Event Analysis Report

Woodland – Property Damage

EIR No.: EI220611A

Date of Event: June 11, 2022

Date Reported to the CPUC: June 12, 2022

CAP Issue No(s).: 123831909, 124299760, 125741152, 125755781, 125935065, 125987828, 125995068

Report Rev: 01

[redacted]	[redacted]	05/16/2023
Leadership Approver	Signature	Date
[redacted]	[redacted]	05/15/2023
Incident Investigator	Signature	Date

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

On June 11, 2022, between 0645 hours and 0820 hours, all customers on PG&E's Woodland 1103 12kV distribution FLISR (Fault Location, Isolation, and Service Restoration).controlled circuit experienced three momentary outage events. At 0650 hours, the Woodland Fire Department (WFD) received notification of a structure fire at [redacted] in Woodland (Incident Location #1), which is the location of the [redacted] (MHP). All PG&E electrical facilities are underground within the MHP. At 0655 hours, WFD personnel arrived at the MHP and observed a gas meter on fire at Incident Location #1, which appeared to have spread to the mobile home. A second fire was subsequently reported by WFD at [redacted] (Incident Location #2), also in the MHP. Incident Location #1 was served by subsurface Transformer T0684 and Incident Location #2 by subsurface Transformer T0686.

PG&E first responders repaired two damaged primary underground cables, source side of T0684, and retained the cable segments as well as an electric SmartMeter™ from Incident Location #2 as evidence. Neither of the two gas meters nor electric Smartmeter™ from Incident Location #1 were retained as evidence at the time.

There were no reported injuries/fatalities or media reports. This incident was reported in a timely manner to the CPUC by PG&E under the property damage criterion, initiating an investigation by the Electric Incident Investigations (EII) team.

Analysis for this event included field observations, an EII electric maintenance tag assessment, site visits, voltage reliability analysis, power quality analysis, SmartMeter™ analysis, outage history analysis, transformer loading evaluation, system protection analysis, failure analysis, weather analysis, fire department analysis, mobile home park permitting/inspection review, internal guidance analysis and code review. These analyses concluded that PG&E experienced two UG primary cable failures, source-side of Transformer T0684 prior to the MHP fires. Fault current may have traveled to the mobile homes, resulting in electrical arcing between customer owned flexible gas lines and PG&E's gas regulators at both Incident Locations. The customer flexible gas lines appeared to be installed within less than an inch (possibly making contact) with PG&E's gas regulators, with potentially circumvented gas insulating fittings, and resulted in gas ignition that appeared to spread to the two structures.[1] The close contact between the customer's flexible gas lines may have obstructed the safe operation of PG&E's gas metering and/or pressure-regulating equipment, resulting in electrical arcing.

PG&E's electrical system is grounded, including at T0684. PG&E is not able to conclusively establish the cause of the two MHP fires through direct evidence. Although there is no direct evidence PG&E equipment caused the ignition, its UG primary cable fault(s) could not be excluded circumstantially as having precipitated or contributed to the two MHP fires. Likewise, PG&E does not know if customer protection equipment, (i.e., overprotection, grounding/bonding of the gas/electrical systems) was sufficient at the time.[2] Based on all information available,

[1] Insulating fittings are designed for cathodic protection/electrical isolation.
[2] California Code of Regulations - Title 25, Division 1, Chapter 2 (Mobilehome Parks), Article 3, §1148 - Overcurrent Protection.

PG&E concluded the most likely apparent cause (AC) and contributing cause (CC) of the event are:

- **AC-1:** Stray current migration from PG&E UG primary cable fault(s) through gas piping and/or other subsurface conductive materials. Based on visual observations, PG&E's UG primary cable(s) failed due to dielectric breakdown of the insulation, resulting in electrical arcing, significant heat damage and complete separation of the conductor. The failure likely propagated from the initiating cable to the second cable due to the proximity of the cables to each other and significant arcing heat generated during the initiating failure. While the primary cable was nearing end of life, that in and of itself does not appear to have caused the incident.
- **CC-1**: Installation of customer-owned metal flexible gas house lines in close proximity (possibly contacting) to PG&E's gas meter regulators, potentially bypassing gas facility insulating fittings, and resulting in a condition causing a release of natural gas.

The following corrective actions (CA) were identified as a result of the incident:

- **CA-1**: Interim repair of a section of UG primary UG cables with splices between J2219L and T0684. Completed between 06/11/22-06/12/22.
- **CA-2**: Replacement of UG primary cables between J2219L and T0684 in conduit which supply the MHP, pursuant to Utility Bulletin TD-061324-B002 (Pub. Date: 05/13/22, Rev.1). CAP 125935065

The following additional finding (AF) was identified:

- **AF-1:** PG&E's Greenbook does not currently have specific guidance related to keeping all customer gas piping, including flexible and rigid pipe, away and not in contact with PG&E gas meter set equipment.

Although not related to the cause of this incident, the following general actions (GA) were identified:

- **GA-1:** Evaluate current circuit protection scheme to determine if additional devices can be added to increase reliability and reduce customer outages. Evaluation completed on

01/13/23. Two sectionalizing SCADA switches will be added outside the MHP to increase reliability and decrease restoration time.[3] CAP 124299760

- **GA-2:** Create 56A Reliability replacement project for primary cables supplying the MHP. CAP 125741152
- **GA-3:** Correct MHP addresses in GIS to reflect true field locations. RW Notification 125755370 created for Electric Mapping to correct in GIS. CAP 125755781. Completed as of 04/12/23.
- **GA-4:** Consider creating a new section in PG&E's Greenbook outlining how customers should maintain space around PG&E gas meter set equipment. CAP 125995068
- **GA-5:** Leak survey to consider updating the FG-4110 Leak Survey Field Guide[4] as well as current Gas Corrective Training 9637, in order to better identify potential situations where customer gas house lines are in close contact with PG&E gas facilities (abnormal operating conditions). CAP 125987828

EII did not identify any non-compliances. PG&E identified a potential non-conformance related to the requirement for permanent replacement of the June 11, 2022 temporary/emergency repaired primary cables between T0684 and J2219L within 90 days, as outlined in Utility Bulletin TD-061324-B002. This bulletin communicates new requirements for failed cable replacement affecting Design and Construction Document 061324 - Guide for the Repair and Replacement of Distribution Underground Primary Cable (07/01/14, Rev. #01).[5]

This report concludes PG&E's investigation into this incident. Unless otherwise noted herein, where there are conflicts between this report and previous PG&E reports related to this incident, this report shall take precedence. If additional information becomes available with the potential to affect the conclusions of this investigation, PG&E reserves the right to re-open this investigation. All times, customer counts, and measurements in this report are approximate.

[3] See Section 6.10 (System Protection Analysis) as well as Figures 13 and 14, for location of proposed sectionalizing switches (FLISR Circuit).
[4] February 2022, Revision #1.
[5] SAP attribute added to facilitate a further internal compliance evaluation.

2. PROBLEM STATEMENT

Standard, Requirement or Managment Expectation

Deliver service reliably and safely to customers.

Deviation

On June 11, 2022, two structure fires occurred at [redacted] in Woodland.

Consequence

Structural damage to the residences.

Signficance:

This type of incident could potentially result in customer and/or PG&E property damage as well as significant injuries or fatalities.

This event was reported to the CPUC under the property damage criterion, triggering the investigation by the EII group. This report summarizes the findings of the investigation.

3. EXTENT OF CONDITION

An extent of condition ("EOC") analysis was performed to determine if the company is at risk for the same or similar occurring event(s). As the direct cause of each of the two fires are unknown, the primary focus was to find any similar company exposure that could adversely impact electric reliability and safety of PG&E customers.

3.1. Mobile Home Parks

On February 02, 2023, PG&E extracted California Mobile Home Data from the California Department of Housing and Community Development - Codes and Standards Automated

System (CASAS) to determine the number of mobile home parks in its service territory. There are approximately 2,543 mobile home parks in PG&E's territory and a total of 5,230 mobile homes in the State of California.[6]

In 2015, PG&E started a pilot program to convert master metered service at MHPs to direct metered service to each of the park's permitted spaces.[7] The Pilot Conversion Program sought to improve safety and reliability of electric and gas utility service at these master metered systems, which are often aging and not well maintained. After a successful pilot program, the program was extended for another 10 years.[8] The MHPs can apply to convert from master metering to individual meters through this program and they are prioritized by a number of factors including but not exclusive to the age of the system and number of leaks. In 2021, 600+ MHPs applied to participate in the program, and as of December 31, 2022, 158 MHP's have been converted from master metering to individual meters. The [redacted] MHP is individually metered and was therefore not a converted project.

3.2. Corrective Action Program (CAP)

On February 10, 2023, a CAP search was performed for a five-year time prior to February 1, 2023, to determine if there were any similar incidents. The majority of the CAP items did not appear to be similar in nature, although some involved gas and electric facilities. Initial review of a 2018 CAP submission discussed a customer residing in a MHP experiencing electrical shorts, sparks, and blown fuses. A responding troubleshooter at the time determined electrical issues originated at the customer-owned electrical pedestal and as a result, the customer requested PG&E to temporarily de-energize electrical service to facilitate contractor repairs[9]. Gas facilities were not involved.

CAP Query[10] - Five Year Prior From 02/10/2023	
Keywords	**Number of Entries Returned**
"Customer Ground" or "Customer Protection" and "Fire"	1
"Arcing" AND "Gas Meter" AND "Fire" AND "Transient" or "Inrush"	13

[6] Search for Mobilehome/RV Parks - CASAS, Data is provided to a reasonable degree of certainty and for general reference purposes.
[7] CPUC Decision 14-03-021
[8] CPUC Decision D.20-04-004
[9] CAP 114793658.
[10] Some CAP query results were duplicates.

“Arcing” AND “Gas Meter” AND “Fire”	15
“Structure Fire” AND “Gas” AND “Electric” AND “Inrush” OR “Locked”	692
“Transient” AND “Cable” AND “Fire” AND “Gas”	1
“Fire” and “Electric” and “Gas” and “Mobile” and “Home” and “Park”	3
“Fire” and “Electric” and “Gas” and “Mobile”	21
“Fire” and “Electric” and “Gas”	441
“Fire” and “Underground Cable” and “Electric”	2

Table 1: CAP Database results

3.3. Electric Incident Reporting (EIR) Database

On February 07, 2023, a five-year search of the EIR database was performed for electric reportable incidents occurring inside MHP’s. Excluding this incident, the search resulted in four incidents which were reviewed by EII below. None of the incidents appear similar in nature to this incident.

EIR Database Query - 02/2018 - 02/07/2023		
EIR Number	**Synopsis**	**Same/Similar?**
EI201024A	Possible customer electrical issue at one of the permanent structures (not mobile home).	No
EI191027D	Vegetation Fire in MHP. Direct cause of fire by wire-to-wire sparks falling to the ground and arcing of uninsulated low-voltage secondary conductors igniting vegetation in the area.	No
EI190530A	Excavator struck the incident pole down-guy, forcing a single-phase conductor to the ground resulting in a grass fire. Incident did not involve a MHP.	No
EI181229A	Mobile home fire, overhead service line-to-ground. Cause: Unable to determine the cause of the structure fire or downed service drop.	No

Table 2: EIR Database results

3.4. Electric Ignition Tracker Database

On February 06, 2023, a query of PG&E’s Electric Ignition Tracker Database was conducted for a period of time between 2014 to February 06, 2023 to determine if records reflect other similar incidents occurred.

