CALIFORNIA PUBLIC UTILITIES COMMISSION
Safety and Enforcement Division
Electric Safety and Reliability Branch

Incident Investigation Report

Report Date: October 27, 2021

Investigator: Matthew Yunge

Incident Number: E20191024-01

Regulated Entity Involved: Pacific Gas & Electric Company (PG&E)

Date and Time of the Incident: October 23, 2019 at 21:20 hours

Location of Incident: Unit 9/10 of the Calpine Geysers Facility, Sonoma County. Lat/Long: 38.795793, -122.767179

Fatality/Injury: 4 injuries, 0 fatalities

Property Damage: News reports dated January 13, 2020 provide an estimated property damage amount of $385 million. CAL FIRE reports 374 structures destroyed.

Regulated Entity Facilities Involved: Geysers #9 Lakeville 230 kV Line

Violation: Yes

I. SUMMARY

On October 23, 2019, a jumper cable on the Geysers #9 Lakeville 230 kV Line broke and arced upon failure. The broken jumper cable also arced upon contact with its associated tower (Tower 001/006). At approximately 21:20 hours, on October 23rd, PG&E became aware of an outage on its Geysers #9 Lakeville 230 kV transmission line.[1] In response to the Kincade Fire, the California Department of Forestry and Fire Protection (CAL FIRE) arrived at the Incident Site at 21:42 hours and noted that there was a broken jumper cable on Tower 001/006 of the Geysers #9 Lakeville line.

[1] Note that unless mentioned otherwise, all times presented are in 24-hour time.

A. Rules and Other Requirements Violated

General Order (GO) 95, Rule 31.1 Design, Construction and Maintenance states in part:

> *"Electrical supply and communication systems shall be designed, constructed, and maintained for their intended use, regard being given to the conditions under which they are to be operated, to enable the furnishing of safe, proper, and adequate service.*
>
> *For all particulars not specified in these rules, design, construction, and maintenance should be done in accordance with accepted good practice for the given local conditions known at the time by those responsible for the design, construction, or maintenance of communication or supply lines and equipment."*

GO 95, Rule 31.6 Abandoned Lines states in whole:

> *"Lines or portions of lines permanently abandoned shall be removed by their owners so that such lines shall not become a public nuisance or a hazard to life or property. For the purposes of this rule, lines that are permanently abandoned shall be defined as those lines that are determined by their owner to have no foreseeable future use."*

GO 95, Rule 44.3 Replacement states in whole:

> *"Lines or parts thereof shall be replaced or reinforced before safety factors have been reduced (due to factors such as deterioration and/or installation of additional facilities) in Grades "A" and "B" construction to less than two-thirds of the safety factors specified in Rule 441. And in Grade "C" construction to less than one-half of the safety factors specified in Rules 44.1. Poles in Grade "C" construction that only support communication lines shall also conform to the requirements of Rules 81.3A. In no case shall the application of this rule be held to permit the use of structures or any member of any structure with a safety factor less than one."*

California Public Utilities Code Section 451 states in part:

> *"Every public utility shall furnish and maintain such adequate, efficient, just, and reasonable service, instrumentalities, equipment, and facilities, including telephone facilities, as defined in Section 54.1 of the Civil Code, as are necessary to promote the safety, health, comfort, and convenience of its patrons, employees, and the public."*

B. Witnesses

	Witness Name	Title
1	Matthew Yunge	CPUC Utilities Engineer
2	Andie Biggs	CPUC Utilities Engineer
3	Nathan Sarina	CPUC Senior Utilities Engineer
4	Gary Uboldi	CAL FIRE Investigator
5	Kyle Steis	CAL FIRE Investigator
6	Shawn Zimmermaker	CAL FIRE Investigator
7	Charlie Laird	CAL FIRE Investigator
8	Jim Nolt	Consultant for CAL FIRE
9	Chris Van Cor	CAL FIRE Deputy Chief
10	Omid Sarvian	PG&E Event Specialist
11	Peter Modlin	Counsel for Calpine
12	Ben Wylly	Counsel for PG&E
13	Allison Kempf	Counsel for PG&E

C. Evidence

No.	Source	Description
1	CPUC	Photographs collected on site visits
2	PG&E	20-day report
3	PG&E	Responses to SED-001-Kincade Fire
4	PG&E	Responses to SED-002-Kincade Fire
5	PG&E	Responses to SED-003-Kincade Fire
6	PG&E	Responses to SED-004-Kincade Fire
7	PG&E	Responses to SED-005-Kincade Fire
8	PG&E	Responses to SED-006-Kincade Fire
9	PG&E	Responses to SED-007-Kincade Fire
10	PG&E	Responses to SED-008-Kincade Fire
11	PG&E	Responses to SED-009-Kincade Fire
12	PG&E	Responses to SED-010-Kincade Fire
13	PG&E	Responses to SED-011-Kincade Fire
14	Calpine	Responses to SED Data Request #1
15	Mesowest	Weather Station Information
16	CalFire	19CALNU019376 Kincade Report

II. BACKGROUND

The Safety and Enforcement Division (SED) and CAL FIRE investigated the electric safety incident in which a jumper cable failed on Tower 001/006 (Incident Tower) of the Geysers #9 Lakeville Line (Incident Line). The goal of SED's investigation was to identify whether there were any violations of the Commission's General Orders, Public Utilities Code, and related requirements under the Commission's jurisdiction. The goal of CAL FIRE's investigation was to determine the cause of the fire, as well as whether the fire was the result of violations of the Public Resources Code, and Title 14 of the California Code of Regulations. SED conducted field observations of evidence collection and reviewed PG&E's operations and maintenance procedures and relevant records.

The incident occurred on Tower 001/006 (Incident Tower) in the Geysers geothermal power generating facility in the Macayamas Mountains, on the Geysers #9 Lakeville 230 kV Line (Incident Circuit or Incident Line). The Incident Tower is located near Geysers Power Company (GPC) Unit 9/10 (called "Fumarole"), which has been inactive since 2001.[2] SED's field visits are summarized below:

- On October 26, 2019, SED conducted an initial site visit.
- On November 1, 2019, SED visited the Incident Site to attend CAL FIRE's removal of evidence.
- On November 10, 2019, SED visited the CAL FIRE facility in Santa Rosa to view evidence.
- On November 13, 2019, SED staff accompanied PG&E as PG&E collected evidence from the Incident Site.[3]
- On January 17, 2020, SED accompanied PG&E as it performed work on Tower 001/009 of the Incident Line.

SED submitted eleven (11) data requests totaling 140 questions to PG&E. The questions included requests for inspection records, inventory of equipment on Tower 001/006, internal

[2] November 20, 2019 GPC response to CPUC data request SED-001-Kincade Fire-Geysers Power Company, Question 3.

[3] For list of evidence collected see December 10, 2019 PG&E response to CPUC data request SED-002-Kincade Fire, Question 8.

communications, Public Safety Power Shut-off (PSPS) criteria, etc. SED also submitted one data request to GPC.

