.m. or that any such operation actually would have prevented an ignition.

III.
THE KOENIGSTEIN IGNITION

Cal Advocates acknowledges that SCE had no prior indication of damage to the conductor that separated and fell to the ground on December 4, 2017. Lacking any affirmative evidence suggesting imprudence, Cal Advocates raises a handful of speculative theories and vague criticisms that are without merit and lack any causal connection to the Koenigstein ignition. Cal Advocates does not dispute that SCE's protective devices operated as designed with respect to the events associated with the Koenigstein ignition, and the evidence shows the devices operated quickly to interrupt fault current and de-energize the portions of the line where faults occurred. Cal Advocates does not present any analysis to support its speculation that earlier implementation of "fast trip" settings could possibly have avoided the ignition, and this argument is nothing more than hindsight bias given such settings were not standard practice for wildfire mitigation in 2017. SCE's analysis shows that, even had SCE used Fast Curve settings on the day of the fire that were consistent with what SCE ultimately implemented in 2018, the Remote Automatic Recloser would have operated just as it did on December 4, 2017.

A. Cal Advocates Acknowledges that SCE Had No Indication Prior to December 4, 2017, of Any Damage to the Conductor that Separated

Cal Advocates acknowledges that the conductor likely was not damaged prior to the pole replacement work in April 2015 and admits that no damage was identified during inspection of these facilities.[54] Yet Cal Advocates speculates that the conductor possibly could have been damaged during the work to replace Pole 566 in April 2015 and then concealed by the avian guard.[55] There is no actual evidence to support such a theory and in fact, this speculation is contradicted by evidence. Specifically, as set forth in SCE-02, the lineman who oversaw this work affirmed that crew members would not put damaged conductor in the "hot arm" due to safety risks, and would repair any conductor damage identified during the work. Given the safety risks created by damaged conductor, and the contract incentive for contractors to make any additional repairs identified during the course of their work, there is no basis for Cal Advocates' conjecture.

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[54] CA-08, pp. 4-5.

[55] CA-08, p. 6.

B. Cal Advocates Concedes that SCE's Protective Devices Operated as Intended and Does Not Show that the More Sensitive Settings It Suggests Could Have Avoided the Koenigstein Ignition

As explained in my testimony in SCE-02, SCE's protective devices operated as intended on December 4, 2017, to interrupt faults and de-energize portions of the line where the faults occurred. Cal Advocates does not dispute this conclusion, but argues that SCE's recloser settings did not provide "sufficient protection."[56] I disagree.

Cal Advocates suggests that it is possible the Remote Automatic Recloser[57] would have operated in response to the downstream phase-to-phase fault preceding the conductor separation if SCE had implemented "fast trip" settings before December 4, 2017.[58] First and foremost, the fact that SCE did not have a "fast trip" program at the time of the Thomas Fire does not suggest any imprudence on the part of SCE, as explained in SCE-12. Second, and as acknowledged by Cal Advocates,[59] "fast trip" settings are intended to quickly interrupt fault current to reduce energy from a fault. That is precisely what happened on December 4, 2017, when the branch line fuse operated ***in less than a tenth of a second*** to interrupt the downstream phase-to-phase fault.[60] Cal Advocates' argument essentially ignores operation of the fuse.

Looking at the Fast Curve settings implemented by SCE in 2018, I conclude that earlier implementation of these settings would not change how the Remote Automatic Recloser operated in response to the faults that occurred on December 4, 2017. I understand that when SCE implemented its "Fast Curve" settings in 2018, the Fast Curve trip for reclosers was set at 5 times the existing Phase Minimum Trip value, and was intended to operate for both phase and ground faults. The Fast Curve trip

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[56] CA-08, p. 12.

[57] The upstream protective device closest to the Koenigstein events was the mainline Remote Automatic Recloser, RAR 179.