Electric Ignition Tracker Database Query - 2014-02/06/2023	
Keywords	**Parameters/Terms**
“PG&E facility ignition”	“Yes”
“type of construction”	“Underground”, “Subsurface”
“asset family_cause”	“Distribution”
“primary/secondary”	“Primary”
“suspected initiating event”	“Equipment”

"ois_number"	'is not null'
"Equipment Facility Failure"	"Conductor"

Table 3: Ignition Tracker Database results

EII reviewed 12 resulting entries. One incident was found that occurred on July 05, 2022, and initial analysis suggests an underground cable-in-conduit conductor riser at a pole failed which arced resulting in a hole in a steel gas service line which ignited.[11] No other similar incidents were found involving both gas and electric facilities.

3.5. Riskmaster - Third-Party Claims

In the last four years, there have been fewer than five paid claims totaling less than $6,000 that match the following criteria:

- Paid 3rd party claims for fire incidents, occurring since 01/01/2019, where both Electric and Gas systems were determined to be involved.

3.6. Gas Regulatory Compliance DOT/CPUC Incident Tracker

On January 31, 2022, a search of PG&E's Gas Regulatory Compliance DOT/CPUC Incident Tracker was performed within a 5-year period of time prior to determine if we have record of similar incidents involving electric assets, and gas assets as secondarily involved. No similar incidents were found, other than an incident which occurred on January 27, 2021, in Carmichael.[12]

The Carmichael incident involved a gas explosion, which is believed to have occurred as the result of a Sacramento Municipal Utility District (SMUD) 12.47kV overhead electric primary distribution line that was downed as the result of a storm. The down line is believed to have created an electrical arc between a gas service line at a residential dwelling (Incident Location) and sewer lateral pipe. The distribution primary conductors likely contacted and energized the secondary neutral, allowing electricity to flow into the ground wiring of the incident house and into the sewer pipe, causing the arc to the gas service line.

[11] Ignition Index Number: 20221072. Note that ignition research is preliminary and subject to change.
[12] Event Identification Number: 2005149.000 – 7144.

3.7. Underground Cables

PG&E experiences roughly 1,000 cable system (cables, splices, elbows, and terminations) related equipment failures per year in its distribution cable systems. This does not factor in failures attributed to external forces such as 3rd party dig-ins, animals or weather related. Approximately 60% of these failures are cable failures; the remaining are splices, elbows, and other termination failures. The majority of these failures occur on local loop underground cables, predominately on unjacketed High Molecular Weight Polyethylene (HMWPE), PE & PEC insulated cables, which is the type of cable involved in this incident. Limited cable testing performed at PG&E over the years has found HMWPE and Cross-Linked Polyethylene (XLPE) unjacketed cables with varying degree of concentric (neutral) corrosion throughout PG&E's system. Various industry research suggests that severely deteriorated concentric (neutrals) could result in stray currents or voltages, which may pose safety risk.[13] Additionally, exposing DB cables without jacket installation to wet conditions, high voltage stress due to repeated faults, and loss of concentric neutral conductors are also known to contribute to premature failure of solid dielectric insulated cables.

PG&E's current control is the 56A Reliability Related Cable Replacement Program (56A Program) which targets underground cables that have a history of two or more failures within five years. The program currently allocates to replace about 18-20 miles of cables per year out of a total existing population of about 26,553 miles of primary cable (See Table 4 below) in its non-network distribution system.[14] Out of the 18-20 cable miles earmarked for replacement, about 40% are successfully replaced every year due to risk prioritization as well as resource allocation that are currently focused on priority overhead conductor replacements in High Fire Threat Districts (HFTD's) as well as PG&E's ongoing commitments to wildfire risk mitigation work.[15]

[13] TD-8106 - Distribution Line Underground Asset Management Plan (Excludes network cables, Publication Date: 11/05/21, Rev. 02). See Page 17 of 58. Stated information is subject to change based upon review of additional data/failure analysis. Design and Construction 061234 – Guide for the Repair and Replacement of Distribution Underground Primary Cable (Publication Date: 07/01/14, Rev. #01).
[14] TD-8106 - See Distribution Line Underground Asset Management Plan (Excludes network cables, Publication Date: 11/05/21, Rev. 02)
[15] 08/12/22 PG&E Asset Strategy internal email and PG&E's 2022 Wildfire Mitigation Plan.

Cable Type	Total (miles)	Installed Year	Average Installed Year	Current Average Age (yrs)	PG&E Expected Average Life (yrs)[16]
EPR	10,365 (39%)	1995 - Current	2008	12	60
HMWPE	7,609 (29%)	1960-1978	1969	51	40
Other	173 (<1%)	NA	1970	50	40
PILC	589 (2%)	Prior to 1960	1945	75	80
XLPE	7,797 (29%)	Late 1960's - 1998	1984	37	50
Grand Total	**26,533**				

Table 4: TD-8106 - Distribution Line Asset Management Plan[17]

Based upon a review of legacy as-built records, the primary HMWPE cables (#2AL-PE-CONC in this particular case) inside the MHP were originally installed in 1971. HMWPE cable is typically installed in cable-in-conduit (CIC) or DB. In this particular application, the subject cables were DB installed as was historical practice in some applications. HMWPE was mainly used for 200-A underground residential distribution (URD) applications from roughly around mid-1960s to late 1970s. HMWPE cable has an annual failure rate of about 8.6 failures per 100 miles, based on 2019 data. Majority of HMWPE cable is unjacketed. PG&E now installs EPR cable in conduit since the late 1990's and is the standard cable type installed at PG&E. Based on 2019 data the annual failure rate of EPR cable is about 0.1 failures per 100 miles.[18]

Electrical infrastructure inside the MHP is not currently identified for replacement under the 56A Reliability Related Cable Replacement Program.

[16] Many factors can contribute to the expected age of an asset, such as, but not limited to: Outage history, and external influences such as soil, weather conditions, cables utilized in conduit, dig-in activity, etc. Values provided are approximate and subject to change based upon current data analysis.
[17] Cross-Linked Polyethylene (XLPE), Ethylene Polypropylene Rubber (EPR), High Molecular Weight Polyethylene (HMWPE), Paper Insulated Lead Covered (PILC), High Density Polyethylene (HDPE), Polyethylene (PE), Ground Shield Composed Concentric Wire (CONC). Values provided in Table 4 are approximate and subject to change.
[18] Other factors can affect the life expectancy of assets. Data provided is subject to change based upon new data and analysis.

4. EVENT SUMMARY

Please refer to the 20-Day Report submitted to the CPUC on July 12, 2022.

4.1. Event Timeline

June 11, 2022

- **06:45:10 hours** - Incident Location #1: SmartMeter™ Badge [redacted] powers down ('NIC Power Down' event recorded).
- **06:45:17 hours - 06:45:40 hours** - First Event: CB 1103/2 relay detects line-to-ground fault activity, and two momentary distribution circuit level outages occur.[19]
    - 2594A fault magnitude and first CB reclose.
    - 2514A fault magnitude and second CB reclose.
- **06:49:17 hours** - WFD receives a first alarm of a structure fire at the MHP.
- **0654 hours** - WFD personnel on scene. A gas meter is reportedly observed on fire at Incident Location #1.
- **06:59:15 hours** – Yolo Emergency Communications Agency (YECA) contacts PG&E's Emergency Phone Line and requests gas/electrical support at Incident Location #1.
- **0703 hours** - GSR #1 is dispatched to the MHP.
- **07:07:13 hours** - YECA contacts PG&E's Emergency Phone Line and advises a second gas meter is on fire at Incident Location #2.
- **0718 hours** - Troubleshooter #1 is dispatched to the MHP.
- **07:27:18 hours** - Incident Location #1: SmartMeter™ Badge [redacted] powers down ('NIC Power Down' event recorded).
- **07:27:26 hours - 07:27:34 hours** - Second Event: CB 1103/2 relay detects additional line-to-ground fault activity resulting in a momentary distribution circuit level outage[20].
    - 2588A fault magnitude with one CB reclose.

[19] Subsequent fault analysis by Planning Engineering was performed after submittal of the 20-Day Report with device downloads from CB 1103/2 relays. PG&E's Distribution Engineering Planning determined the protection system operated as designed. Fault magnitude dissipated within the reclosing cycle such that the CB did not lock out.

[20] PG&E's Distribution Engineering Planning determined the protection system operated as designed. Analysis determined fault magnitudes dissipated within the reclosing cycle such that the CB did not lock out.

- **0731 hours** - Troubleshooter #2 is dispatched to the MHP.
- **0735 hours** - GSR #1 arrives at the MHP. GSR #1 confirms both fires were extinguished prior to arrival, and the flow of gas was shut-in, presumably by WFD[21]. Gas repair crew is dispatched to facilitate gas repair work.
- **07:56:16 hours** - Location #2: SmartMeter™ Badge [redacted] loses power ('Last Gasp' event recorded).
- **0805 hours** - Gas repair crew arrives. Gas crew determines no underground repairs are required at the time by them.
- **~0810 hours** - Troubleshooter #1 arrives and observes WFD and police department personnel on scene.
    - WFD indicates observing electrical sparks near both PG&E gas meters.
    - Troubleshooter #1 opens both customer main circuit breakers (Incident Locations #1 and #2) at the direction of the WFD.
- **08:19:26 hours** - Incident Location #1: SmartMeter™ Badge [redacted] powers down ('NIC Power Down' event recorded).
- **08:20:38 hours - 08:20:46 hours** - Third Event: CB 1103/2 relay detects an additional line-to-ground fault which results in a momentary distribution circuit level outage.[22]
    - 2645A fault magnitude with one CB reclose.
- **08:25:05 hours** - A Distribution Control Center (DCC) Operator disables CB 1103/2's reclosing functionality via SCADA.
- **0825 Hours** - Last WFD personnel departs from the scene.
- **08:27:07 hours** - Troubleshooter #1 - DCC
    - Customer/witness downstream from T0684, indicates to Troubleshooter #1 that their residence initially had 'partial power', followed by 'no power'.[23]
    - Troubleshooter #1 confirms one fire at Incident Location #1, fed by T0684 and a second fire at Incident Location #2, fed by T0686.
    - T0686 tests 'good power'.[24]

[21] During PG&E's equipment assessment post-incident, visual signs of electrical arcing were observed by PG&E first responders, between the customer flexible gas lines and PG&E's gas-meter regulators. The flexible gas lines were physically located very close (possibly contacting) PG&E's gas-meter regulators, thus potentially bypassing gas insulating fittings, and theoretically creating a path-to-ground for electrical current.
[22] PG&E's Distribution Engineering Planning determined the protection system operated as designed. Fault magnitude dissipated within the reclosing cycle such that the CB did not lock out.
[23] The identity of the customer/witness is not known.
[24] See DRU11263, PG&E response to CPUC Data Request #1 Q04, submitted on 01/19/22.