SED's investigation focused on PG&E's implementation of PSPS, the inspection history of the Incident Tower, the weather at the time of the incident, the configuration of the jumper cables on the Incident Tower, as well as the Incident Jumper Cable's mode of failure.

The Incident Tower, as well as the conductors and jumper cables on that tower, were installed in 1973 by PG&E.[4] The Incident Tower carries two circuits, the Incident Line and the Geysers #12 Fulton Line as shown in Figure 1.[5] The Incident Line runs north ending at the Incident Tower and is connected to the eastern arms of the Incident Tower, which are on the side of the Incident Tower closest to Unit 9/10.[6] The jumper cable that failed was connected to the topmost arm (of three) of the Incident Tower.[7] The Geysers #12 Fulton Line runs parallel to the Incident Line but continues northward past Unit 9/10 as shown in Figure 2.[8]

[4] November 26, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 34.

[5] December 23, 2019 PG&E Incident Report Form.

[6] See October 26, 2019 Observation Reports of Matthew Yunge and Andie Biggs.

[7] See October 26, 2019 Observation Reports of Matthew Yunge and Andie Biggs

[8] See October 26, 2019 Observation Report of Andie Biggs.

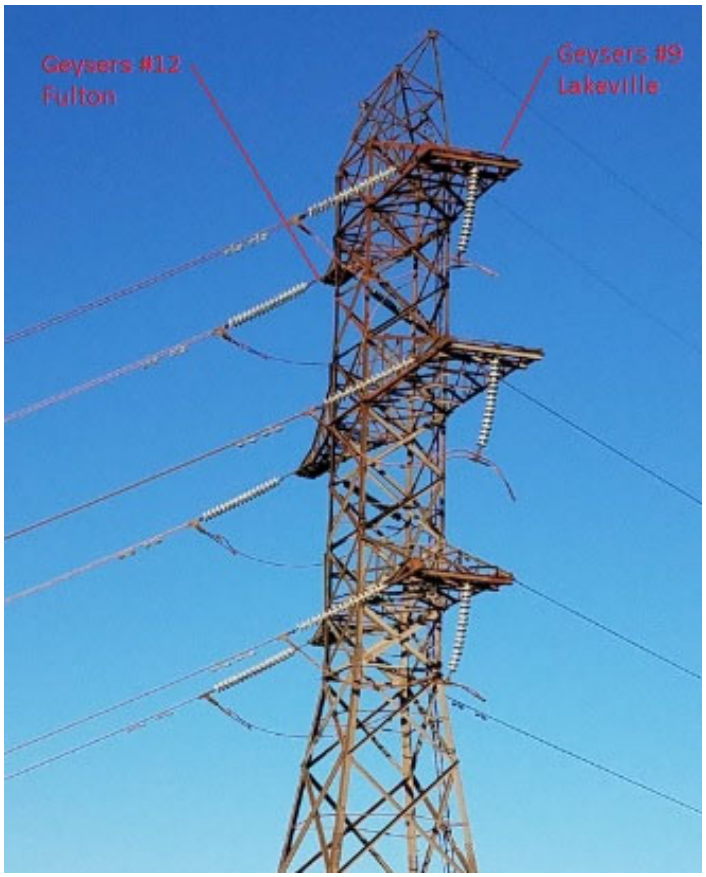

Figure 1: View of the Incident Tower immediately prior to evidence removal. Photograph is taken from the grounds of GPC Unit 9/10.

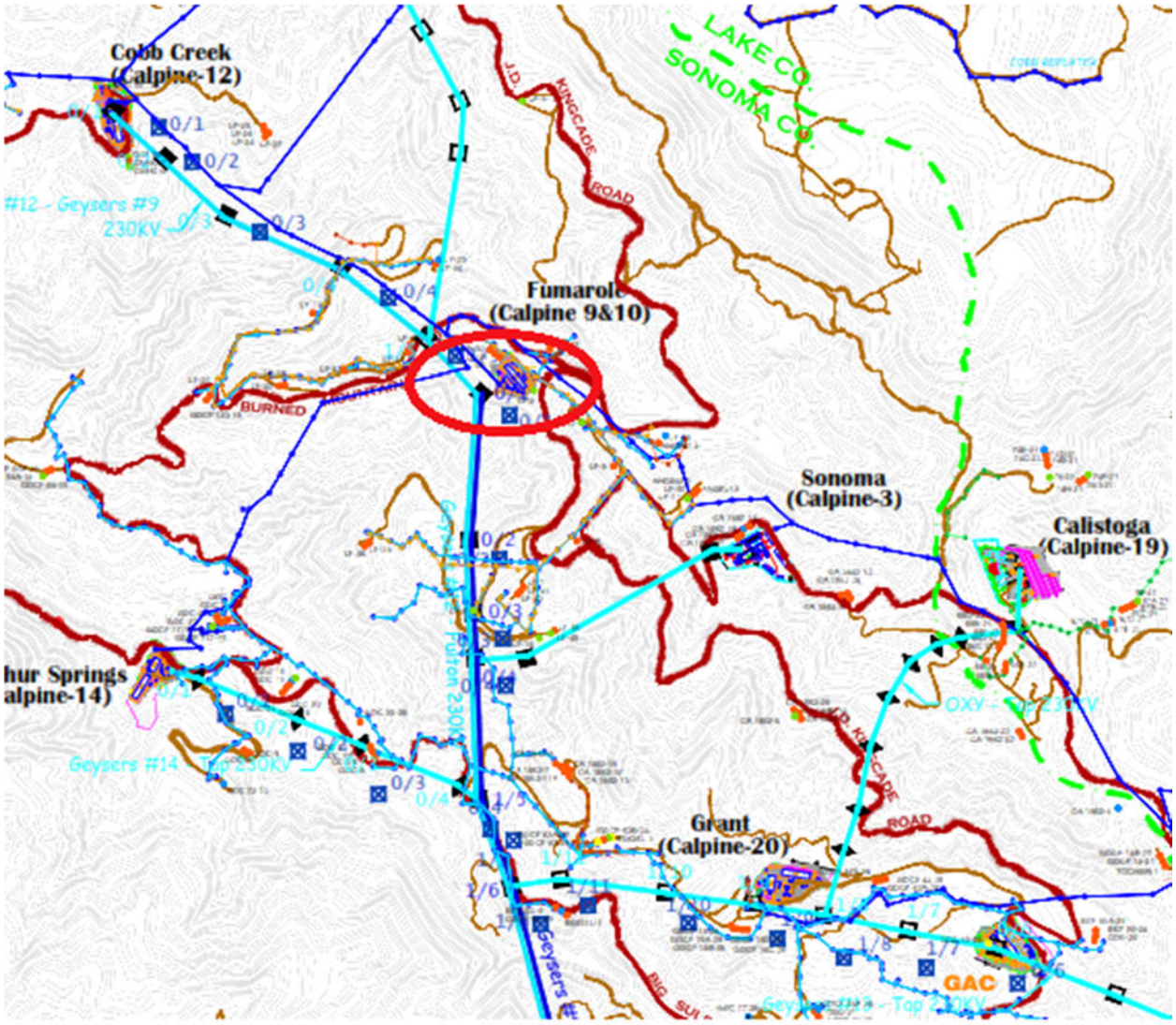

Figure 2: Map indicating incident location (circled) and Incident Line. The dark blue line approaching from the south and terminating at "Calpine 9&10" is the Incident Line. The blue line that is parallel to the Incident Line and continues running northwest past Unit 9/10 is the Geysers #12 Fulton Line.