[58] CA-08, pp. 12-13. In CA-10, Cal Advocates argues that on Red Flag Warning days "SCE should have adjusted the phase and ground current settings to be more sensitive" to "minimiz[e] the risk of wildfire ignition." CA-10, p. 1. This suggests to me the witness is referring to "fast trip" settings, but he does not use that specific term. I understand that SCE began working to develop its version of "fast trip" settings, called Fast Curve, in late 2017 and first implemented those settings in HFRAs in 2018. SCE-12 presents SCE's testimony showing that its decision not to implement such settings prior to 2017 was reasonable and appropriate.

[59] CA-08, p. 13.

[60] SCE-02, pp. 71-73.

value for the Remote Automatic Recloser implemented in 2018 was 1400 amps [5 x 280 amps Phase Minimum Trip = 1400 amps]. As shown in SCE-02 Appendix A, the maximum recorded fault currents for the downstream phase-to-phase fault were 924 amps (A phase) and 858 amps (C phase), and the maximum recorded fault currents for the phase-to-ground faults were 643 amps (C phase) and 658 amps (ground), all of which were significantly lower than the 1400 amp Fast Curve trip value that would have triggered operation of the recloser. Thus, there is no causal connection between Cal Advocates' speculation regarding earlier implementation of SCE's Fast Curve settings and the Koenigstein ignition.[61]

Cal Advocates also criticizes SCE's adjustment of the ground fault setting of the Remote Automatic Recloser in 2014, and suggests the prior setting possibly could have avoided the ignition.[62] Again, Cal Advocates' criticism is without merit and tainted by hindsight bias. I understand that the initial increase to the ground fault setting in 2014 was to provide adequate coordination with downstream devices in connection with SCE's upgrade of the Remote Automatic Recloser at the base of Anlauf Canyon[63] to a microprocessor-based relay. As explained above, having a process for analyzing and adjusting settings to improve coordination is an industry best practice. I understand the second change to the ground fault setting, which made it more sensitive, was to ensure SCE's protective devices were set to operate effectively for end of line faults. There is nothing remotely imprudent about these 2014 settings updates to the Remote Automatic Recloser, and Cal Advocates does not dispute that coordination of protective devices is reasonable and appropriate.

Cal Advocates misleadingly suggests there was a single "phase-to-ground fault that lasted approximately 2.5 seconds before the recloser tripped."[64] In reality, and as I explained in SCE-02, ground faults are by nature chaotic and the fault current was changing rapidly on December 4, 2017, as

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[61] I understand that SCE updated its Fast Curve settings in 2022, changing the Fast Curve trip for reclosers to 2.3 times the existing Phase Minimum Trip value and adding a Fast Curve setting for ground faults. While it is possible the downstream phase-to-phase fault could have triggered operation of the Remote Automatic Recloser under this new approach [2.3 x 280 amps = 644 amps], I conclude it is more likely the recloser would *not* have operated because the branch line fuse operated so quickly—the updated Fast Curve settings have a 4-cycle time delay to allow for coordination with downstream fuses, and as shown in Figure IV-42 in SCE-02, the fuse operated in approximately 4 cycles (or even less) to clear the downstream phase-to-phase fault.

[62] CA-10, p. 9.

[63] The Remote Automatic Recloser at the base of Anlauf Canyon is RAR 1228.

[64] CA-10, p. 7.

shown by the electrical event records. Once the fault current was stable, the Remote Automatic Recloser operated in roughly one second to de-energize the line.[65] Cal Advocates posits that the "pre-2014 settings" might have resulted in the Remote Automatic Recloser tripping sooner in response to the phase-to-ground faults on December 4, 2017. First, and as acknowledged by Cal Advocates, this would only be the case "if the fault lasted long enough,"[66] which is not known. Even assuming the previous ground fault setting could have resulted in quicker operation of the Remote Automatic Recloser, the relay would not even have registered the fault until the energized conductor was already in contact with the ground, arcing in dry fuel, and even with an "immediate" operation, there is a finite amount of time required for the device to operate mechanically.