  - DCC confirms reclosing functionality was disabled via SCADA as the result of three momentary outages.
- **0834 hours** - GSR #1 departs from the MHP.
- **0854 hours** - Gas crew departs from the MHP.
- **09:03:08 Hours** - Coordination between Troubleshooter #1 and the DCC:
  - Confirmation that an FI tripped at J2219L towards T0684.
  - Structure fire near T0684 ([redacted]), and 'no power' at the transformer.[25]
- **0930 hours** - GSR #2 is dispatched to the MHP.
- **0951 hours** - Troubleshooter #1 continues an electrical assessment, opens load-break elbows on primary cables at J2219L towards T0684, and confirms de-energization.
  - All 25 customers de-energized load side of T0684, isolating the fault.
- **1025 hours** - Electric repair crew is dispatched.
- **1100 hours** - Automatic Sectionalizing (Fault Location, Isolation and Service Restoration ("FLISR") is temporarily disabled by a DCC system operator until repairs are completed.
- **11:01:44 hours** - DCC restores reclosing functionality to CB 1103/2.
- **1144 - 2036 hours** - Electric repair crew arrives and facilities restoration work in conjunction with the DCC, including but not limited to, UG primary cable (2) repairs, and additional switching operations as required for project completion.
  - Neither Transformer T0684 nor Transformer T0686 were damaged.
- **1340 hours** - GSR #2 arrives to assist with gas system related work.
  - Gas meters were removed from both Incident Locations.
- **1430 hours** - Gas service to Incident Locations #1 and #2 restored.
- **1950 hours** - All electric repair work completed, and all customers restored.
  - One section of two DB primary UG cables source side of T0684, and load side of J2219L were repaired with splices complete. Neither T0684 nor T0686 were found to be damaged.[26]
  - **2036 hours - 2037 hours** - CB1103/2 relays cut back in and FLISR functionality restored via SCADA by the DCC. Circuit returned back to a normal operating configuration.

[25] The actual physical address is [redacted]. EDGIS incorrectly indicates [redacted].
[26] See DRU11263, PG&E response to CPUC Data Request #1 Q04, submitted on 01/19/22.

June 12, 2022

- **09:56:52 hours** - PG&E reports the incident to the CPUC, out of an abundance of caution.[27]

November 28, 2022 - December 02, 2022

- Completion of gas/electric relocation at Incident Location #2 due to apparent electric panel which was damaged at request of the customer to meet J15 clearances (increased utility separation). Customer electrician to complete like-for-like panel upgrade.[28]

5. HISTORY

5.1. Electric Asset History

PG&E's Asset Knowledge and Management reviewed UG primary and secondary cable installation records specifically related to Incident Locations #1 and #2. Installation of DB UG primary 2-2AL PE-CONC 22kV cables into the MHP to T0684 was completed by September 17, 1971.[29] Secondary 3-2AL cables in 2" conduit were installed from a subsurface 200-Amp splice box (Object ID 14241862). The cables are connected to the low side of T0684, and travel to Incident Location #1. Installation was completed under the same project. Electrical services to Incident Locations #1 and #2 are not mapped.

Table 5 below, identifies attributes associated to T0684. This unit was in service at the time of this incident on June 11, 2022:

Subsurface Transformer T0684 Information	
Type	Subsurface Round Single-Phase Self-Protected
Size	100kVA
SAP ID	40222563
Installation Year	07/03/91
Operating Voltage	12kv
Low-Side Voltage	120/240V Single Phase
Manufacturer	General Electric

[27] As of 02/06/23, no related claims have been received.
[28] Application 124173247. PM 35386595.
[29] See GM463689-71. See DRU11263, PG&E's response to CPUC Data Request #1 Q12, submitted on 01/19/22.

Serial Number	P847730XXE
CGC	220721036538
Material Code	2058
Install Job Number	215373A

Table 5: T0684 attributes on June 11, 2022.

T0684 was replaced October 02, 2022, with a higher capacity switched transformer, following an outage/UG primary cable fault, as outlined in Table 6 below[30]:

Subsurface Transformer T0684 Information	
Type	Subsurface Round Single-Phase Self-Protected
Size	167kVA
Installation Date	10/03/22
Operating Voltage	12kv
Low-Side Voltage	120/240V Single Phase
Manufacturer	Howard Industries, Inc.
Serial Number	HI2540823115
CGC	220721036538
Material Code	M262099[31]
Install Job Number	35391561
ILIS Outage Number	22-0117011

Table 6: T0684 replacement transformer as of October 03, 2022.

T0686 was installed on December 7, 2013, following a transformer and UG primary/secondary cable faults, as outlined in Table 7 below[32]:

Subsurface Transformer T0686 Information	
Type	Subsurface Round Single-Phase Self-Protected
Size	100kVA
Installation Date	12/07/13
Operating Voltage	12kv
Low-Side Voltage	120/240V Single Phase
Manufacturer	Howard Industries, Inc.
Serial Number	3772905212
CGC	220723436507
Material Code	M262060
Install Job Number	31041422
ILIS	13-0081064
OIS	0921342

Table 7: T0686 replacement transformer as of December 07, 2013.

[30] Switched transformer was installed due to availability at the time. EC Tag 124608324.
[31] See Construction Document 062111 - Application of Underground Distribution Transformers (03/25/22, Rev. #27, Table 26, Page 14 of 26).
[32] EC Tags: 107512056 (transformer replacement), 107537570 (40' UG 1/0 primary conductor repaired with splices) 107537507 (15' of UG secondary conductor repaired).

5.2. Gas Asset History

Installation of steel gas mains and ¾" steel gas service lines, as well as primary/secondary electric lines in the MHP (61 mobile homes) was completed by September 17, 1971.[33] Gas services to Incident Location #1 and #2 were installed utilizing ¾" steel pipe.

Figure 1: Excerpt from 02/12/20 Gas Plat Map YOL2460-HF

As the mobile home park increased in size, alterations appeared to have been made to the existing gas system (and electrical system) to accommodate additional customers, which required the addition of plastic gas services and a plastic gas main extension, including, but not limited to customers depicted in the green circle in Figure 1 above which were of 1987 vintage.[34] See Figure 2 below for the original gas as-built configuration from 1971.[35]

[33] See GM463689-71.
[34] Addresses: [redacted], [redacted]. Gas WO48857A.
[35] Obtained voluntarily from a MHP representative.

Figure 2: PG&E 1971 As-Built Gas Drawing - GM463689-71

5.3. GO 165 Patrol Records

As part of this investigation, the last two GO 165 Underground Patrol Records prior to the occurrence of this incident were reviewed. The records showed no findings.

- July 03, 2019 - No abnormal conditions noted inside the mobile home park or to J2219L.
- September 17, 2021 - No abnormal conditions noted inside the mobile home park or to J2219L.

5.4. GO 165 Inspection Records

As part of this investigation, GO 165 Underground Inspection Records were reviewed prior to the occurrence of this incident were reviewed. The records showed no findings.

- July 25, 2017 - July 27, 2017 - No abnormal conditions noted inside the mobile home park or to J2219L.
- September 17, 2021 - No abnormal conditions noted inside the mobile home park or to J2219L.

5.5. Gas Leak Survey Records/Atmospheric Corrosion (AC) Inspections

EII reviewed the most recent three leak surveys and the last two AC inspection records, which include an emergency survey conducted on the date following this incident. No gas leaks were found at either Incident Location #1 or Incident Location #2. No preexisting gas leaks or atmospheric corrosion conditions are believed to be related to the ignition of the subject MHP fires.

February 2020 Leak Survey and AC Inspection

In February of 2020, mobile/foot leak surveys and AC inspections were performed in the MHP. No AC issues were found. An above ground Grade 3 riser thread leak was found at [redacted] and another above ground Grade 3 riser thread leak was found at [redacted], which were subsequently repaired.[36]

June 11, 2022 Special Leak Survey (Post-Incident)

After the incident on June 11, 2022, PG&E conducted a special leak survey of all the gas services and mains within the MHP as well as a portion of gas infrastructure outside the park, in conjunction with Utility Procedure TD-4911-P-05.[37] Figure 3 specifies the boundaries of the surveyed area. One gas leak was found at [redacted] on a section of steel gas main, which we believe was likely caused by contact between the gas line and an encroaching metallic water service line.[38] The gas leak was repaired by PG&E Gas Maintenance and Construction and the water line was rerouted to create additional separation in order to mitigate recurrence.[39] No additional gas leaks were found. Due to the proximity of the gas leak, we do not believe this had any relevancy to the initiation of the two MHP fires. Although not known in this case, close proximity of metallic water facilities to subsurface steel gas lines as well as electric infrastructure could increase the likelihood for stray fault current to travel.

[36] See A-Forms 118536091 and 118536079 as well as 02/20 Leak Survey/AC inspection documentation. EDGIS and the PLAT maps require updating. The actual physical address of [redacted] is [redacted] The actual physical address of [redacted] is [redacted].
[37] Response to Gas Distribution Assets Impacted by Electrical Fault or Lightning (Pub. Date. 05/28/21, Rev. 0)
[38] GIS/Plat maps reflect [redacted]; however, the actual physical address is [redacted].
[39] See PM 45340417.

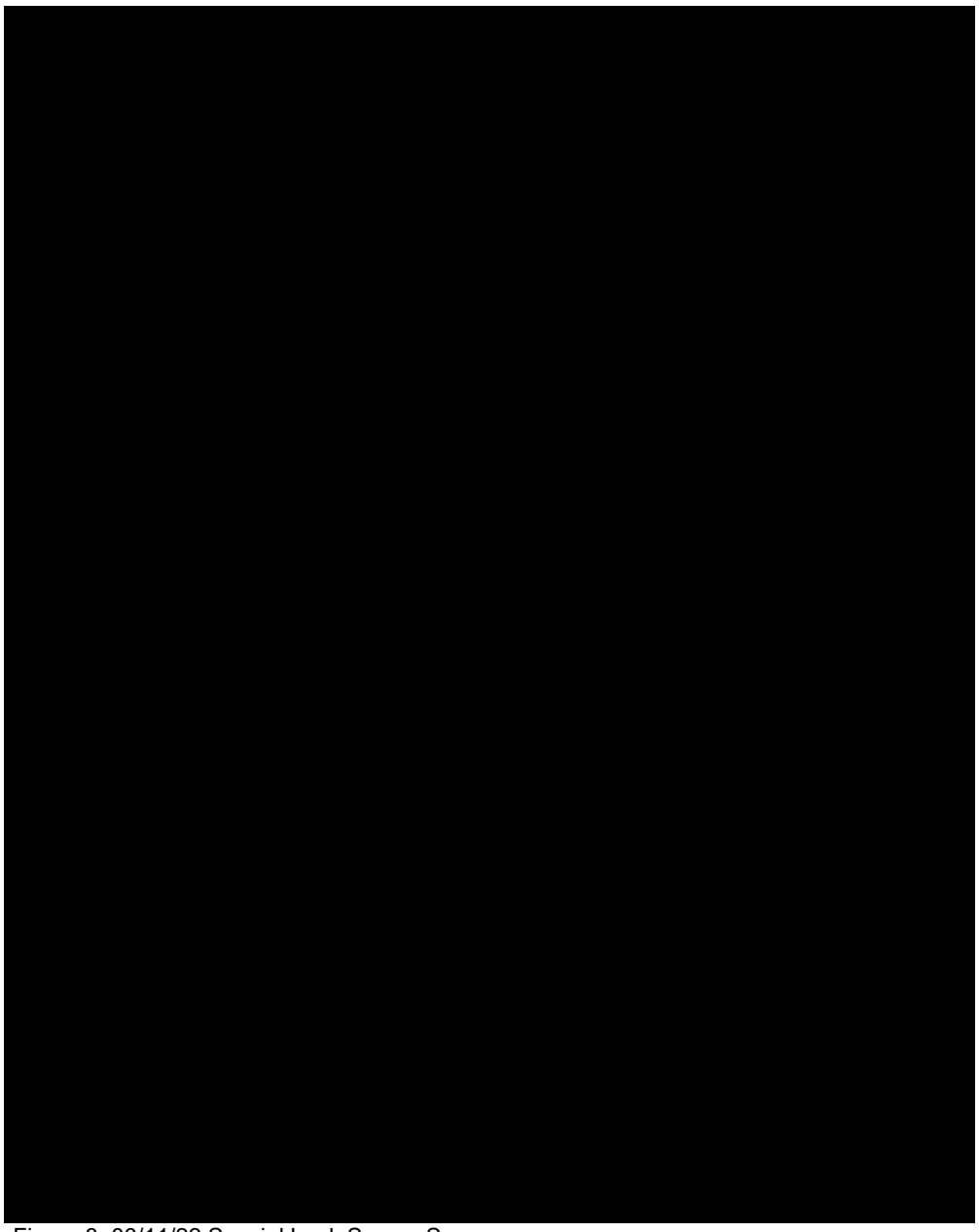

Figure 3: 06/11/22 Special Leak Survey Scope

September 2022 Leak Survey and AC Inspections

In September of 2022, foot/mobile leak surveys and AC inspections were performed in the MHP. No AC issues were found. No leaks were found.[40]

[40] See 09/22 Leak Survey/AC inspection documentation.