III. SED Review and Analysis

A. Timeline Summary of the incident

On October 23, 2019, at 08:24 hours, PG&E notified GPC, a subsidiary of Calpine Corporation, that a Public Safety Power Shutoff (PSPS) event would begin between 12:00 hours and 14:00 hours of the same day. At 11:10 hours, PG&E notified GPC that distribution lines 1144 and 1146 would be de-energized.[9] Although PG&E de-energized the selected distribution lines near the

[9] November 20, 2019 GPC response to CPUC data request SED-001-Kincade Fire-Geysers Power Company, Question 1.

Incident Site, its transmission lines (including the Incident Line) remained energized. At 21:20 hours, PG&E received a Supervisory Control and Data Acquisition (SCADA) alarm that there was a line-to-ground fault on the Incident Line.[10] Video captured by the Barham N camera near Santa Rosa, CA on the ALERTWildfire camera network show what appears to be a fault, followed by an ignition at approximately 21:20 hours and 30 seconds.[11] According to CAL FIRE, the approximate start time of the Kincade Fire was 21:27 hours.[12] CAL FIRE confirmed with Northern California Power Authority (NCPA) that NCPA detected a phase to ground fault at 09:19 hours on October 23, 2019.[13] This chain of events supports the conclusion that the fault on the Incident Tower caused the Kincade Fire.

B. Field Review

For purposes of this Report, the Incident Tower and the nearby GPC Unit 9/10 are referred to as the "Incident Site" and are shown in Figure 3. The Incident Site is accessible by automobile via Kincade Road in Sonoma County.

[10] December 23, 2019 PG&E Amended 20-day Report.

[11] https://www.youtube.com/watch?v=nb2m8KKuwxk

[12] https://www.fire.ca.gov/Incidents/2019/10/23/kincade-fire/

[13] CAL FIRE Report, p5.

Figure 3: Google Earth view of the Incident Site. Incident Tower (shown with pin) located immediately southwest of GPC Unit 9/10. Road to the east is Kincade Road.

At the time of the incident, the highest measured wind gust speed within a 10-mile radius of the Incident Tower was 63 miles per hour (mph). This was recorded by weather station PG305, which is located about 2.2 miles south of the Incident Tower.[14] Other weather stations in the incident area recorded wind gust speeds of approximately 30 mph or lower. At 00:20 on the night of the incident, CAL FIRE measured wind speeds of 35 mph from the North, North/east direction at the incident location.[15] Figure 4 below is a map of nearby weather stations, including station PG305 and the Incident Tower location.[16] Figure 5 shows ten weather stations which recorded the highest wind gust speeds around the Incident Site.[17]

[14] December 10, 2019 Attachments to PG&E response to CPUC data request SED-001, Question 7, Bates Number PGE-KINC-CPUC-00000000189–216.

[15] CAL FIRE Report Attachment 6.5, p1.

[16] SED map based on information in December 10, 2019 Attachments to PG&E response to CPUC data request SED-001, Question 7, Bates Number PGE-KINC-CPUC-00000000189–216.

[17] SED chart based on information in December 10, 2019 Attachments to PG&E response to CPUC data request SED-001, Question 7, Bates Number PGE-KINC-CPUC-00000000189–216.

Figure 4: Map of Incident Site and nearby weather stations. Distance from Incident Site to weather station PG303 is approximately 4.6 miles.

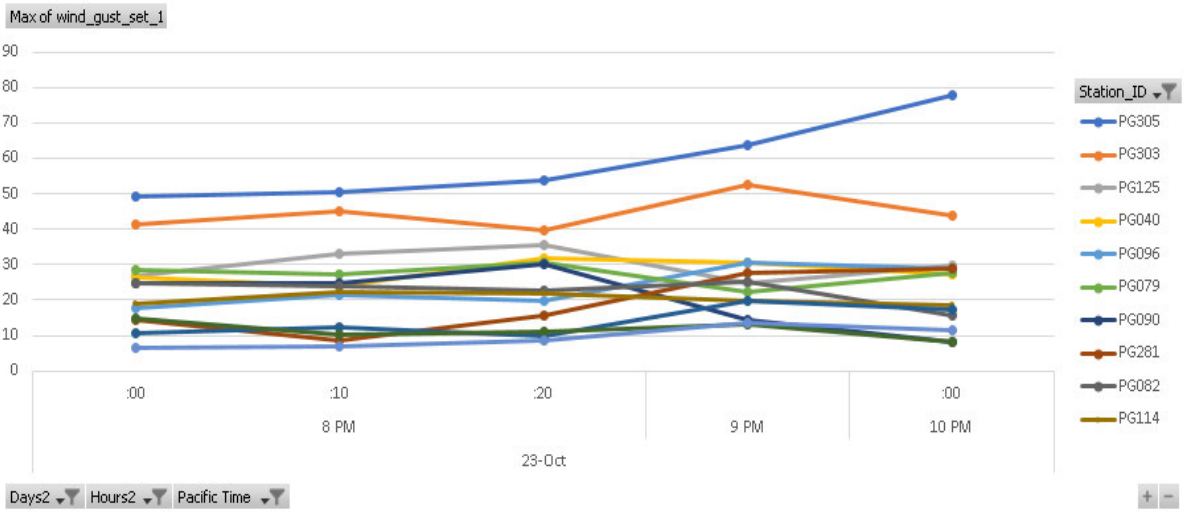

Figure 5: Wind gust speed of the 10 weather stations within 10 miles of the Incident Site that recorded the highest wind gust speeds at the time of the incident. (vertical axis indicates wind gust speeds in miles per hour)

CAL FIRE notes in its report that the Geysers area experiences stronger weather conditions compared to the surrounding areas in Sonoma County and Lake County. CAL FIRE also notes that weather conditions and the local topography are the predominate factors that contribute to large fires in the Geysers area.[18]

[18] CAL FIRE Report, p41.

CAL FIRE secured the Incident Site and access to the equipment at the Incident Site beginning October 23, 2019 at 21:42 hours until November 3, 2019 at approximately 17:00 hours.[19]
On October 26, 2019, SED staff visited the Incident Site. SED met CAL FIRE investigators at the Incident Site and examined the location, including nearby PG&E equipment and GPC facilities. SED noted that the topmost jumper cable on the side of the tower closest to Unit 9/10 was broken and still hanging from the tower as shown in Figure 6.