C. Cal Advocates' Critiques of SCE's Infrared Inspection Program, Conductor Records, and Wire-Down Data Are Baseless and Have No Causal Connection to the Koenigstein Ignition

1. There Is No Evidence Suggesting the Infrared Inspection "Missed" the Conductor Damage

The evidence shows that no "hot spots" were identified on the Castro Circuit when it was subject to infrared inspection in 2017.[67] While Cal Advocates speculates "[i]t is possible that SCE's infrared inspections failed to identify the damage" on the conductor that separated,[68] there is no evidence to support that speculation. Thus, irrespective of Cal Advocates critiques of certain aspects of the program,[69] there is no causal connection between any purported deficiencies in SCE's pilot program and the Koenigstein ignition.

As an initial matter, there is no evidence that the conductor was damaged at the time the infrared inspection was performed in March-May 2017.[70] All that is known is that the conductor separated unexpectedly during moderate fault current conditions on December 4, 2017,[71] and that, while it is possible there was latent damage at the point of separation, no such damage was identified during

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[65] SCE-02, p. 73.

[66] CA-10, p. 9.

[67] SCE-03, p. 50.

[68] CA-08, p. 8.

[69] SCE-14 shows that these critiques are unjustified because SCE's pilot program went above and beyond requirements and in no way suggestive of imprudence.

[70] *See* SCE-03, p. 50 (confirming infrared inspections of Castro Circuit performed from March to May 2017).

[71] Cal Advocates' testimony acknowledges that the preceding phase-to-phase fault generated "relatively low fault currents of 924 and 858 amps (on phases A and C, respectively)." CA-10, p. 7.

the course of SCE's investigation and examination. Moreover, as explained in SCE-03, infrared inspections use a thermal camera to identify "hot spots," which generally occur at "*connections and equipment*, such as switch contacts, connectors, splices, and connections to equipment terminals, that may have degraded" and thereby create temperature differentials.[72] I understand that records from SCE's infrared inspections of distribution lines confirm that identified "hot spots" generally occur at connection points such as connectors and splices, and at equipment such as switches and transformers, and that SCE was not able to find a single record of a "hot spot" reflecting damage on a mid-span primary distribution conductor.

Moreover, the conductor separation on December 4, 2017 occurred during fault current conditions, which far exceeded even peak operating load. Analysis of load data confirms that operating load in this area was relatively low, which makes sense given it is near the end of the line, and that the range of difference between "peak" and "non-peak" load was relatively small. I understand that, based on conservative calculations using historical usage data, peak load on this portion of the line (the portion downstream of the branch line fuse pole adjacent to the separation location) was approximately 4 amps. The branch line fuse adjacent to the separation location was rated at 25 amps, which means the maximum expected load in this area was materially less than 25 amps. Cal Advocates' unreasonable critique that SCE did not perform infrared inspections at peak load has no connection to the Koenigstein ignition.

2. **The Conductor that Separated Showed No Signs of Age-Related Deterioration or Damage from Environmental Exposure that Would Materially Impact the Strength of the Conductor**

In its testimony addressing the Koenigstein ignition, Cal Advocates raises a concern that SCE did not track conductor installation dates and notes that conductors can deteriorate and exhibit a loss of strength over time.[73] While theoretically there can be a small reduction in strength over time, I have seen no evidence indicating there was any loss of strength that would be relevant to the

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[72] SCE-03, pp. 48-49 (emphasis added).

[73] CA-08, pp. 11-12.

Koenigstein ignition. Even a five to ten percent reduction as referenced by Cal Advocates[74] is not a meaningful reduction in strength, especially on a relatively short span like this one.[75]

As described in SCE-02, I examined on several occasions the #4 ACSR conductor that separated and fell to the ground on December 4, 2017.[76] During those examinations, I observed no signs of age-related deterioration or damage from environmental exposure that would materially impact the strength of the conductor and, as explained in SCE-02, the separation occurred due to localized internal melting, not gradual deterioration over time that caused a tensile overload failure. I understand that this center phase conductor likely was installed later than the two outer copper conductors, when this branch line went from single phase to three phase service.[77] SCE records indicate the earliest installation of three-phase transformer banks downstream of this location beginning in the early 1990s. Installation of the #4 ACSR conductor in or around that time frame is consistent with the condition of the conductor which did not show signs of age-related deterioration or damage from environmental exposure.