6. OBSERVATIONS & EVENT ANALYSIS

Analysis for this event included field observations, an EII electric maintenance tag assessment, site visits, voltage reliability analysis, power quality analysis, SmartMeter™ analysis, outage history analysis, transformer loading evaluation, system protection analysis, failure analysis, weather analysis, fire department analysis, mobile home park permitting/inspection review, internal guidance analysis and code review. These analyses concluded that PG&E experienced two UG primary cable failures, source-side of T0684 prior to the MHP fires. Fault current may have traveled to the mobile homes resulting in electrical arcing between the customers gas flexible lines which were installed (possibly making contact) to PG&E's gas regulators at both Incident Locations, potentially circumventing gas insulating fittings, resulting in gas ignition that appeared to spread to the two structures. PG&E's electrical system is grounded, including at T0684. However, while we are not able to substantiate through direct evidence, based upon the totality of known circumstances reviewed during the course of this analysis, we believe the most likely precipitating event of the fires was PG&E's primary UG cable fault(s). Likewise, we do not know if customer protection equipment, (i.e., overprotection, grounding/bonding of the gas/electrical systems) was sufficient at the time.

6.1. Field Observations

Gas Facilities: Based upon the totality of known circumstances, we do not currently believe that PG&E's gas infrastructure was likely the initiating trigger of the two MHP fires.

GSR #1 indicated that both mobile homes sustained fire damage. The flow of gas at both Incident Locations was shut-in prior to his arrival, presumably by fire personnel. GSR # 1 recalled that there was significant burning around the regulator and customer-owned flexible gas lines at both Incident Locations, consistent with what appeared to be electrical arcing. GSR #1 recalled that vintage non-Mueller gas shut-off valves were present at both Incident Locations #1 and #2. GSR #1 did not believe the old-style service valves themselves were insulated (legacy 1971 installation). Insulating service valves are now standard for all new installations. Both gas meter sets were supplied by ¾" steel gas lines and risers. GSR #1 did note that the gas regulator vent and associated cap were missing at Incident Location #1 and surmised that they could have melted/blown away as a result of high pressure gas release.

GSR #2 indicated that he transported existing gas meter sets to the yard for disposal after he left the scene. EII requested to preserve the gas meters; however, GSR #2 advised that he checked the yard on June 16, 2022, and both gas meter sets were scrapped.

Visual observations of GSR images from both Incident Locations indicate the presence of insulator bushings associated to ¾" steel 90-degree pipe fittings at both Incident Locations. Insulators are used to electrically isolate PG&E facilities from customer piping to enable cathodic protection of metallic facilities.[41] We do not physically bond gas meter set equipment to the electrical system ground during any meter set installation or maintenance work.[42] The customer flexible gas lines were observed within an inch or less (possibly touching) to PG&E's gas regulators. This potentially circumvented PG&E's gas insulating fitting functionality and created a condition which resulted in electrical arcing. The condition of customer owned house lines at both Incident Locations is unknown. PG&E also does not know if the customer flexible gas lines were grounded/bonded electrically on the customer's side, beyond PG&E's ¾" 90-degree insulating fittings, as this is beyond our area of responsibility.

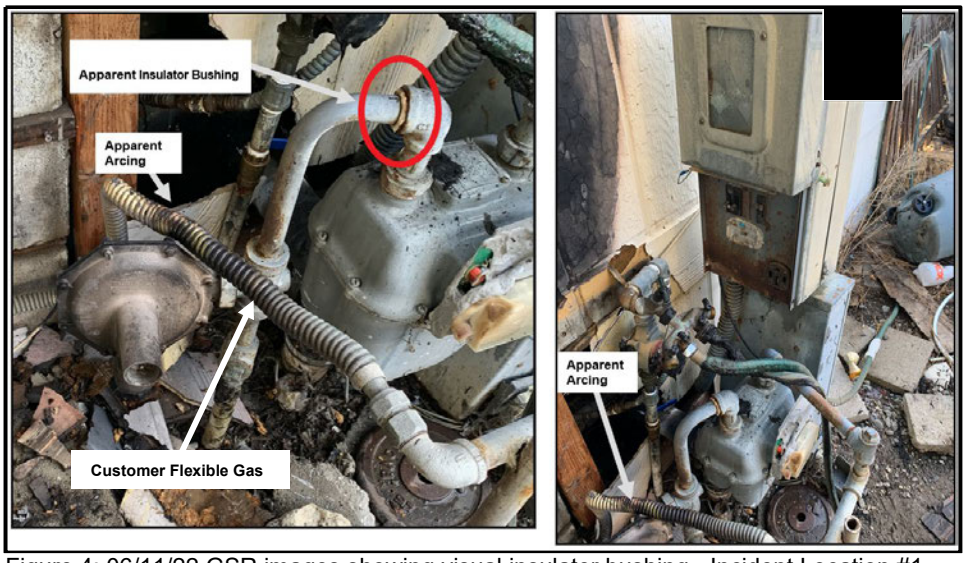

Figure 4: 06/11/22 GSR images showing visual insulator bushing - Incident Location #1

[41] Utility Procedure TD-6100P-13 – Gas Meter Set Maintenance, Section 9 requires meter set insulation between gas riser and meter set (Effective Date: 07/01/22, Rev. 02).
[42] See DRU11263, PG&E response to CPUC Data Request #1 Q11, submitted on January 19, 2022.

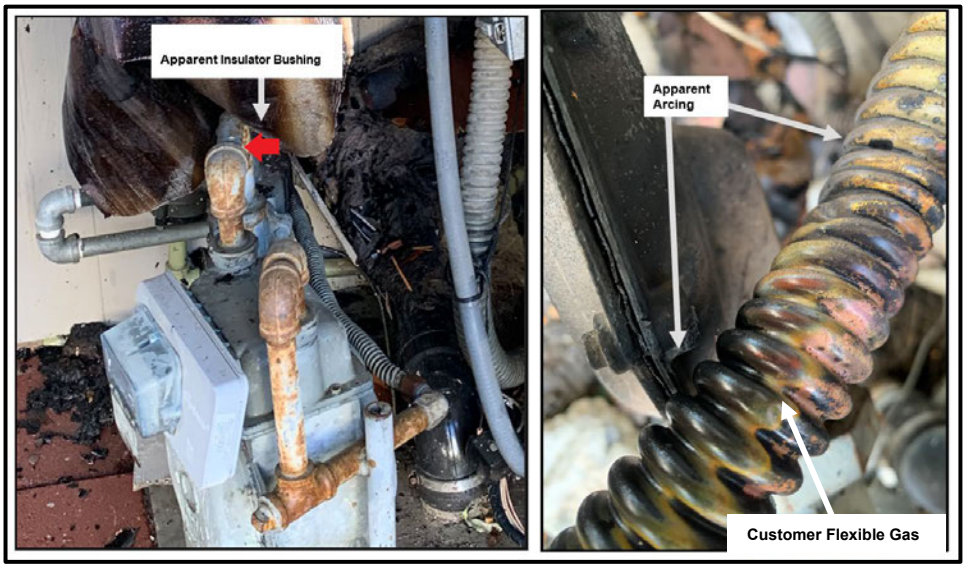

Figure 5: 06/11/22 GSR images showing visual insulator bushing - Incident Location #2

Electric Facilities:

An electric pedestal panel/metering was present at both Incident Locations, in close proximity to other utilities including gas, water, and sewer facilities. Troubleshooter #1 explained that when he arrived on site, the fire department indicated there appeared to be an electrical issue and requested him to open the customers main electric circuit breakers, which de-energized structures at both Incident Locations. He indicated that he initially removed the meter at Incident Location #1 and determined partial voltage (66 volts) conditions existed at the time, which was indicative of partial power at T0684. As a result, he de-energized UG primary cables feeding T0684. He recalled that a customer (from [redacted]) contacted him at the time and showed him a video which apparently showed several ground fault interrupter plugs tripping on and off at Incident Location #1.[43] EII was not able to verify the authenticity of the videos. Troubleshooter #1 removed the meter at Incident Location #2, and confirmed voltages were within range. This meter was later retained as evidence by PG&E. T0686 was found to have 'good power'.

[43] EII later contacted the customer at [redacted] and received several digital videos of GFI plugs tripping.

6.2. EII Electric Maintenance Tag Assessment

On January 4, 2023, EII conducted a review of maintenance/repair work in SAP in relation to in its Outage Information System (OIS) and its Integrated Logging System (ILIS) for work completed on the primary cable segments between J2219L and T0684, as well as attached secondary wires.[44] Date of work, location, and type of repairs are shown geographically below in Figure 6 below:

Figure 6: EC Tag and fault locations between T0684 and J2219L.

[44] See DRU11263, Supplemental Data Response, additional three EC Tags (124940100, 124608324, 114858517) were submitted to the CPUC on 02/14/23.

01/04/2023 EC Maintenance Tag Query					
EC Tag #:	**Date Initiated:**	**Due Date:**	**Priority:**	**Issue:**	**EII Notes:**
124940100	11/26/22	Completed on 02/26/23.	B	OIS High-Low Voltage Complaints. Repair Sweethearts (Multi-terminal bus) in secondary splice box.[45]	Sweethearts replaced. OIS 1869443. T0684 AND J2219L checked. No direct evidence to support that the reported high-low voltage complaints nor any potential existing equipment issues caused/contributed to the 06/11/22 incident.
124608324	10/02/22	Completed by 10/03/22.	A	UG primary cable failure between J2219L and T0684. Transformer loading over nameplate rating.[46]	T0684 100kVA replaced with 167kVA and UG cables repaired with splices. OIS 1826082. ILIS 22-0117011 No direct evidence to support that the fault caused/contributed to the 06/11/22 incident.
123822882	06/11/22	Completed by 06/12/22.	A	UG primary cable failure between J2219L and T0684.	UG primary cables repaired with splices after the fault. T0684 not damaged. OIS 1728348. ILIS: 22-0073176, 22-0073190, 22-0073192.
114858517	08/07/18	Completed by 08/08/18.	A	UG primary cable failure between J2219L and T0684.	UG primary cables repaired with splices. Transformer overloading discussion noted on the tag. No evidence to support the fault was caused/contributed to the 06/11/22 incident. OIS 150308. ILIS 18-0067272. No direct evidence to support that the fault caused/contributed to the 06/11/22 incident.