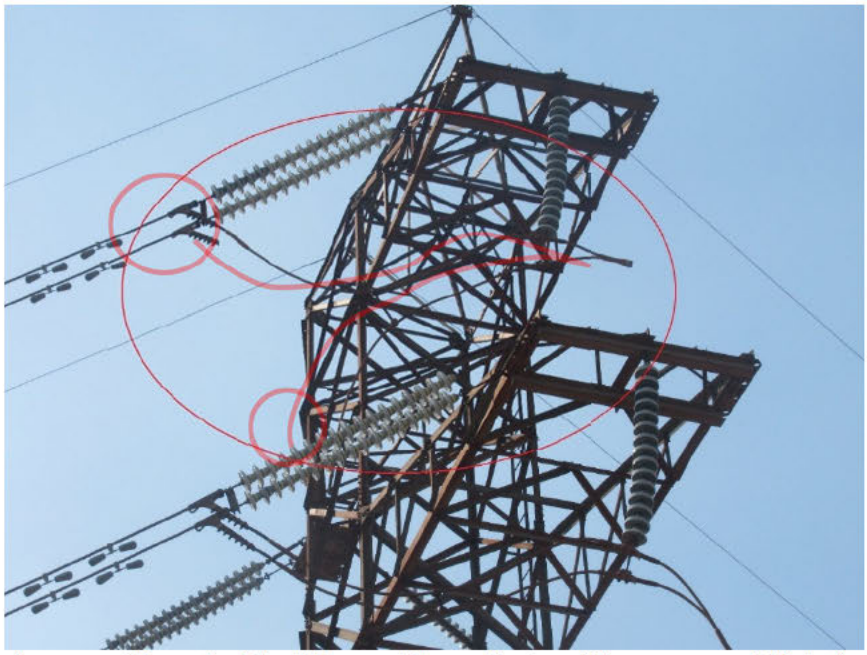

Figure 6: Broken jumper cable on Incident Tower, taken prior to evidence removal. Note that only one strand of the jumper cable's two stands is broken. The other strand is still attached to its shoe.

On November 1, 2019, SED visited the Incident Site to attend CAL FIRE's removal of evidence. During that process, SED observed PG&E personnel remove a tower arm from the middle level of the tower as well as jumper cables and insulator strings. PG&E replaced the insulator strings with new insulator strings in a different configuration than what was present during the time of the incident (see Figure 7 below). SED took note of the failed jumper cable. SED documented the damage at both ends of the failure point as well as signs of arcing damage/residue on the shoe of the failed jumper cable and on the spacing bar of the failed jumper cable. SED also noted multiple locations on the removed tower arm that had signs of arcing. CAL FIRE collected a portion of the tower arm that had sustained arcing damage, the incident jumper cable, and the

[19] January 31, 2020 PG&E response to CPUC data request SED-001-Kincade Fire, Question 1.

insulator string attached to the incident jumper cable. That evidence was sent to a CAL FIRE facility in Santa Rosa.

Figure 7: Installation of new insulator strings.

On November 10, 2019, SED went to the CAL FIRE facility in Santa Rosa and further investigated the evidence that CAL FIRE had collected on November 1, 2019.

On November 13, 2019, SED accompanied PG&E as PG&E collected evidence from the Incident Site. Physical evidence was collected by a contractor retained by PG&E. PG&E collected the sections of the tower arm that CAL FIRE did not collect and had left at the Incident Site. SED noted that the bolt holes in that section of the tower arm showed signs of wear as shown in Figure 8.

Figure 8: Bolt hole on tower arm collected by PG&E on November 13, 2019.

On January 17, 2020, SED accompanied PG&E as PG&E performed work on towers located approximately 0.63 miles south of the incident location on the Incident Line. PG&E reconfigured the jumper cables of Tower 001/009 of the Incident Line such that the Incident Line, from Tower 001/009 to 001/006, would be de-energized and isolated from the rest of the Incident Line. PG&E took this action because it determined that the Incident Line did not carry any electrical load between Tower 001/009 and Tower 001/006 and should be removed from service.[20]

C. Analysis

1. Service History

The jumper cables on the Incident Tower are all-aluminum and were installed in 1973 by PG&E.[21] The configuration of the jumper cables at the time of the incident was that for each of the Incident Line's three phases, two separate conductors were attached to their own strain

[20] December 20, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 40.

[21] November 26, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 34.

clamps, also called “shoes” (see Figure 9). From there, the span conductors exit the shoe and are attached to jumper cables via a non-tension connector. The two jumper cables are then joined together and connected to a suspended string of insulators.[22]

The failure point of the jumper cable was in the exit portion of the shoe shown in Figures 10 and 11. The two ends of the jumper cable on each side of the failure point showed different types of damage. The end of the broken jumper cable that is not in the shoe shows signs of arcing damage and appears to be melted and smoothed over as shown in Figure 12. On the other hand, the ends of the aluminum strands inside the shoe were jagged, with no signs of melting as shown in Figure 11. The lack of apparent melting implies that the portion of the jumper cable inside the shoe did not suffer arcing damage. CAL FIRE also found an additional wire failure inside the jumper cable splice. The wire failure in the splice showed signs of fatigue fracture and arc damage.[23]

[22] For ease of discussion, this Report will refer to the jumper cables, the connectors, and the portions of the span conductor inside the shoes as “jumper cables.” The side of the shoes where the span conductors entered the shoe will be referred to as the “entrance” and the portion of the shoe that leads toward the splices and suspended insulator strands will be referred to as the “exit.”

[23] CAL FIRE Report Attachment 20, p3.

Figure 9: Configuration of the jumper cables and insulators on the Incident Line.[24]

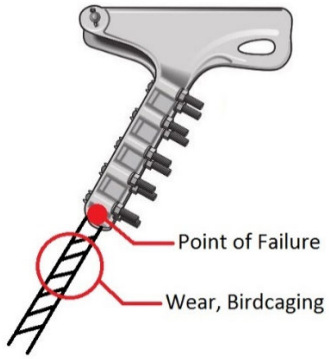

Figure 10: Depiction of the failure point of the incident jumper cable. Device that the cable is attached to is a strain clamp or "shoe".

Figure 11: View of the failure point. This segment is still inside the shoe.

[24] December 10, 2019 Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 60, "PGE-KINC-CPUC-00000000475.pdf."

Figure 12: View of the failure point. This is the side of the failure point that was hanging in the air prior to evidence removal.

Additionally, the incident jumper cable showed slight signs of bowing or bird-caging at the points near the exit of the shoe. This was noticed not just on the incident jumper cables but also on the other phases' jumper cables for the Incident Line. It is possible that this bird-caging is indicative of fatigue stress on the jumper cables and may have weakened the structural integrity of the jumper cables.

Figure 13: Shoes of the failed jumper cable. Note slight caging on cable that has not failed.

Figure 14: Signs of caging on intact jumper cables removed from the Incident Tower.