3. Cal Advocates' Concerns Regarding High Operating Temperatures and Wire Down Data Are Not Relevant to the Koenigstein Ignition

Cal Advocates raises a theoretical concern that high operating temperatures can contribute to a loss of conductor strength over time.[78] This is irrelevant from my perspective because, as described above, this portion of the Castro Circuit near the Koenigstein location had low operating load (~4 amps), and was well within the design limits of #4 ACSR conductor.

Cal Advocates also raises vague concerns about SCE's data collection and analysis for wire down incidents but does not attempt to tie its concerns to the Koenigstein ignition in particular.[79] As set forth in SCE-02, although SCE has performed a diligent and extensive investigation, it has not been able to determine why the conductor separated in the manner that it did on December 4, 2017. Under these circumstances, Cal Advocates does not suggest (nor could it) that additional data collection or analysis of wire down events could somehow have avoided this ignition. More broadly, Cal

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[74] CA-08, p. 11 (noting Southwire recommendations "designed to limit the loss of strength of the conductor to five to ten percent over the life of the line").

[75] I am informed that the LiDAR data shows that the subject span here is only approximately 265 feet.

[76] SCE-02, pp. 68-69.

[77] SCE-02, p. 71.

[78] CA-08, p. 11.

[79] CA-08, p. 9-10.

Advocates' concerns are unfounded based on my understanding of SCE's robust process for analyzing conductor issues and wire down events, including the Overhead Conductor Program (OCP), which was described in SCE-03. I also understand the Castro Circuit did not have an anomalous number of wire down events in the years prior to the Thomas Fire, and had fewer wire down events as compared to the systemwide average.[80]

[80] SCE-14, p. 29, Fig. III-3. I am not aware of any utility that historically tracked the date of conductor installation independently, i.e., separate and apart from the underlying construction and maintenance records, and I understand Cal Advocates has acknowledged it has no basis to criticize SCE's practices relative to those of other utilities. *See* SCE-14, Appendix A, Cal Advocates Response to SCE-PubAdv-01, Question 5 ("Cal Advocates has not performed a comparative analysis of utility practices with respect to tracking conductor installation dates."). Nor am I aware of scientific literature finding an age-related mechanism for conductor failure. In any event, as described above, SCE records indicate that the center phase conductor that separated on December 4, 2017, likely was installed in or around the early 1990s, which is not old for conductor.

Appendix A

Evidentiary Tables

Appendix A

Evidentiary Tables

Cal Advocates / Fire Agencies' ignition theory fails because the fire (1) ignited before 6:17 p.m. and (2) not in the CP Rectifier area		
	Evidence Supporting Cal Advocates / Fire Agencies	**Evidence Disproving Cal Advocates / Fire Agencies**
Radar Data		Radar analysis shows a developing smoke plume from the Anlauf ignition before 6:17 p.m. and as early as 6:07 p.m. (before any electrical event on SCE's system)
Fire Size Modeling		Analysis of fire size data from surveillance camera footage shows that the Anlauf ignition occurred well before 6:17 p.m.—likely around 6:03 to 6:06 p.m.
Electrical Data	Record of a phase-to-phase fault on SCE's system at 6:17 p.m.	The 6:17 p.m. fault occurred in the Oil Field Area, not the CP rectifier area, as evidenced by electrical event records and fresh arc marks pointing to that time and place. Happened after smoke plumes already detected. No other phase-to-phase fault during this time frame.
Arc Marks	Arc marks on SCE conductors in CP Rectifier area	Arc marks are all heavily oxidized, meaning conductor contact was old and did not occur on Dec. 4, 2017.
Surveillance Cameras—Flashes	Western flashes captured by surveillance camera footage at 6:17 p.m., location determined to be in the vast 22-acre General Origin Area	Photogrammetric analysis of surveillance camera footage shows in better detail that western flashes did not occur in CP Rectifier area
Surveillance Cameras—Fire		Surveillance camera footage shows fire at 6:17 p.m. located in area down canyon from the CP Rectifier area.
Fire Markers	Fire agencies evaluated fire markers and identified a 22-acre General Origin Area and focused on the CP Rectifier area even though unable to identify a Specific Origin Area; no photographic documentation of individual fire markers or other information sufficient to validate analysis	SCE's fire origin and cause expert documented thousands of fire movement indicators over hundreds of acres in Anlauf Canyon and each fire marker was documented with photographs, compass reading and GPS coordinates, leading to conclusion that fire started near private residence