[45] Design and Construction Document 036640 - Multi-Tap Splice for 600-Volt Insulated Cables (Date: 12/01/19, Rev. #07).
[46] During the time period between 08/22-09/22, EII determined a peak demand of 110.6Kva occurred on 09/09/22.

112814287	04/27/17	Cancelled on 11/13/17	A	Underground facility inspection cancelled because the customer made repairs to their panel and did not need to de-energize service.	[redacted] off Transformer T1692, not Transformer T0684.

Table 8: Maintenance tag search results

6.3. Site Visits

Site Visit #1: On January 19, 2023, EII arranged a site visit with PG&E MHP gas and electric inspection personnel. The purpose of the site visit was to better understand the general physical layout of utilities within the MHP, including gas, electric, sewer and water facilities. The majority of the spot-checked mobile homes utilities (gas/electricity/water/sewage) were located in close proximity to each other, as was typical practice during 1971 era installations.

New construction, including upgraded meter electrical panels, currently requires 36" minimum separation between electric and gas facilities, as was followed post-fire rebuild efforts at Incident Location #2 after the customer requested an electrical panel upgrade.[47] The 36" minimum separation requirement now also applies to water sources in relation to gas and electric facilities as well. This increased separation allows for safer maintenance and operation.[48]

Site Visit #2: On January 24, 2023, an EII investigator and Troubleshooter #2 responded to the MHP to conduct a subsequent site survey.

The MHP manager (manager), who also resides at [redacted], was contacted onsite and indicated she was not aware of on-going voltage concerns at the time.[49] However, she explained that previously, she and another resident observed flickering light conditions (11/26/22) at mobile homes highlighted in Figure 07 below.[50]

[47] See J-15 - Gas Design Standard Gas Meter Locations (Pub. Date: 06/09/22, Rev. 9b) and Greenbook Section 5.4.3 - "Meter Set Clearance Requirements" (2022-2023).
[48] See AF-3.
[49] See 20230124_Interview of [redacted] MHP Manager and Resident.pdf. See Footnote #6.
[50] EDGIS shows [redacted] and [redacted]; however, the actual physical addresses are [redacted] and [redacted] and [redacted], respectively. See OIS 186443 and Section 4.

Figure 7: EDGIS Image of mobile home complaints of flickering lights.

Based upon conversation with the manager at the site visit, the troubleshooter recommended placement of a recording voltage meter (RVM) at the [redacted] customer primary meter panel to gather data to detect any electrical anomalies associated to power delivery at this location as well as other customers downstream from this location, off the same secondary wiring from T0684. The recommended placement location was downstream from the secondary 200-Amp splice box, just south of T0684 at [redacted].

On January 25, 2023, the RVM was installed by Troubleshooter #3 at [redacted].[51] The device was removed, and data was submitted on February 8, 2023, to PG&E's Voltage Reliability/Power Quality Teams for further assessment.[52] See Section 6.5 for further discussion.

The manager voluntarily provided images of MHP 1971 utility engineering drawings (photos taken by EII). Based upon these drawings, EII confirmed original sewer installation appeared to be asbestos cement, or clay with cast iron bends. City approved engineering drawings indicated MHP owned streetlights were to be installed with #10 continuous grounds to all metal parts. Approved water infrastructure was copper pipe, P.V.C. and asbestos cement. It appears water lateral piping was originally copper.

[51] FO 5561236539.
[52] FO 5568316808.

6.4. Voltage Reliability Analysis

PG&E's Voltage Reliability Team checked for prior voltage complaints at the following addresses inside the MHP, that receive power from T0684 for a period between 2017 to February 08, 2023.

- [redacted] Woodland
- [redacted] Woodland
- [redacted] Woodland

Voltage Reliability did not have records of customer complaints during this time period.

On December 29, 2022, a voltage complaint (two rooms without power) was received from [redacted] (off T0684); however, it was determined that the customer had 'good power', and confirmed there was a 'no good' customer breaker. A troubleshooter advised the customer to hire an electrician.[53] This was determined to be a customer related issue. No evidence was discovered to substantiate that the voltage concern was related to the causation of the MHP fires.

6.5. Power Quality Analysis

PG&E's Power Quality Team reviewed SmartMeter™ Data, SCADA data, and the ILIS outage report for this incident and did not find any data to support electric system anomalies were present prior to the occurrence of the June 11, 2022, incident.

SmartMeter™ data from customers receiving electricity from T0684, including Incident Location #1, and T0686, including Incident Location #2, evidence voltage was within Tariff Rule 2 limits throughout 2022 both before, and after the incident (See Figures 8 and 9). As data is recorded at 60-minute intervals and measures phase-to-phase (240V), there is no visibility on the neutral wire. Voltage was observed as historically lower at T0864 in the summertime likely due to increase usage, and remained within Tariff Rule 2 limits, +/- of 240V (See Figure 10).

[53] FO T005831046, OIS 1901504.

Figure 8: SmartMeter™ voltage data in 2022 - T0684

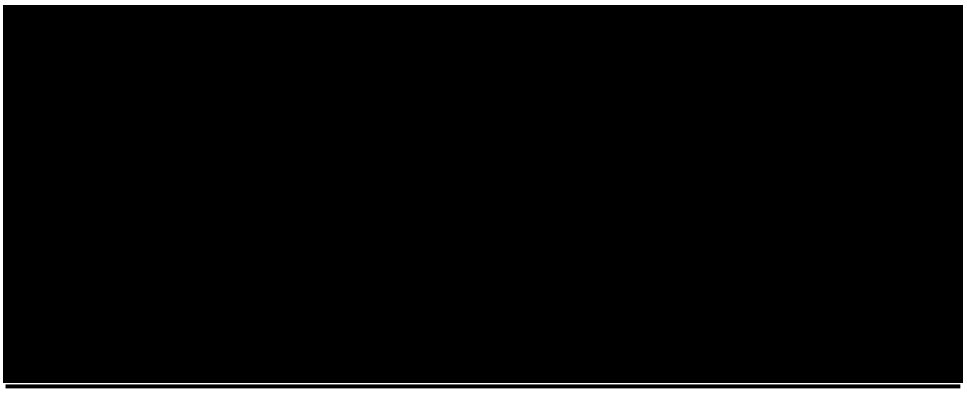

Figure 9: SmartMeter™ voltage data in 2022 - T0686

Figure 10: SmartMeter™ voltage and usage data – T0864

An RVM was not installed inside the MHP at the time of the June 11, 2022, incident. As a result, we are not able to leverage additional data to show what may have happened at the time of the incident. Monitors are typically installed when customers raise concerns about potential power

quality related issues. Monitors are also installed to gain a better understanding of possible electrical anomalies. They are not typically installed to record customer-side electrical equipment anomalies; however, PG&E continues to consider technology enhancements as business needs arise.

The recent RVM data (obtained from January 5, 2023 to February 8, 2023) was reviewed and the following preliminary observations were made:

- Hi/low voltage (mostly high) is seen throughout the monitoring period (13 days, 23 hours)
- Voltage unbalance observed, voltage imbalance hits 10% - 12% on some days.
- It appears that there may be a loose or corroded connection somewhere upstream of where the RVM was placed. Voltage climbs as high as 143V on leg 2 and simultaneously drops to 104.1V on leg 1.
- T0684 was replaced in December of 2022, but it is unlikely that the transformer is failing.

As a result of this investigation, it was recommended that the field check all 200-Amp terminations at T0684 AND J2219L. On February 26, 2023, EC Tag 124940100 was completed and terminations at the secondary splice box associated with T0684 were replaced. Terminations at J2219L were also checked and no anomalies were found.

EII is unable to establish a link between the recent voltage imbalance anomalies, and the MHP fires.

6.6. SmartMeter™ Analysis

On June 14, 2022, EII obtained SmartMeter™ processed event data from all electric SmartMeters™ on the Incident Circuit, including inside the MHP. SmartMeter™ data supports the timeline established in Section 4.1 above.[54]

[54] Also see Power Quality Analysis for additional discussion of SmartMeter™ data.

EII confirmed that Electric SmartMeter™ [redacted] (Incident Location #2) was retained by field personnel and held in evidence.

6.7. Outage History Analysis

PG&E's Distribution Planning determined there were ten unplanned primary outages (momentary and sustained) in 2022 on the same circuit all affecting the same protection zone, circuit breaker, as this device is the only mainline protective device currently on the feeder.[55]

Figure 11: Circuit trace from Incident Locations to the substation.

On January 3, 2023, EII conducted a search in FocalPoint[56] to determine the total number of faults occurring in the MHP between January 1, 2015, to January 3, 2023, and located three separate outages all involving the same UG primary cable(s) between J2219L and T0684 as evidenced below in Figure 12 below.

[55] ILIS: 22-0073176, 22-0073216, 22-0073190, 22-0073192, 22-0086913, 22-0117011.1, 22-0117011.2, 22-0117011.3, 22-0117011.4, 22-0132827.
[56] FocalPoint is PG&E's system of record for distribution transformer level outages and above.

Figure 12: Google Earth image with gas and electrical facilities

6.8. Transformer Loading Evaluation

EII extracted transformer loading data for T0684 and T0686, from SmartMeters™ for the month of June 2022. Both transformers at the time were 100kVA manufacturer rated units. Available data evidences the single-phase transformers were not overloaded at the time of the incident during the month of June of 2022:

- T0684 - Peak demand was recorded at 98.6kVA on 06/10/22 at 1700 hours[57].
- T0686 - Peak demand was recorded at 73.1kVA on 06/10/22 at 1700 hours[58].

Design Document 032771 - Distribution Transformer Capability - Indicates both transformers calculated maximum loading for normal summer interior residential locations is 100kVA.[59]

[57] 25 SmartMeter™ customers.
[58] 20 SmartMeter™ customers.
[59] See PG&E's Electric Design Manual, Distribution Transformer Capability Design Standard 032771, Rev. #02, Dated 12/01/19.

Electric Design Manual

Distribution Transformer Capability

Table 8 Subsurface Transformer Normal Capability in kVA

Transformer Location and Size		Summer Interior		Summer Coastal and Winter	
		Residential	Non-Residential	Residential	Non-Residential
		40% Annual Load Factor	40% – 80% Annual Load Factor	40% Annual Load Factor	40% – 80% Annual Load Factor
Subsurface – Single-Phase	15 kV	24	23	27	26
	25 kVA	40	38	45	43
	37-1/2 kVA	60	56	68	64
	50 kVA	60	55	70	70
	75 kVA	90	83	105	105
	100 kVA	100	90	120	110
	150 kVA	135	135	165	165
	167 kVA	150	150	184	184
	200 kVA	180	180	220	220
	250 kVA	225	225	275	275
	333 kVA	300	300	366	366
Subsurface – Duplex	25/10 kVA	40/16	38/15	45/18	43/17
	50/10 kVA	60/12	55/11	70/14	70/14
	75/10 kVA	90/18	83/17	105/21	105/21
	100/25 kVA	100/25	90/23	120/30	110/28
	100/50 kVA	100/50	90/45	120/60	110/55
Subsurface – Three-Phase	112-1/2 kVA	124	124	203	135
	150 kVA	165	165	270	180
	225 kVA	248	248	405	270
	300 kVA	300	300	360	330
	500 kVA	500	500	600	550
	750 kVA	675	675	825	825
	1,000 kVA	900	900	1,100	1,100
	1,500 kVA	1,350	1,350	1,650	1,650
	2,000 kVA	1,800	1,800	2,200	2,200
	2,500 kVA	2,250	2,250	2,750	2,750

Table 9: Electric Design Manual - Subsurface Single-Phase Transformer Normal Capacity

On August 7, 2018, PG&E identified T0684 as potentially overloaded (PM 43431751; EC Tag 114858517) after an outage and primary cable fault between J2219L and the transformer. However, the repair crew found that the transformer was not damaged and it remained in service at the time.