Service History/Configuration of Tower 001/006 of Geyser #9 Lakeville 230kV Line

The Incident Line ended at the Incident Tower and was not connected to GPC Unit 9/10 when the incident occurred.[25] The Incident Line originally served Unit 9/10 by connecting Unit 9/10 to Tower 001/006 and delivering that power to Circuit Breaker 222 at PG&E's Lakeville Substation, as shown in Figure 15.[26] In 2001, GPC "mothballed" (ceased generating power) at Unit 9/10.[27] In 2005, GPC notified PG&E that Unit 9/10 had been inactive for years and requested that Unit 9/10 be disconnected from the Incident Line.[28] PG&E disconnected Unit 9/10

[25] March 26, 2020 PG&E response to CPUC data request SED-005-Kincade Fire, Question 1.

[26] March 26, 2020 PG&E response to CPUC data request SED-005-Kincade Fire, Question 1.

[27] November 20, 2019 GPC response to CPUC data request SED-001-Kincade Fire-Geysers Power Company, Question 3.

[28] March 26, 2020 PG&E response to CPUC data request SED-005-Kincade Fire, Question 7.

from the Incident Tower in May 2006 by removing the facilities between the jumper cables on Tower 001/006 and Unit 9/10.[29]

After the Incident, PG&E chose to remove the jumper cables at Tower 001/009 on January 17-18, 2020. This de-energized the Incident Line from Tower 001/009 to Tower 001/006 while leaving the conductors in place.[30] On March 6, 2020, PG&E stated that the reason for removing the jumper cables at Tower 001/009 was that there was no need for the section of the Incident Line between 001/006 and 001/009 to remain electrically connected to the rest of the Incident Line.[31] After Unit 9/10 was disconnected from the Incident Line in 2006, the nearest source of power feeding into the Incident Line was GPC Unit #3, ("Sonoma PP") which connected to the rest of the Incident Line at Tower 001/009.[32] See Figures 2 and 15 for representations of Unit 3 and its connection to the Incident Line.

2. PSPS and De-energization

The incident occurred during the October 23, 2019 PSPS event and as discussed below, PG&E de-energized select distribution lines near the Incident Site, but the transmission lines remained energized. The Commission's General Orders, Decisions, and Public Utilities Code do not provide specific guidance on what conditions require electric transmission lines to be de-energized. Per Resolution ESRB-8 and Decision (D.)12-04-024, the Commission may review a

[29] March 26, 2020 PG&E response to CPUC data request SED-005-Kincade Fire, Question 3.

[30] March 6, 2020 PG&E response to CPUC data request SED-004-Kincade Fire, Question 3.

[31] March 6, 2020 PG&E response to CPUC data request SED-004-Kincade Fire, Question 3.

[32] December 20, 2019 PG&E response to CPUC data request SED-002-Kincade Fire, Question 4.

decision by the utilities to shut off power.[33], [34] While this investigation did not include a review of the entire PSPS event that PG&E initiated on October 23, 2019, it did review the PSPS event to the extent that the PSPS event is related to the incident.

In evaluating PG&E's conduct regarding the October 23, 2019 PSPS event, SED found that PG&E's protocols provide significant amounts of leeway for subjective judgement in determining the final scope of a PSPS footprint and in determining which circuits within that footprint would be de-energized.[35] For example, PG&E determined that GPC's distribution system would be subject to PSPS, but not the transmission lines in the same area. For this reason, SED only evaluated PG&E's determination of the *initial* PSPS scope.

PG&E uses five criteria to determine if a transmission line that is in the geographic footprint of a PSPS event needs to be de-energized. These include:

I. The presence of open Priority Code A tags;

II. The line's status as "idle";[36],[37]

III. An expected wildfire risk score greater than 10 units;

IV. More than a low risk of vegetation coming into contact with the line during a weather event (for 60 and 70kV lines);

V. A maximum potential consequence score greater than 1,000 units.[38]

When planning for the October 23, 2019 PSPS event, PG&E determined that the Incident Line did not meet any of the five criteria listed above.[39]

[33] D.19-05-042, p. 5.

[34] ESRB-8, p. 35.

[35] November 26, 2019 Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 29, PGE-KINC-CPUC-00000000109-110.

[36] June 12, 2020 PG&E Response to CPUC data request SED-007-Kincade Fire, Question 1.

[37] PG&E classified transmission lines as "idle" for purposes of determining the initial transmission scope if the complete circuit was disconnected and did not carry any load.

[38] February 13, 2020 PG&E response to CPUC data request SED-003-Kincade Fire, Question 23.

[39] February 21, 2020 PG&E response to CPUC data request SED-003-Kincade Fire, Question 22.

There were no open Priority Code A tags on the Incident Line as of October 23, 2019, addressing PG&E's criteria I.[40] The only open work tag for the Incident Tower was a priority E, which involved repainting the Incident Tower in order to address rust issues.[41] PG&E's criteria IV is not applicable as the Incident Line operates at 230 kV. Below is a table from PG&E's procedures that indicates the timeframes in which safety conditions must be corrected. Priority A conditions are the most severe and Priority F conditions are the least severe.

Priority Code	Priority Description
A	The condition is urgent and requires **immediate** response and continued action until the condition is repaired or no longer presents a potential hazard. SAP due date will be 30 days to allow time for post-construction processes and notification close-out.
B	Corrective action is required within **3 months** from the date the condition is identified. The condition must be reported to the transmission line supervisor as soon as practical.
E	Corrective action is required within **12 months** from the date the condition is identified.
F	Corrective action is recommended within **24 months** from the date the condition is identified, (due beyond 12 months, not to exceed 24 months). Requires Director approval.

Figure 16: Table of PG&E's Priority Codes and associated descriptions of those codes.[42]

SED reviewed PG&E's documentation for the potential consequence score to determine if the Incident Line should have been included in the initial scope of the October 23, 2019 PSPS event per PG&E's criteria listed above. The consequence score is an output from a model made by REAX Engineering (REAX Model). This model generates a maximum consequence score based on how much land would be expected to be burned and the associated residential structure density of the area. [redacted]

SED reviewed PG&E's documentation for the wildfire risk score to determine if the Incident Line should have been included in the initial scope of the October 23, 2019 PSPS event per

[40] November 26, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 12.

[41] November 26, 2019 PG&E response to CPUC data request SED-001, Question 12.

[42] April 2, 2019 PG&E response to CPUC data request SED-002, Question 36, PG&E-CAMP-CPUC-0000019356.

[redacted]

PG&E's criteria III. [redacted] This score is calculated from the outputs of the REAX Model, the Operability Assessment model (OA model), and the Fire Potential Index (FPI) model.[45] The OA model gives a probability of failure of a transmission structure at a given wind speed, given the structure's design, age, and nearby environmental factors. With regards to the October 23, 2019 PSPS event, the probability of failure provided by PG&E's OA model was 0.000000094% or 1/1,063,829,787 with 45 mph gusts.[46] Based on highest wind gust speeds measured by nearby weather station PG305 (assuming 63 mph) the probability of failure based on the OA model was 0.00154% or 1/64,935.