The evidence shows the Anlauf ignition likely was not caused by any SCE facilities		
	SCE's Evidence	**Cal Advocates' Position and [SCE's Response]**
Radar Data	Radar analysis shows a developing smoke plume from the Anlauf ignition as early as 6:07 p.m. and before any electrical event on SCE's system.	Challenges reliability and validity of SCE's radar analysis. *[Data comes from a government-owned and calibrated radar station; methodology and analysis is supported by satellite imagery and peer-reviewed scientific literature; location of plume is consistent with weather conditions in Anlauf Canyon.*]
Fire Size Modeling	Analysis of fire size data from surveillance camera footage shows that the Anlauf ignition likely occurred around 6:03 to 6:06 p.m., before any electrical event on SCE's system.	Challenges SCE's fire size analysis and modeling of the initial fire growth behavior. [*Critiques of fire growth modeling and analysis are inconsistent with literature and Cal Advocates' assumptions would suggest the fire ignited much earlier (in the early afternoon). Critiques of fire size analysis misunderstand the limited role of the surrogate camera and the basis for the margin of error.*]
Electrical Data	The earliest electrical event on SCE's system was a single phase-to-phase fault recorded at 6:17 p.m. This fault occurred in the Oil Field Area as confirmed by analysis of electrical event records, fresh arc marks in Oil Field Area, and surveillance camera footage showing eastern flashes.	[*Does not challenge SCE's testimony locating the 6:17 p.m. fault in the Oil Field Area.*]
Arc Marks/ SCE Facilities	The evidence rules out an ignition by SCE facilities in any of the three possible origin areas: (1) SCE had no facilities in the origin area identified by SCE near the private residence; (2) arc marks on conductors in the CP Rectifier area are all heavily oxidized, meaning no conductor contact on Dec. 4, 2017; (3) Pole 761 likely failed as a result of the fire and did not cause it (location of fresh arc marks consistent with pole failure and 6:41 p.m. permanent fault that tripped the remote automatic recloser).	(1) Challenges SCE's fire marker analysis based on timing of SCE's investigation and potential for disturbance. [*Does not indicate any ignition by SCE; SCE expeditiously began its investigation and accounted for possible disturbance.*] (2) Suggests that arc marks in the CP Rectifier area could have become oxidized due to possible exposure to smoke or fire or time spent in Cal Fire's evidence locker. [*Specu1ation is refuted by the evidence—arc marks were old and oxidized even before the conductors were taken into evidence; conductors were still in the air and showed no signs of exposure to smoke or fire; by contrast, fresh arc marks from the Oil Field Area did not oxidize in field or evidence storage.*] (3) [*Does not challenge SCE's conclusion regarding Pole 761.*]

Appendix B

Technical Appendix to August 18, 2023 High Impact Report

TECHNICAL APPENDIX

This technical appendix to the August 18, 2023 High Impact Report[1] provides additional, technical information regarding certain aspects of the methodology and processes employed by High Impact to estimate fire size from the surveillance camera footage. The August 18, 2023 Report uses available footage of the Thomas Fire from December 4th, 2017 that was recorded by two surveillance cameras: the "StorHouse" camera was located at the StorHouse Storage Center, 3201 West Fifth Street, Oxnard, California, near the Oxnard Airport; the "Topa" camera was located on the roof of the Topa office building at 300 E. Esplanade Drive in Oxnard.

Building the 3D Model

As described in the August 18, 2023 Report, the High Impact team collected data in order to build a 3D computer model of the site, including virtual versions of the two surveillance cameras, which could then be used to estimate the size of the fire using video recorded from the day of the event. This process involved multiple steps, including conducting LiDAR scans of the area, both locally around the sites of the two surveillance cameras and more broadly including the terrain in which the fire occurred using a survey-grade laser system mounted to a helicopter, then using those data to create a 3D model of the area and to place virtual versions of the two surveillance cameras within the model in locations corresponding to their locations in the field.