Following the June 11, 2022 incident, estimating determined that between July 2021 and June 2022, T0684 was slightly overloaded above the 100kVA nameplate at 104.7kVA; however, a larger capacity unit was not installed by the repair crew at this time.[60]

Following an October 2, 2022, outage (PM 3539156, EC Tag 124608324), estimating determined T0684 loading between September 2021 and August 2022 was slightly over

[60] See PM 3535588.

nameplate at 102.7kVA. The repair crew upgraded the transformer from a 100kVA to 167kVA at this time.

PG&E currently has a dedicated Overloaded Transformer program (06B) to proactively manage overloaded transformers. Asset Strategy performed an extent of condition and a population of transformers overloaded was identified through this process. Given the concern of a failure leading to an ignition, the program focuses on transformer replacement in HFTD to best manage the risk on PG&E's system. The transformer in service at the time was not replaced as part of the Overloaded Transformer Program due to this risk prioritization that focuses on higher overload and consequence locations.

On December 28, 2022, EII checked loading for the month of June 2022, and confirmed transformers were not overloaded during the month of the incident and thus does not believe loading was a contributing factor to the cause of the incident.

6.9. Weather Analysis

On June 11, 2022, at 0700 hours PDT, Weather station CQ132 located about 1.16 miles from the MHP recorded a temperature of 66 degrees Fahrenheit, a wind speed of 1.15 Miles per Hour. No evidence was discovered to support that this contributed to this incident.

6.10. System Protection Analysis

Circuit normal summer capability is 578 Amps. Actual circuit loading (circuit breaker) prior to the first momentary outage at approximately 0615 hours, was within range indicating it was not overloaded:

- A-Phase: 110 Amps
- B-Phase: 80 Amps
- C-Phase: 90 Amps

On July 6, 2022, EII requested a PG&E Substation Tech respond to the Woodland Substation to download as-found settings, status/meters, events, and time comparisons for the Woodland

1103 CB for subsequent analysis. The data was extracted on July 7, 2022, and reviewed by PG&E's Distribution Planning Engineering Department.

PG&E's protection system operated as intended as designed by current configuration. However, based on further evaluation, planning engineering determined that currently all 2054 customers on the circuit experience an outage for a fault in the CB zone. Hence, it is recommended to install two subsurface 600A SCADA controlled switches to the FLISR circuit for additional protection.[61] The two SCADA controlled switches will sectionalize the feeder within their respective protection zones upon detecting fault activity, and prevent 1404 customers and 698 customers, respectively, from experiencing a sustained outage. As a result, this will reduce future restoration times, further improving safety and reliability, as the patrol zone will be reduced significantly reduced.

Figure 13: Location of SCADA Capable Sectionalizing Switches

[61] See CA-1 in Section 8.

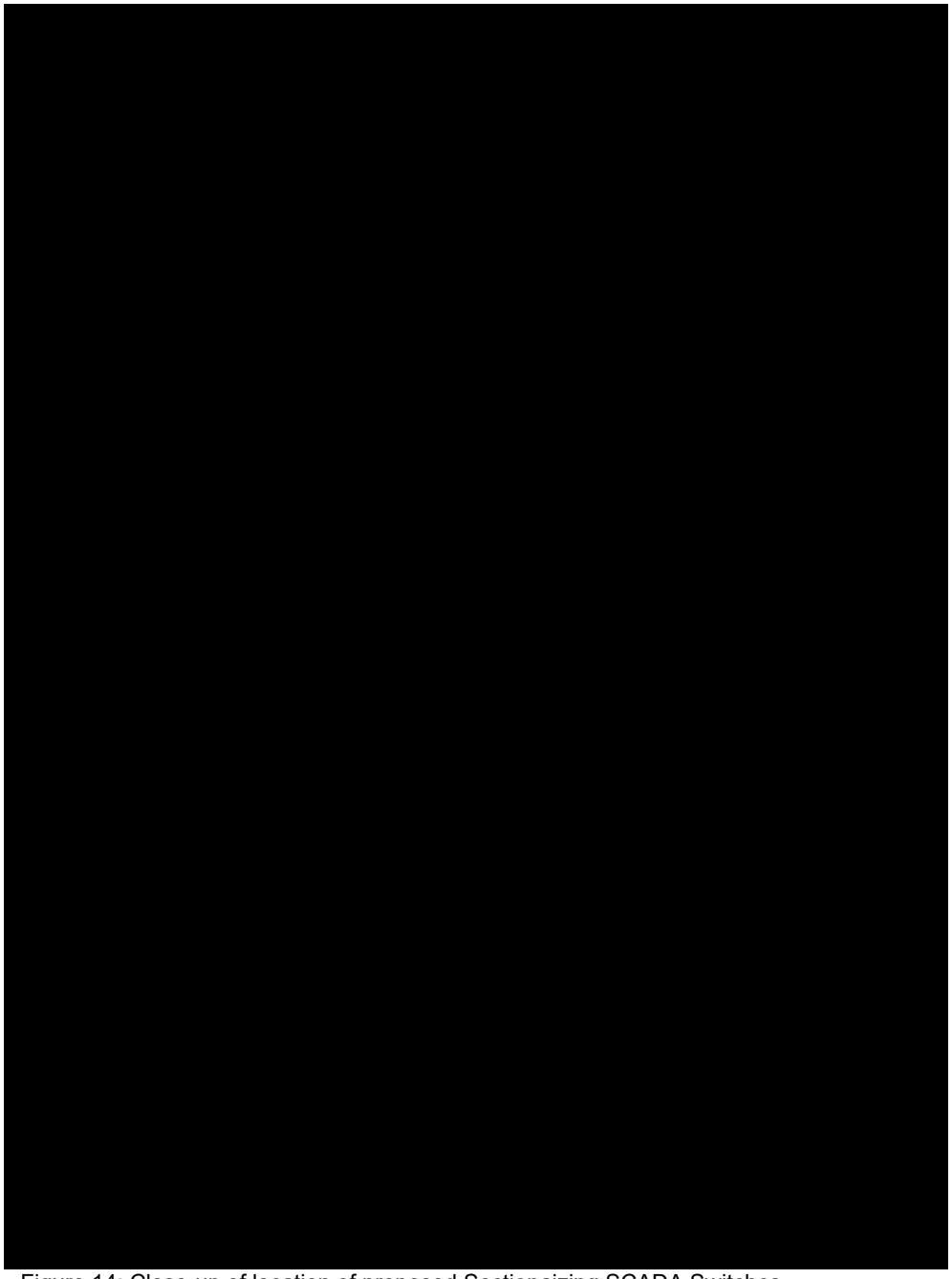

Figure 14: Close-up of location of proposed Sectionaizing SCADA Switches

6.11. Fire Department Report Analysis

A separate fire department incident report was issued for each Incident Location.

Incident Location #1 - The area of origin is listed as exterior stairway, ramp, or fire escape, item first ignited was “Exterior wall covering or finish”, heat source was “arcing” and natural gas

was a contributing cause to the ignition. The report also notes, “Fire possibly due to a power surge that took place approx. 20 min. prior to the fire.” Damages were estimated at $500.00.

Incident Location #2 – The report indicates that the WFD personnel were on scene of another fire in the same MHP, when they were alerted of this fire. The area of origin is listed as, “Egress/exit, other.” item first ignited, “Exterior wall covering or finish”, Cause of Ignition, “Cause under investigation” contribution to ignition 1, “unspecified short-circuit arc”, and equipment type, “wiring from meter box circuit breaker”. Equipment power is listed as “Electrical line voltage (>=50 volts) and type of material contributing to, is “natural gas”. Property loss was estimated as $10,000 and content loss was $1,500.00.

6.12. Mobile Home Park Permitting/Inspection Review

On January 23, 2023, EII submitted a public requests request through California Department of Housing and Community Development to obtain any and all historical inspection and permitting history for both Incident Locations.[62] EII received records on March 13, 2023.

No historical permitting records were provided in relation to Incident Location #1. No historical permitting records were provided related to Incident Location #2 prior to the occurrence of this incident. On August 01, 2022, a HCD 415 Application for Alterations was filed to replace the electrical panel at Incident Location #2. On September 21, 2022, an application for Permit to Construct was filed to replace the electrical pedestal (Like-for-Like) for Incident Location #2. An apparent circuit diagram included in the paperwork was redacted, and EII is unable to draw any further conclusions.

Additionally, a July 26-27, 2017, MHP Report of Inspection resulted in issuance of a Notice of Violation for numerous violations. The following violations were found associated to Incident Location #1 and #2:

Department of Housing and Community Development – Incident Locations - Notice of Violations		
Description of Violation:	**Location (Units):**	**Comments:**
Identify circuitry	[redacted]	At lot pedestals

[62] Public Records Request #R003901-012323.

Misc park plumbing hazard	[redacted]	Vent pipe missing or open
LP tank not secured	[redacted]	None
Awning/carport support missing/damaged	[redacted]	Damaged, Bent or Misplaced
No stairway handrail	[redacted]	Rear
Stairs and landing unsound	[redacted]	Rear
MH/RV weather protection	[redacted]	Broken windows/Missing or Blocked at Window Air Conditioning Unit

Table 10: Department of Housing – Incident Locations #1 and #2 violations

Based upon the provided documentation, it appears a re-inspection was conducted, and the above violations were designated as 'cleared.'[63] EII does not know if any additional safety related infractions could have occurred between the time of the 2017 inspection and the date of June 11, 2022, incident.

The July 09, 2020, Mobile Home Park Inspection State Audit Report 2019-111, in part, found that The Department of Housing and Community Development needed to improve its inspection processes, its communication with park residents and park owners, and its oversight of inspectors' activity in order to better execute its responsibility (Page 1).

6.13. Failure Analysis

Based on visual observations, the primary cable failed due to dielectric breakdown of the insulation, resulting in electrical arcing, significant heat damage and complete separation of the conductor.[64] The failure likely propagated from the initiating cable dielectric breakdown to the second cable due to the proximity of the cables to each other and significant arcing heat generated during the initiating failure.

The gas supply pipe buried in the proximity of PG&E's UG electrical cables is metallic and is a much better conductor than the soil. The line to ground fault current must return to the source transformer low voltage windings located in the source substation. However, not proven, it can be theorized that the electrical current utilized the gas pipe as a return path. Both subject mobile

[63] It does not appear all pages of the MHP reinspection were provided.
[64] See DRU11602_Atch01_ATS_Report_CONF.pdf

homes had the customer owned flexible gas pipe in close proximity to the gas pressure regulator where electrical arcing and subsequent fires occurred. It appears that the flexible gas line electrically bypassed the electrical gas insulator fittings at both subject locations. Due to the insulation system being bypassed, the current likely traveled into the mobile home. The current return path from the mobile home back to the substation is unknown, but the mobile home has an electrical grounding system connected back to the source mobile home park transformer having a lower impedance than an earth return path.

6.14. Internal Guidance Analysis

Based on the review of the following internal guidance, PG&E determined that although it followed internal guidance to temporarily repair the June 11, 2022, UG DB failed primary cables, it did not follow internal guidance related to enclosing all replaced phases in conduit. PG&E does not know if either customer had adequate overcurrent devices or grounding installed to protect their home electrical equipment in the case of any voltage irregularities.