Based on SED's review detailed above, SED finds no violation of Commission Decisions or Resolutions regarding PG&E's determination to exclude the Incident Line from the initial scope of the October 23, 2019 de-energization event.

3. Inspections

General Order 165 establishes the requirements for electric distribution and transmission lines regarding inspections to ensure safe and high-quality electrical service. PG&E's procedures require that overhead transmission assets be patrolled annually.[47] Detailed Inspections are required every five years.[48] These inspections are in line with the inspection intervals used for the Incident Tower. PG&E's 2014 detailed inspection of the Incident Tower found no issues.[49] Similarly, PG&E did not note any issues in its latest detailed inspection of the Incident Tower completed in July 2019.[50]

[redacted]

[45] February 13, 2020 PG&E response to CPUC data request SED-003-Kincade Fire, Question 24.

[46] December 20, 2019Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 19, "PGE-KINC-CPUC-00000001072."

[47] April 2, 2019 PG&E Electric Preventative Maintenance Manual, PGE-CAMP-CPUC-0000019391.

[48] April 2, 2019 PG&E Electric Preventative Maintenance Manual, PGE_CAMP_CPUC-0000019382.

[49] December 20, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 16, "PGE-KINC-CPUC-00000000645".

[50] December 23, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 44, "PGE-KINC-CPUC-00000000140-142".

PG&E inspected the Incident Tower as part of its Wildfire Safety Inspection Program (WSIP) in February 2019 and May 2019.[51] PG&E conducted a drone inspection on the Incident Tower on May 11, 2019. During that inspection, PG&E inspectors used an incorrect inspection template, thus erroneously finding that the tower was non-steel, and submitted "N/A" when prompted about the condition of the jumpers.[52] On June 18, 2019, PG&E re-reviewed the photographs from the May 11th inspection as part of a routine review of forms on which no conditions were reported. PG&E determined in its June 18, 2019 re-review that the Incident Tower was missing a danger sign.[53]

A climbing inspection occurred on February 6, 2019 of the Incident Tower.[54] The February 6th inspection form indicates that the inspector found issues with the prevalence of rust on the tower itself.[55] The inspector also noted a small crack in one of the concrete stubs of the Incident Tower.[56] However, the inspector found no issue with the jumper cables or insulators on the Incident Tower.[57] Under the field "Jumper in poor condition" the inspector's input was "no."[58] In reviewing photographs taken from the May 11, 2019 inspection of the Incident Tower, SED noted that the bowing present in the jumper cables on the Incident Line-side of the tower during the Incident Site visit was also present during the May 11, 2019 inspection as shown in Figure 17.

[51] November 26, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 13.

[52] December 10, 2019 Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 64, "PGE-KINC-CPUC-00000000534."

[53] November 26, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 57.

[54] November 26, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 12.

[55] December 10, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 64, "PGE-KINC-CPUC-00000000546."

[56] December 10,2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 64, "PGE-KINC-CPUC-00000000543."

[57] December 10, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 64, "PGE-KINC-CPUC-00000000550."

[58] December 10, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 64, "PGE-KINC-CPUC-00000000550."

Figure 17: Jumper cable and shoe from May 11, 2019 drone inspection. Note signs of caging/bowing near shoe closer to the camera.[59]

When PG&E removed the insulators from the topmost arm of the Incident Tower on November 1, 2019, the insulators were in good condition. The insulators, which are shown in Figure 18, appeared to have arcing residue, presumably from the incident.[60]

Figure 18: Insulator string that was attached to incident Jumper Cable. The grey spots on the ceramic "skirt" are the arcing residue.

[59] December 10, 2019 PG&E response to CPUC data request SED-001-Kincade Fire, Question 60, "PGE-KINC-CPUC-00000000504".

[60] See photographs from SED visit of November 1, 2019 site Visit.

4. Equipment Configuration

SED noted the unusual configuration of the jumper cables on the Lakeville-side of the Incident Tower. Typically, in transmission system applications, string insulators are used in configurations that limit swinging motions to an extent. For example, in one configuration, by being attached "in line" to a span, a tension insulator string can be held in place by the tension of the conductor span on one end and a tower arm on the other. In a second configuration, an insulator string can be vertically suspended while supporting a passing span. In the second case, the tension of the supported span helps to limit the movement of the suspension insulator string.

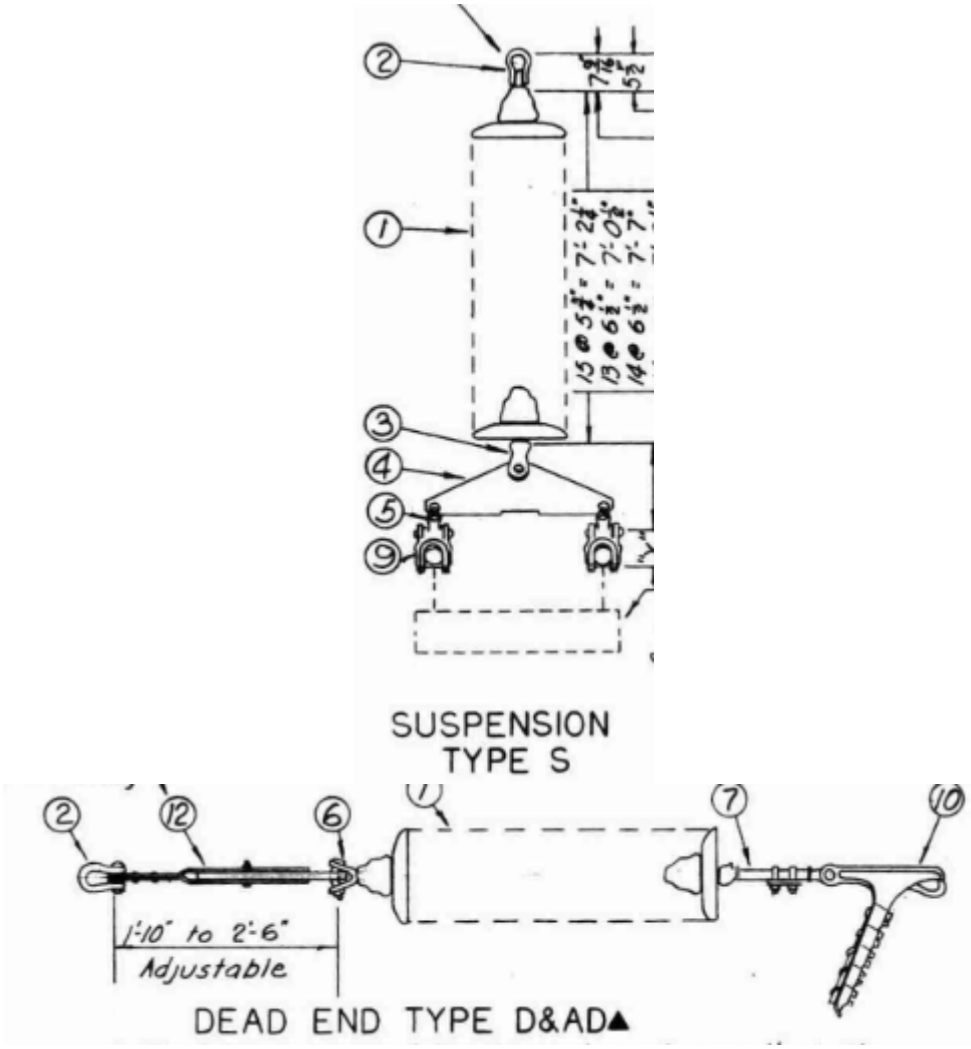

Figure 19: Design drawings of suspension and dead end type insulator configurations[61]

[61] January 31, 2020 Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 2, PGE-KINC-CPUC-00000001669.