During site inspections of both the Topa and StorHouse cameras, the High Impact team conducted LiDAR scans of features nearest to the cameras. Scan data were processed through software that compares similar scan features/measurements and aligns the scans to one another with a high degree of accuracy. The StorHouse PointCloud and TOPA PointCloud were used as the foundations to build highly accurate 3D models of each camera's location and surroundings. Each PointCloud was geotagged with ten high-precision ground control targets with other geo-referenced PointClouds that described features seen within the surveillance footage. LiDAR coverage of significant topographic features identified in the surveillance footage was mapped with a mobile survey-grade laser system mounted to a helicopter. The aerial and terrestrial LiDAR scans, along with the supplementary USGS data, were combined into an overall 3D model.

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1 The original report was produced by SCE in response to Cal Advocates' data request. *See* CA-07-SA, SCE Response to Cal Advocates Data Request Set-A2308013-02, Question 04 Revised Supplemental. The report was erroneously titled "Report regarding High Impact Project on December 14, 2027 Fire in Anlauf Canyon." The correct title is "Report Regarding High Impact Project on December 4, 2017 Fire in Anlauf Canyon."

Camera Calibration

Cameras with the same specifications, including make, model, and lens, as the Topa and StorHouse cameras were acquired to perform camera calibration in order to determine the appropriate settings for the virtual cameras in the 3D model. The software algorithm function determines a camera's focal length, lens distortion, format aspect ratio, and principal point. The resulting camera specification file is saved on disk and used to accurately recreate the camera's properties with a virtual camera in the 3D model. These parameters relating to the geometric line-of-sight, and solved by software, have virtual counterpart parameters to recreate the camera's view. Control points with known positions in the 3D scene were matched to points in each source image and evaluated in concurrence with each camera specification file to ensure accuracy.

Exposure Calibration

The StorHouse and Topa cameras automatically adjust their exposure settings based on environmental lighting conditions. Thus, properly calibrating the virtual cameras in the 3D model required determining the exposure settings of the StorHouse and Topa cameras at the time the footage was captured on December 4, 2017. For this reason, a visual study was conducted under similar lighting conditions (at night) using a surrogate camera whose settings could be manually adjusted for determining the appropriate exposure settings to reach identical conditions. This surrogate camera was used as an instrument by the visual observers to determine an equivalent matching exposure to the subject surveillance camera. The observer compared contrasts of individual elements in images between the cameras until they were nearly identical.

The surrogate camera was a Canon EOS 5D Mark III, which had variable settings that are analogous to the parameters that can be adjusted for the virtual camera in the 3D model. The Canon EOS 5D Mark III camera was used as an instrument to capture an image with equivalent luminance as the Topa's HIK Vision DS-2CD2042WD camera. Similarly, the Canon EOS 5D Mark III camera was used as an instrument to capture an image with equivalent luminance as the StorHouse's Arecont Vision AV8185DN 8MP 180 Panoramic Color IP Camera. A ring light was attached to the surrogate camera and used to match the infrared lighting recorded from the subject camera's black and white recording. The matching image exposure was determined by adjustment to the camera's aperture (f-stop), shutter speed (exposure time), and ISO settings.

These variables have virtual counterparts within the computer model and were used to properly expose the rendering. Just like a real camera, the virtual camera can be moved within the environment to get an appropriate matching view and the exposure setting can be adjusted. Just like a real light, the intensity and color settings can be adjusted, as well as virtually measured in any direction to conform to experimentally derived data.

3D Virtual Modeling

High fidelity meshes were derived from the mobile aerial LiDAR and stationary terrestrial scans utilizing specialized software. The scanned meshes were exported to a 3D modeling software. In the modeling software, the meshed scans were optimized. The camera was aligned to the 3D model by extracting control points and spline outlines that corresponded to distinct features on the surveillance video (below).