- Utility Bulletin TD-061324-B002 - Strategy for Replacing Failed Underground Primary Distribution Cable (Publication Date: 05/13/22, Rev. #01)
    - Section 2.1 - Permanently REPLACE existing underground primary distribution cable with new underground primary distribution cable after 1 cable failure (Table 1).
    - Section 2.2 - DB Cable Construction - Temporary restoration allowed, Simultaneously, begin making the arrangements to install rigid conduit and Replace cable, according to current construction standards.
- Guide for the Repair and Replacement of Distribution Underground Primary Cable - Design and Construction Document 061324 (Publication Date: 07/01/14, Rev. #01)
    - Criteria and methods for determining when distribution underground primary cable should be treated to extend insulation life or when it must be replaced.
    - Table 2 - Decision Matrix to Repair or Replace Underground Primary Cable After Failure.
    - The guide in currently being revised to incorporate requirements listed in TD-061324-B002 (above).
- Construction Document 060462 - Grounding of Underground Equipment (Publication Date: 03/25/22, Rev. #15)

  - Grounding requirements of underground equipment. These principles apply to all distribution voltages using subsurface or pad-mounted equipment.
- Design Document 068183 - PG&E Neutral Systems (Publication Date: 07/31/15, Rev. #03)
  - The document provides an overall description of, and requirements for, neutral construction in its distribution system.
- F-80 - Gas Design Standard Meter Valves (Effective 05/17/21, Rev. 2c)
  - Valve insulation requirements.
- J-15 - Gas Design Standard – Gas Meter Locations (Effective 06/09/22, Rev. 9b)
  - 3.A. (17) - Electric grounding or bonding wires must not be attached to any part of the gas meter set. No bonding is permitted within 36 inches of PG&E meter set assembly on the customer houseline.
- Drawing 052521 - Gas and Electric Service Requirements for Mobile Homes (Date: 09/11/72, Sheets 1-4)
  - Requires a 36-inch minimum work space clearance shall be maintained in front of the access panel to the service terminating pull section of the electric meter pedestal. When located elsewhere a distance of 12 to 18 inches will be maintained from the pedestal to the gas riser or houseline support and 12 inches minimum to other utilities such as water and sewer.
- TD-2011S - Voltage Complaint Standard (Date: 05/15/17, Rev. 0)
  - This standard defines the requirements for investigating, detecting, and resolving customer voltage complaints. Voltage complaints include inquiries customers make to PG&E regarding the level or quality of the electrical service they receive from PG&E. This includes bright or dim lights, poor appliance or equipment performance, partial power within the facility, flickering lights, or improperly operating computer/electronic processing equipment.
    - EC Tag 124940100 generated as a result of high-low voltage concerns.

6.15. Code Review

Based on the review of the following codes, PG&E determined it appears to have followed all code requirements at the time of installation in accordance with Title 25.

- California Code of Regulations - Title 25, Division 1, Chapter 2 (Mobilehome Parks), Article 3, §1162 - Grounding Connections

  - System grounding conductors and equipment grounding conductors shall be connected as required by the California Electrical Code, article 250. The connection of a grounding conductor to a grounding electrode shall be exposed and readily accessible.
- California Code of Regulations - Title 25, Division 1, Chapter 2 (Mobilehome Parks), Article 3, §1163 - Grounding of Units
  - All exposed, noncurrent-carrying metal parts of a unit, when connected to the lot service equipment, shall be grounded by means of a grounding conductor run with the circuit conductors or in a listed power supply cord provided with an approved polarized multi-prong plug. One prong of the plug shall be for the sole purpose of connecting that grounding conductor, by means of a listed and approved grounding receptacle, to the grounded terminal at the lot service. The conductor shall be insulated and identified by a green color.
- California Code of Regulations - Title 25, Division 1, Chapter 2 (Mobilehome Parks), Article 3, §1148 - Overcurrent Protection
  - (a) Conductors shall be protected by overcurrent protective devices. A fuse or circuit breaker rating shall not be greater than the allowable ampacity of the conductors to be protected as specified in Tables 310-16 through 310-19 found in the California Electrical Code, except as provided in Articles 210, 240, and 430.
  - (b) All electrical equipment and devices, including service equipment, transformers and receptacles, shall be protected by overcurrent protective devices rated at not more than the rating of the equipment or device, except as provided in Articles 210, 240, 430, and 450 of the California Electrical Code.
- California Code of Regulations - Title 25, Division 1, Chapter 2 (Mobilehome Parks), Article 3, §1146 - Voltage Drop
  - The voltage drop shall not exceed five (5) percent on the park electrical wiring system from the park service to the most remote outlet on the system, except that taps to compensate for below normal full capacity voltage may be used on the primary side of secondary distribution transformers to correct for voltage drop on the primary feeders. The voltage of secondary systems shall not exceed a nominal 240 volts.

6.16. External and Other Guidance Documents/Regulations

- Electric Tariff Rule No. 2, Section E
    - Protective Devices
        - It shall be the applicant's responsibility to furnish, install, inspect, and keep in good and safe condition at his own risk and expense, all appropriate protective devices of any kind or character, which may be required to properly protect the applicant's facilities.
        - PG&E shall not be responsible for any loss or damage occasioned or caused by the negligence, or wrongful act of the applicant or of any of his agents, employees or licensees in omitting, installing, maintaining, using, operating or interfering with any such protective devices.
- TD-7001M - The Greenbook (2022-2023 Greenbook Manual)
    - Section 2.4.2 - Gas Meter-Set Locations
    - Applicants must ***not*** install any electrical devices or equipment, including wires, cables, metering enclosures, telecommunication enclosures, bond wires, clamps, or ground rods within the shaded area around the gas meter. The 36-inch distance can be reduced to 18 inches for electrical devices or equipment certified for NEC Class I, Division 2 locations.
    - Figure 2-20 - Gas Meter Set Clearance From Building Openings
        - The building vent openings, sources of ignition, and above-ground water sources must be a minimum of 36 inches of the gas riser and electric facilities.
        - Applicants must not install water spigots, lines, gutter systems, or other water sources within 36 inches away from the riser.
    - Section 2.5 - Applicant-Owned and Installed Gas Service Piping (e.g., Houseline), Valves, and Automatic Shut-Off Devices:
        - Applicants must ensure that after their equipment is installed, the equipment does ***not*** obstruct the operation or serviceability of PG&E's piping, metering, and pressure-regulating equipment.
    - Section 2.5.3 - Electrically Bonding and Grounding Gas Pipe
        - A. Do not install electrical devices or equipment, wires, cables, bonding or grounding wires, clamps, or ground rods around the gas meter set.

        - B. Do not use PG&E's gas service piping, gas risers, or meter facilities for electric bonding or grounding that allows the gas meter, piping, or other gas facilities to become current-carrying conductors.
        - C. Do not allow customer houseline to be electrically bonded within meter enclosures, cabinets, or meter rooms.
    - Section 3.3.3.1 - Electric & Gas Service Requirements
        - New and existing rigid steel conduit does not need to be bonded to the electric panel.[65]

7. CAUSE & CONTRIBUTING CAUSES

A fault tree analysis was performed as part of this investigation. These analyses concluded that PG&E experienced two UG primary cable failures, source-side of Transformer T0684 prior to the MHP fires. Fault current may have traveled to the mobile homes resulting in electrical arcing between the customer owned flexible gas lines which appeared to be installed within less than an inch (possibly making contact) with PG&E's gas regulators at both Incident Locations, potentially circumventing gas insulating fittings, and resulting in the ignition of gas which appeared to spread to the two structures. Based on all information available, PG&E concluded the most likely apparent cause (AC) and contributing cause (CC) of the event are:

- **AC-1:** Stray current migration from PG&E UG primary cable fault(s) through gas piping and/or other subsurface conductive materials. Based on visual observations, the primary cable failed due to dielectric breakdown of the insulation, resulting in electrical arcing, significant heat damage and complete separation of the conductor. The failure likely propagated from the initiating cable to the second cable due to the proximity of the cables to each other and significant arcing heat generated during the initiating failure. While the primary cable was nearing end of life, that in and of itself does not appear to have caused the incident.
- **CC-1**: Installation of customer-owned metal flexible gas house lines in close proximity (possibly contacting) PG&E's gas meter regulators, potentially bypassing gas facility insulating fittings, and resulting in a condition causing a release of natural gas.

[65] See DRU11263, PG&E's response to CPUC Data Request Q10 on January 19, 2022.

The following additional finding (AF) was identified:

- **AF-1:** PG&E's Greenbook does not currently have specific guidance related to keeping all customer gas piping, including flexible and rigid pipe, away and not in contact with PG&E gas meter set equipment.

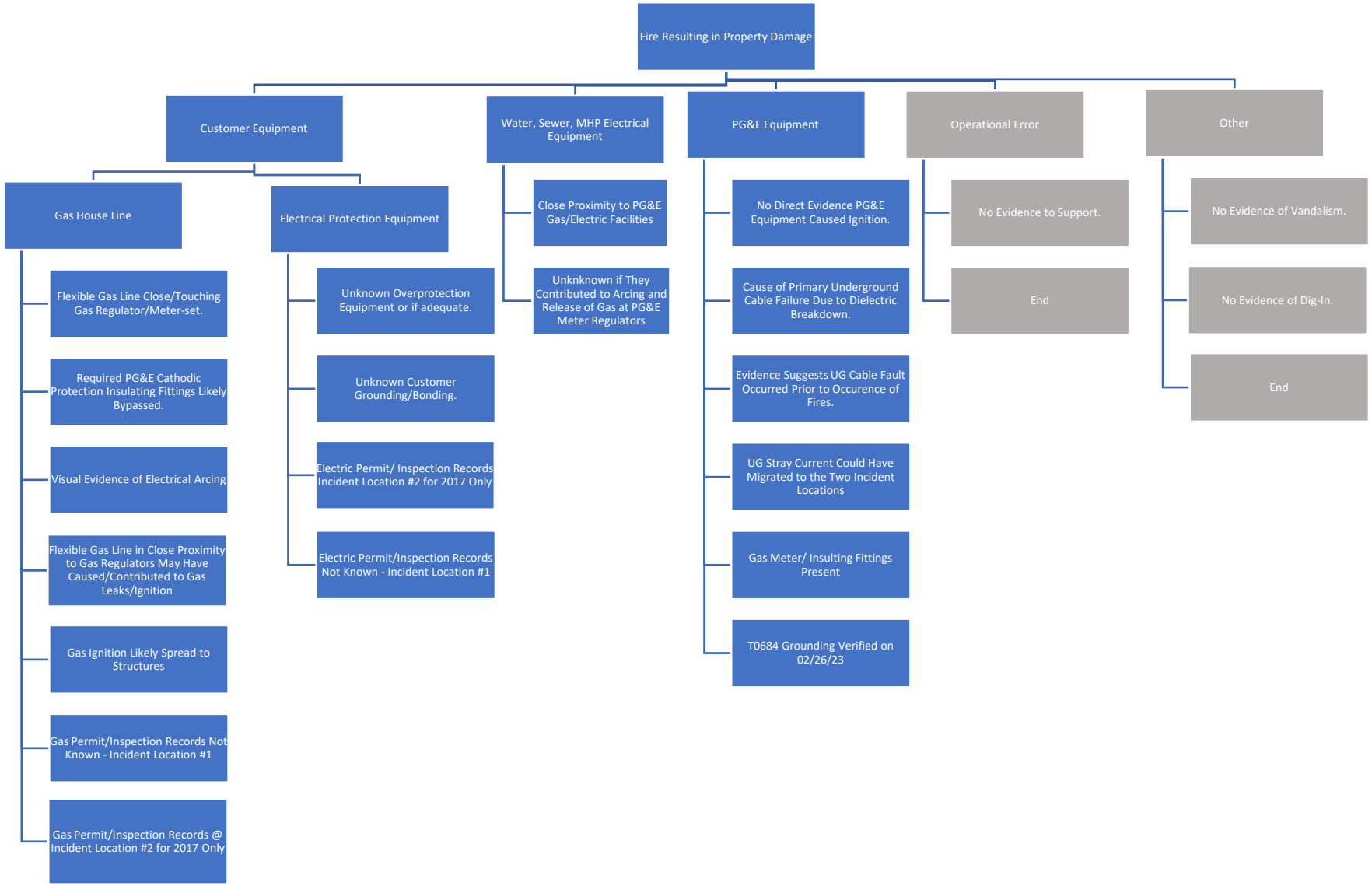

Figure 14: Fault Tree Analysis

8. CORRECTIVE/GENERAL ACTIONS (CA/GA) SUMMARY

The following table summarizes the corrective or general actions identified as a result of this investigation, both directly related to the incident and additional findings as a result of the investigation.