Design drawings provided by PG&E and shown in Figure 19 above, illustrate the use of a "jumper string" configuration at the Incident Tower that uses a weight to limit the movement of the insulator string.[62],[63] There are also items that were not on the tower at the time of the incident that are marked on a 1985 structure data sheet from PG&E. These include the aforementioned "hold down weights" and the "hold down shackles" that are used to attach the weights to the jumper cable assemblies.[64]

Regarding the Incident Tower, there was nothing that limited the movement of the bottom end of the Lakeville-side suspended insulator strings. Under windy conditions, the bottom of the insulator string was free to swing without impediment, thereby causing the jumper cables to bend to the point that the jumper cable failed from fatigue stress.

5. Failure Analysis

A fracture evaluation of the incident jumper cable indicates that the cause of the fracture was mainly low-cycle fatigue.[65],[66] Microscopic examinations show that the jumper cable bore fatigue-induced striations and aluminum deposits that were likely caused by fretting between the wires.[67],[68] In instances where indicators of low-cycle fatigue were not found, the fractures were obscured by either fretting damage or damages caused by the final overload.[69] Additionally, the fracture evaluation found a fractured wire within the splice approximately eight inches away

[62] January 31, 2020 Attachment to PG&E response to CPUC data request SED-002-Kincade Fire, Question 1, PGE-KINC-CPUC-00000001686.

[63] January 31, 2020 Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 2, PGE-KINC-CPUC-00000001672.

[64] March 6, 2020 PG&E response to November 21, 2019 Attachment to PG&E response to CPUC data request SED-001-Kincade Fire, Question 3.

[65] CAL FIRE Report Attachment 20, p1.

[66] Fatigue failure refers to when a material fails after experiencing a large number of repeated stresses. Low-cycle fatigue failure generally refers to when fatigue failure occurs in under 1000 cycles.

[67] CAL FIRE Report Attachment 20, p3.

[68] Fretting refers to wear induced by small motions of tightly fitting components.

[69] CAL FIRE Report Attachment 20, p3.

from the main fracture that occurred at the shoe.[70] CAL FIRE's evaluation mentioned that it is likely that more evidence of fatigue exists inside the splice.[71]

It is unlikely that the signs of fatigue stress weakening the incident jumper cable would have been visible via a visual inspection, since it occurred within the shoe and splice. The promulgation of any fatigue cracks in the cables, the extent of corrosion in the interior strands of the cable, and the resultant impact of those factors on expected service life would probably not be determinable without removing the cables from service for a more thorough examination.

6. Area Fire History

CAL FIRE states in its report that the Kincade Fire bears many similarities to the Sawmill Fire.[72] CAL FIRE notes that low-cycle fatigue failures of PG&E equipment caused both incidents. Additionally, CAL FIRE notes that high winds were a factor in the mechanical failure that led to the Sawmill Fire. Lastly, CAL FIRE states that the findings for the cause of the Sawmill Fire were communicated to PG&E with the expectation that PG&E would take measures to prevent similar failures from occurring on their equipment that is exposed to similar conditions.[73]
The Sawmill Fire was also investigated by SED. The Sawmill Fire occurred on September 25, 2016 at the Geyser Plant which is within three miles of the Kincade Fire Incident Site. SED concluded on February 23, 2018 that the fastening hardware that attached a bond wire to a pole had failed in a manner that allowed that bond wire to contact one of the energized lines. At the time when SED closed its investigation, CAL FIRE indicated that the Sawmill Fire was still under investigation.

IV. DISCUSSION OF VIOLATIONS/CONCLUSIONS

A. Line Abandonment

GO 95, Rule 31.6 states:

> *"Lines or portions of lines permanently abandoned shall be removed by their owners so that such lines shall not become a public nuisance or a hazard to life or property. For the purposes of this rule, lines that are*

[70] CAL FIRE Report Attachment 20, p. 3.

[71] CAL FIRE Report Attachment 20, p. 4.

[72] CAL FIRE Report, p. 41.

[73] CAL FIRE Report, p. 42.

permanently abandoned shall be defined as those lines that are determined by their owner to have no foreseeable future use."

As previously noted, after PG&E disconnected the Incident Line from Unit 9/10, the jumper cables on the Lakeville side of the Incident Tower were still connected to the Incident Line and remained energized.[74] PG&E stated that when it disconnected the Incident Line from Unit 9/10 in 2006, it had no information regarding any potential future use of Unit 9/10.[75] PG&E had no foreseeable use for the section of the Incident Line which formerly served Unit 9/10 and runs from Tower 001/009 to Tower 001/006, and should have removed those additional facilities. In January 2020 PG&E removed the jumper cables at Tower 001/009, de-energizing the section from Tower 001/009 to Tower 001/006 but did not physically remove the conductor spans.

Furthermore, PG&E Utility Standard TD-1003S "Management of Idle Electric Transmission Line Facilities" states that:

> "Idle overhead transmission facilities that have no foreseeable future use must be categorized and handled according to the following requirements:
>
> - The facilities must be designated PA [permanently abandoned].
> - They must be removed."[76]

As defined in Utility Standard TD-1003S, PA stands for "permanently abandoned." Also, for this standard, idle transmission facilities are "Facilities that are not currently being used to serve transmission load or generation facilities but may have a potential future use by the Company."[77]

GO 95, Rule 31.6 does not differentiate between energized and de-energized lines, so long as these spans have no foreseeable future use they should be removed. Therefore, PG&E is in violation of GO 95, Rule 31.6 for improperly abandoning facilities starting in May 2006 and continuing until the span's removal in 2020.

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[74] See Figure 9.

[75] March 26, 2020 PG&E response to CPUC data request SED-005-Kincade Fire, Question 7.

[76] June 12, 2020 Attachment to PG&E response to CPUC data request SED-007-Kincade Fire, Question 1, PGE-KINC-CPUC-00000006176-6177.

[77] June 12, 2020 Attachment to PG&E response to CPUC data request SED-007-Kincade Fire, Question 1, PGE-KINC-CPUC-00000006180.