Topa:

StorHouse:

The calibrated camera parameters and surveyed points were then used to produce an idealized camera and accompanying image. Consistent with photogrammetric industry standards and practices, the image is remapped (pixel by pixel) to reverse any lens distortion, non-centered principal, point, and any non-square pixels. The control points are then adjusted to match the undistorted image. The virtual camera and undistorted image used as a backplate are imported into the virtual 3D model (below).

Topa:

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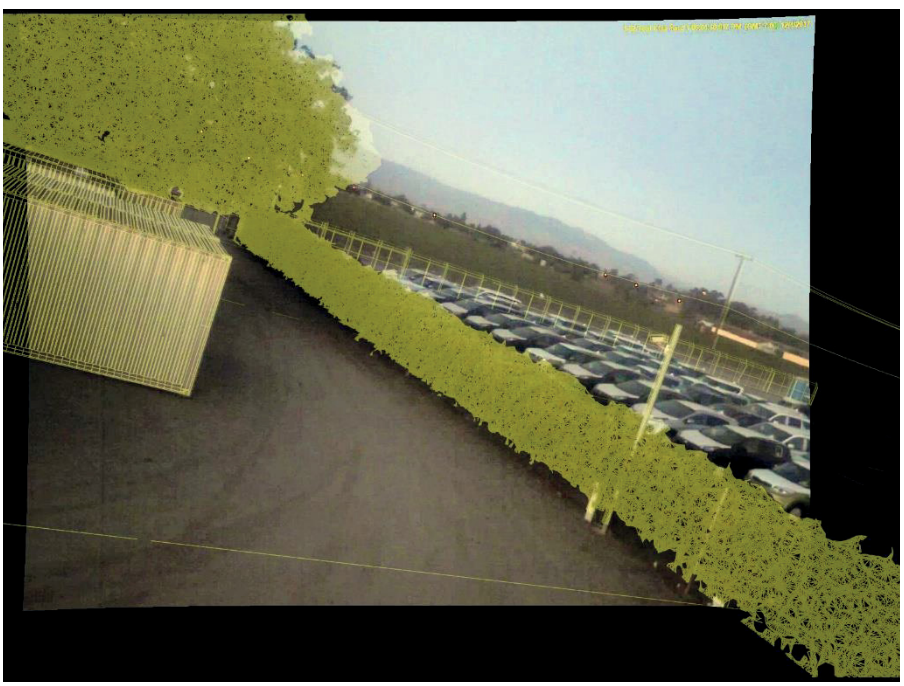
StorHouse:



Lighting in the TOPA visualization model was adjusted to match the reference surveillance video. The ring light attached to the TOPA surrogate camera was virtually recreated. The size of the light was modeled to scale. The StorHouse location lacks any bright light sources in the near foreground. Each camera's exposure was determined by reference photography taken on location under similar lowlight conditions.

Fire Size Estimates

An estimate of fire size was taken from an estimate of each pixel in 2D video images from the surveillance camera footage to approximately 16 cubic meters in the 3D model. Pixels were evaluated on a sliding scale: any pixel of 90% or higher brightness counted as 1 pixel, any pixel between 70% and 90% brightness counted as 0.5 pixels, and any pixel less than 70% was not counted. By discounting less bright pixels from the images, a more accurate estimate of the size of the fire could be obtained to account for fluctuations in brightness caused by smoke and other particulate matter. This led to a margin of error of plus or minus 10 meters based on the counting of half pixels. Any pixel between 70% to 90% brightness counted as part fire and part non-fire, i.e., the edge of the fire, which is within industry standard based on these calculations.

Cathleen M. Moore, Ph.D.
11 Wildberry Ct NE
Iowa City, IA 52240

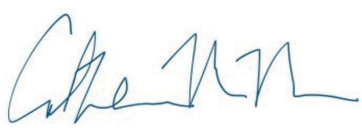
sent by electronic mail

July 8, 2024

To Whom It May Concern:

I have reviewed and affirm the Technical Appendix concerning the High Impact project on the 2017 fire in Anlauf Canyon.

Sincerely,



Cathleen M. Moore, Ph.D.