NERC Code	Cause(s)	CA/GA #	CA Description	Action Owner	Due Date
A2B6C01 Equipment/ Material; Defective, Failed, or Contaminate; Damaged, defective, or failed part.	AC-1: Interim repair of a section of primary UG cables w/ splices between J2219L and T0684.	CA-1	Repair failed UG cables with splices. **Deliverable:** Completed EC Tag recorded in SAP.	[redacted], Electric Field Operations Superintendent	Completed by 06/12/22 under EC Tag 123822882
A4B1C01 Management/Organization, Management Methods LTA, Management policy guidance or expectations are not well defined, understood, or enforced.	AC-1: UG primary cables were not enclosed in conduit from J2219L to T0684 when they were replaced.	CA-2 CAP 125935065	Replacement of UG primary cable feeders between J2219L and T0684 in conduit which supply MHP, pursuant to Utility Bulletin TD-061324-B002 (Pub. Date: 05/13/22, Rev.1) under SAP MAT Code 2BA. **Deliverable:** Replace primary UG cables supplying the MHP in conduit, and document closure.	[redacted], Electric Field Operations Superintendent	06/30/23

N/A	Evaluate current circuit protection scheme.	GA-1 CAP 124299760	Evaluate current circuit protection scheme to determine if additional devices can be added to increase reliability and reduce customer outages. **Deliverable:** Document results of evaluation and faciliate request to install new devices, if determined appropriate.	[redacted], Distribution Planning Engineering	Completed on 01/13/23. Two new circuit SCADA sectionalizing Switches (FLISR circuit) will be added to the current protection scheme to improve reliability and reduce potential restoration time.
N/A	Assessment of current primary UG feeder cables inside the MHP to consider if planned 56A reliability replacement work is appropriate.	GA-2 CAP 125741152	Create 56A primary cable replacement project for cables feeding the mobile home park. **Deliverable:** Conduct assessment, create a project, document findings and facilitate 56A work, if appropriate.	[redacted], Distribution Planning Engineering	05/31/2023

N/A	Inaccurate GIS land base mapping.	GA-3 CAP 125755781	Correct MHP addresses in GIS to reflect true field locations. **Deliverables:** **Action #1:** GIS Asset Data Governance to submit mapping correction with map provided by EII, obtained from the MHP. See RW Notification 125755370. **Action #2:** EII to create a CAP for tracking and cross reference to the RW Notification, then close.	[redacted], EII	Action #1 completed on 03/29/23 under RW Notification 125755370. Action #2 completed on 03/29/23. Completed as of 04/12/23.
N/A	AF-1: Greenbook does not have a specific section requiring the need to maintain space around gas/electric assets.	GA-4 CAP 125995068	Consider creating a new section in PG&E's Greenbook outlining how customers should maintain space around PG&E gas meter set equipment. **Deliverables:** Document findings of evaluation. Facilitate appropriate Greenbook update(s), as needed.	[redacted], Gas Methods and Procedures	06/01/2024

N/A	AF-1: Assessment of Leak Survey Field Guide as well as current Gas Corrective Training 9637.	GA-5 CAP 125987828	Leak Survey to consider updating the FG-4110 Leak Survey Field Guide[66] as well as current Gas Corrective Training 9637, in order to better identify potential situations where customer gas houselines' are in close contact (abnormal operating condition) with PG&E gas facilities. **Deliverable:** Conduct assessment, document findings, and institute applicable training.	[redacted], Gas Program Manager	11/01/23

Table 2: General and Corrective Actions

9. POTENTIAL NON-CONFORMANCES AND NON-COMPLIANCES

No potential non-compliances were identified as a result of this investigation. However, a non-conformance evaluation will be documented, related to permanent replacement of the June 11, 2022, temporary/emergency repaired primary cables between T0684 and J2219L in conduit as outlined in Utility Bulletin TD-061324-B002 (Publication Date: 05/13/22, Rev. 01). [67] This bulletin communicates new requirements for failed cable replacement affecting Design and Construction Document 061324 – Guide for the Repair and Replacement of Distribution Underground Primary Cable (07/01/14, Rev. #01).

[66] February 2022, Revision #1.
[67] On 02/15/23, an SAP attribute 'PGNC' was added to CAP 123831909 to facilitate a further non-conformance evaluation. The first version of this document (Rev. #00) was published on 11/15/21.

10. REFERENCES

Internal Documents

- Emails
- Bulletins
- Engineering Standards and Procedures
    - TD-8106 - Distribution Line Underground Asset Management Plan (Excludes network cables, Publication Date: 11/05/21, Rev. 02)
    - Design and Construction Document 061324 - Guide for the Repair and Replacement of Distribution Underground Primary Cable (Date: 07/01/14, Rev. #01)
    - Utility Bulletin TD-061324-B002 - Strategy for Replacing failed Underground Primary Distribution Cable (Date: 05/13/22, Rev. #01)
    - TD-061324-B002 - Guidance Tailboard - Strategy for Replacing Failed Underground Primary Distribution Cable (Issued: 05/13/22, Tailboard by: 06/13/22)
    - Construction Document 062111 - Application of Underground Distribution Transformers (Dated: 03/25/22, Rev. #27, Table 26, Page 14 of 26)
    - Utility Procedure TD-2700P-05 - Operating Procedures for Fault Location, Isolation & Service Restoration (FLISR) [Date: 04/07/22, Rev.# 03]
    - Utility Procedure TD-4911P-05 - Response to Gas Distribution Assets Impacted by Electrical Fault or Lightning Strike (Date: 05/28/21, Rev. #00)
    - Construction Document 060462 - Grounding of Underground Equipment (Date: 03/25/22, Rev. #15)
    - Design Document 068183 - PG&E Neutral Systems (Date: 07/31/15, Rev. #03)
    - Utility Standard TD-2301S - Patrols and Detailed/Intrusive Inspections of Electric Overhead and Underground Distribution Facilities (Date: 05/15/20, Rev. #01)
    - Drawing 088661 – Meter – Data Sheet – Gas Meter Locations Gas Standard (Date: 10/02/87, Rev. 1)
    - Utility Procedure TD-6100P-13 - Gas Meter Set Maintenance (Eff. Date. 07/01/22, Rev 02)
    - Construction Document 052521 - Electrical Service Requirements for Mobile Home Developments (Date: 11/01/18, Rev. 07)

  - Drawing 052521 - Gas and Electric Service Requirements for Mobile Homes (Date: 09/11/72, Sheets: 1-4)
  - FG-4110 Leak Survey Field Guide, (Date: 02/22, Rev. 01)
  - J-15 - Gas Design Standard Gas Meter Locations (Pub. Date: 06/09/22, Rev. 9b)
- Outage Reports
- Prior CAPs
- Job Sketches

External Documents

- Fire Report
- California Code of Regulations - Title 25, Division 1, Chapter 2 (Mobilehome Parks)
- Digital Images of MHP Engineering Documents (1971 vintage)
- July 09, 2020, Mobile Home Park Inspection State Audit Report 2019-111.

11. ATTACHMENTS

- DRU11602_Atch01_ATS_Report_CONF.pdf
- DRU11602_Atch02_Design and Construction Document 061324_CONF.pdf (Guide for the Repair and Replacement of Distribution Underground Primary Cable)
- DRU11602_Atch03_Utility Bulletin TD-061324-B002_UG Primary Cable Strategy_CONF.pdf
  (Strategy for Replacing Failed Underground Primary Distribution Cable)
- DRU11602_Atch04_TD-061324-B002–UG Primary Cable Strategy_Tailboard.pdf (Strategy for Replacing Failed Underground Primary Distribution Cable)
- DRU11602_Atch05_EC Tag 124940100_CONF.pdf
- DRU11602_Atch06_HCD 415 Application_Incident Location 2_CONF.pdf
- DRU11602_Atch07_2017 HCD_MHP Inspection Results_CONF.pdf
- DRU11602_Atch08_Application for Permit to Instruct_Incident Location 2_CONF.pdf
- DRU11602_Atch09_Fire Report_Incident Location 1_CONF.pdf
- DRU11602_Atch10_Fire Report_Incident Location 2_CONF.pdf

12. PREVIOUSLY COMPLETED REPORTS AND DATA REQUESTS

20-Day Report

20-Day Report_EI220611A – Woodland – Property Damage_CONF.pdf, submitted to the CPUC July 12, 2022 [68].

Attachment 01_2019 UG Patrol_J1812_CONF.pdf

Attachment 02_2021 UG Patrol Record_J1812_CONF.pdf

Attachment 03_2017 UG Inspect_J1812_CONF.pdf

Attachment 04_2020 UG Inspection Record_J1812_CONF.pdf

Attachment 05_EC Tag 123822882_CONF.pdf

Attachment 06_FAS Tag 5560481786_5560113569_CONF.pdf

Attachment 07_ILIS 22-0073176_22-0073190_22-0073192_CONF.pdf

Attachment 08_ILIS 22-0073216_CONF.pdf

Attachment 09_Photos_CONF.pdf

Attachment 10_Woodland Fire Department Reports_CONF.pdf

Attachment 11_Incident Map_Diagram_CONF.pdf

[68] For Attachments 01-04, “GO165” was inadvertently omitted in the file names submitted to the CPUC on July 12, 2022.

Data Request

DRU11263_Electric Incident-EI220611A-Woodland-Property Damage-Data Request_CPUC_01.pdf, Data Request submitted to the CPUC on January 19, 2023.

DRU11263_Atch 01_ Names_CONF.pdf

DRU11263_Q02_Atch01_EC 123822882_CONF.pdf

DRU11263_Q02_Atch02_EC 112814287_CONF.pdf

DRU11263_Q07_Atch01_Photos_CONF.pdf

DRU11263_Q10_Atch01_Grounding of Underground Equipment_CONF.pdf

DRU11263_Q10_Atch02_PG&E Neutral Systems_CONF.pdf

DRU11263_Q13_Atch01_TD-2301S_Patrols and Inspections_CONF.pdf

DRU11263_Q13_Atch02_TD-2305M-JA03_Underground Inspection.pdf

DRU11263_Q14_Atch01_TeradataIntervalUsageData_CONF.xlsx