B. Design for Safe, Proper, Adequate Service

GO 95, Rule 31.1 states:

> *"Electrical supply and communication systems shall be designed, constructed, and maintained for their intended use, regard being given to the conditions under which they are to be operated, to enable the furnishing of safe, proper, and adequate service."*

In evaluating compliance with GO 95, Rule 31.1, SED considered whether PG&E acted in accordance with its own best practices and procedures in constructing and configuring the equipment attached to the Incident Tower. If configuration of equipment on the Incident Tower was not in compliance with PG&E's own procedures and if there is insufficient justification for the deviation from those procedures, then SED would determine that PG&E did not construct the equipment (when detaching from GPC Unit 9/10) on the Incident Tower with regard given to being able to provide safe, proper, and adequate service.

SED evaluated whether there was an issue with the design or construction of the equipment on the Incident Tower. SED noted that the design of the Lakeville-side jumper cables and insulator strings as they were prior to the incident was unusual. As can be seen in Figure 9, unlike typical span conductors, the ends of the jumper cables on the incident Circuit side of the Incident Tower were not secured to two fixed points (or points that were relatively stable by being under tension). Instead, the jumper cables were attached to the ends of suspension insulators that were hanging freely from the Incident Tower arm.

Typically, in transmission system applications, string insulators are used in configurations that limit swinging motions to an extent. In one configuration, by being attached "in line" to a span, a tension insulator string can be held in place by the tension of the conductor span on one end and a tower arm on the other. In a second configuration, an insulator string can be vertically suspended while supporting a passing span. In the second case, the tension of the supported span helps to limit the movement of the suspension insulator string.

Utilities can also use post insulators, which are rigid insulators. PG&E's Transmission Engineering documents illustrate the use of post insulators for overhead conductors.[78] A configuration using post insulators would be less likely to move in high wind conditions compared to the freely hanging configuration used at the Incident Tower.

Lastly, a review of SED's Camp Fire Report shows that in some cases PG&E uses hold-down anchors to limit the movement of an insulator string.[79] In this case PG&E noted that an anchor broke at Tower 27/221 of the Caribou-Palermo Transmission Line. This meant that the insulator string was freely hanging. PG&E noted this and created a work order to rectify the hazard. While the configuration of the Incident Tower differs from the configuration mentioned in the Camp Fire Report, PG&E's previous notes illustrate that freely hanging suspension insulators that are capable of a full range of motion on one end are a potential hazard.

PG&E's engineering standards and guidance documents do not reference the configuration used for the incident Jumper Cable after it was disconnected from GPC Unit 9/10. Specifically, PG&E stated in response to an SED data request asking about the configuration of the incident Jumper Cable as it existed at the time of the May 2019 drone inspection:

> *"Based on a review of its records, PG&E understands that there are no engineering standards, design drawings or guidance documents that reference the specific Tower 001/006 jumper configuration or that recommend or discourage this specific configuration."*[80]

With regards to the incident, there was nothing that limited the movement of the bottom end of the Lakeville-side suspended insulator strings. As noted in CAL FIRE's report, the original configuration of the Incident Tower secured the jumper cables and insulator strings in place and prevented excessive movement of that equipment.[81] By configuring the Incident Tower's jumper cables and insulator strings in the manner shown in Figure 9 after disconnecting GPC Unit 9/10 from PG&E's transmission system, PG&E allowed that equipment to have a greater range of

[78] June 12, 2020 Attachment to PG&E response to CPUC data request SED-009-Kincade Fire, Question 1, PGE-KINC-CPUC-00000006271.

[79] SED Camp Fire Report, CAMP-00014 – 00015.

[80] June 26, 2020 PG&E response to CPUC data request SED-009-Kincade Fire, Question 3.

[81] CAL FIRE Report, p39.

movement than other configurations on its system, thereby making it vulnerable to the low-cycle fatigue that gradually weakened the jumper cable to the point that the jumper cable failed during the October 23, 2019 wind event.[82]

Additionally, CAL FIRE had previously informed PG&E of its findings regarding the Sawmill Fire, the cause of which was similar to the Kincade Fire.[83] It is reasonable to conclude that PG&E was not only aware of the high wind conditions that are present in the Geysers Plant region, but also that PG&E's equipment in the area was susceptible to fatigue failure induced by high wind events.

The configuration that PG&E used at the Incident Tower after 2006 is not permitted by PG&E's own manuals and procedures. Therefore, PG&E did not configure the lines in accordance with its own procedures and consequently did not configure the equipment on the Incident Tower in a manner that enabled the furnishing of safe and adequate service.

C. Health and Safety

California Public Utilities Code Section 451 states in part:

> *"Every public utility shall furnish and maintain such adequate, efficient, just, and reasonable service, instrumentalities, equipment, and facilities, including telephone facilities, as defined in Section 54.1 of the Civil Code, as are necessary to promote the safety, health, comfort, and convenience of its patrons, employees, and the public."*

SED finds that PG&E did not furnish and maintain its facilities in a manner that promoted the safety and health of its patrons and the public, in violation of California Public Utilities Code Section 451.

PG&E left abandoned equipment energized for thirteen years even though that equipment provided no benefit or convenience to the public. Additionally, the configuration of the Lakeville #9-side jumper cables is not recommended by PG&E's own procedures. By leaving the Incident Tower's Lakeville #9-side jumper cables on the towers in a non-standard configuration, PG&E

[82] CAL FIRE Report, pp. 39-40.

[83] CAL FIRE Report, p. 42.

acted in a manner that increased the risk of an electric incident occurring. PG&E also took no action to remediate the configuration of these jumper cables while the incident span was not providing service between 2006 and November 1, 2019.

Because PG&E left abandoned energized equipment and failed to remediate an imprudent configuration of the Incident Tower's jumper cables, SED finds that PG&E failed to adequately furnish and maintain its equipment and facilities in a manner necessary to promote the health and safety of its patrons and the public, thus in violation of Public Utilities Code Section 451.

VI. CONCLUSION

Based on the evidence reviewed, SED's investigation has identified three (3) violations of Commission General Orders and regulations and the California Public Utilities Code by PG&E:

- PG&E failed to configure the jumper cables and insulator strings at the Incident Tower in a manner that is permitted by its own procedures and policies; and in doing so configured its equipment in a manner that does not enable the furnishing of safe and adequate service. Therefore, it is a violation of **GO 95, Rule 31.1**.
- PG&E failed to remove an abandoned line; therefore, it is a violation of **GO 95, Rule 31.6**.
- PG&E abandoned energized equipment and failed to remediate an imprudent configuration of the Incident Tower's jumper cables, and thereby failed to adequately furnish and maintain its equipment and facilities as is necessary to promote the safety and health of both its patrons and public; therefore, it is in violation of **PU Code Section 451.**

If SED becomes aware of additional information that could modify SED's findings in this Incident Investigation Report, SED may re-open the investigation. If so, SED may modify this report and take further actions as appropriate.