LLNL-AR-868859

Lawrence Livermore National Laboratory

Root Cause Analysis of the June 1, 2024, Corral Fire that Disrupted Operations at LLNL's Site 300

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September 6, 2024

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Identification Information

Title: Corral Fire Disrupts Operations at Site 300

Organization: SD/S300 **Date of Event:** June 1, 2024

Occurrence Report: NA--LFO-LLNL-LLNL-2024-0020 **ITS Assessment:** OCCR-123708.01

Work Control Document: N/A

Causal Analysis Team:

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Location where the event occurred: Southeast portion of S300

System or Equipment Involved: Electric Utility Division High Voltage Pole 8009 and its associated equipment appears to be where the fire started.

Executive Summary

On June 1, 2024, at approximately 2:23 p.m., a grassland fire referred to by local, regional, and national media as the "Corral Fire" was reported at LLNL's Site 300 (S300) disrupting ongoing site operations. Several S300 facilities experienced power interruptions. S300 personnel observed power dips that restored themselves three times over the course of a minute. There were also several notifications and alarms sent to Electric Utility Division (EUD) personnel from the Supervisory Control and Data Acquisition (SCADA) system.

The fire was first seen by a Protective Force Division (PFD) Officer east of Building 892 in the west firing area. Prevailing high winds, averaging 32.7 mph with gusts averaging 43.1 mph, drove the fire east. The fire quickly spread through the Building 834 complex, the Engineering Test Area, and into the General Services Area of S300. The fire eventually crossed Corral Hollow Road, affecting offsite property southeast of S300.

Alameda County Fire Department (ACFD) Station 21, resident to S300, responded to the fire and notified Alameda County Regional Emergency Communication Center (ACRECC). ACRECC dispatched many additional units to the area. After the fire was 100% contained, California Department of Forestry and Fire Protection (CalFire) documented 14,168 acres as the total area burned by the Corral Fire.

An EUD lineman identified that the fire ignited around pole 8009, the 9th pole in Feeder 8 at S300. The lineman observed that an aluminum hand tie on the B-phase line (i.e., middle conductor) atop pole 8009 had failed, causing the conductor to no longer be held to the insulator, the direct cause. The failed hand tie allowed the A- and B-phase lines to make contact with one another. It is suspected the contact between lines A & B caused arcing resulting in sparks that ignited the surrounding grassland. The exact reason for the hand tie failure remains unknown, but high winds were determined to be a likely factor. Feeder 8, one of two feeders running north to south on the tallest ridgeline of S300, tends to experience the highest winds.

The week prior to the fire, S300 had initiated scheduled prescribed burns that are performed every year. There is no evidence that the prescribed burns ignited the Corral Fire; the western-most point of the Corral Fire is approximately 2,900 feet away from the edge of the controlled burn perimeter that was closest to the suspected area of origin. The last prescribed burn was completed on Friday, May 31, 2024, around 2:50 p.m., approximately 24 hours before the first report of fire.

LLNL assembled a root cause analysis team consisting of subject matter experts in causal analyses, fire protection and safety, and LLNL's electrical distribution systems and processes. The issue for analysis was that a fire initiated at S300 disrupting operations. Two apparent causes were identified, (1) other fastening methods, the steel F-neck and vise clamps, were not installed on the B-phase line of pole 8009. An aluminum hand tie was used on the B-phase line of pole 8009, which is an acceptable and approved fastening method, but the steel F-neck has 8-18 times the tensile strength of the aluminum hand tie; (2) although not required, no other controls to protect electrical utilities against high winds had been implemented on areas at S300 affected by high winds.

A root cause was identified after further analysis of the apparent causes. Records at LLNL, which go back as far as 2008, indicate that this is the first instance of a hand tie failing in high winds, not due to a high temperature arc from a flashover that melted the tie, as was the case in an event that occurred in 2023. The rarity of this failure mode and the significant resources/equipment required to implement additional controls to protect electrical utilities against high wind were the reasons such controls were not implemented.

LLNL had a plan to replace hand-ties with steel F-neck fastenings over time and started implementing that plan prior to 2014. As of July 26, 2024, only eight poles with hand ties were left to replace at S300, which includes at most 24 hand ties, three per pole. All hand ties have been replaced at Site 200 (S200). The absence of any history of this failure mode of securing the conductor to the insulators, combined with the fact that hand ties are an industry standard method, also indicated that the plan to replace fastenings over time was reasonable.

Considering this event, EUD will present additional controls to protect against high winds at S300 to management, which will evaluate them to determine if additional controls beyond installation of F-neck fastenings are needed. Such controls may include operational changes, such as turning off reclosers during extreme wind, relocating feeders, moving feeder 8 electrical utilities underground, insulating feeder 8 conductors, and/or implementing Power Safety Power Shutoffs (PSPS) at S300.

Issue for Analysis

A fire initiated at S300 that disrupted operations at S300.

Scope

The scope of this root cause analysis is limited to the initiation of the fire, the fact that the conductors were able to contact one another and possibly produce sparks that ignited the fire. This analysis does not analyze the spread of the fire after it started.

Occurrence and Reporting Processing System (ORPS) Description

On June 1, 2024, approximately 2:23 p.m., a grassland fire now being referred to by local, regional, and national media as the "Corral Fire", was reported at Site 300 (S300) disrupting ongoing Site operations. Several S300 facilities experienced power interruption.

The fire was first seen east of Building 892 in the west firing area and was driven eastward by prevailing winds. The fire quickly spread and moved through the Building 834 complex and Engineering Test Area, in the southeast area of S300. The fire extended into the General Services Area, reaching up to Building 871, and crossed Corral Hollow Road to the southeast, affecting offsite property.

Fire damage has been identified on the following: power poles, guardrail posts, Environmental Restoration Department (ERD) equipment; a PVC septic vent line, a wood retaining wall, trailers, a stack of new power poles, and the structure of cold and dark Building 830 (B830).

Perimeter and security fencing are secured with no structural damage. No major issues were reported in areas west of the Engineering Test Area including the East and West Firing Areas, Chemistry Area, Process Area, and the General Services Area.

Lawrence Livermore National Lab requested Alameda County Fire Department for a cause and origin report.

Routine operations resumed at S300 on Wednesday, June 5, 2024.

On June 1st a wildfire burned a shingled awning of a building at S300. The mastic and roofing shingles tested as high as 10% for chrysotile asbestos. This resulted in an estimated release of greater than 1 pound of friable asbestos and meeting reporting thresholds. Notifications were sent to the National Response Center, California Office of Emergency Services, and San Joaquin Environmental Health Department.

This Occurrence Report was categorized with the following reporting criteria:

- 2B(2) – *Any fire that: Activates a fixed automatic fire suppression system (e.g., clean agent or wet pipe automatic sprinkler protection), Takes longer than 10 minutes to extinguish following*

the initiation of firefighting efforts by the emergency response organization, or Disrupts normal operations in the facility for more than four hours.

- 2B(4) – *Any wild land fire (e.g., forest fire, grassland fire) or other fire outside of a DOE facility that has the potential to threaten the facility.*

- 5B(2) - *Any release (onsite or offsite) of a pollutant from a DOE facility that is above levels or limits specified by outside agencies in a permit, license, or equivalent authorization, when reporting is required in a format other than routine periodic reports.*

- 10(3) – *Any Occurrence that may result in a significant concern by affected state, tribal, or local officials, press, or general population; that could damage the credibility of the Department; or that may result in inquiries to Headquarters.*

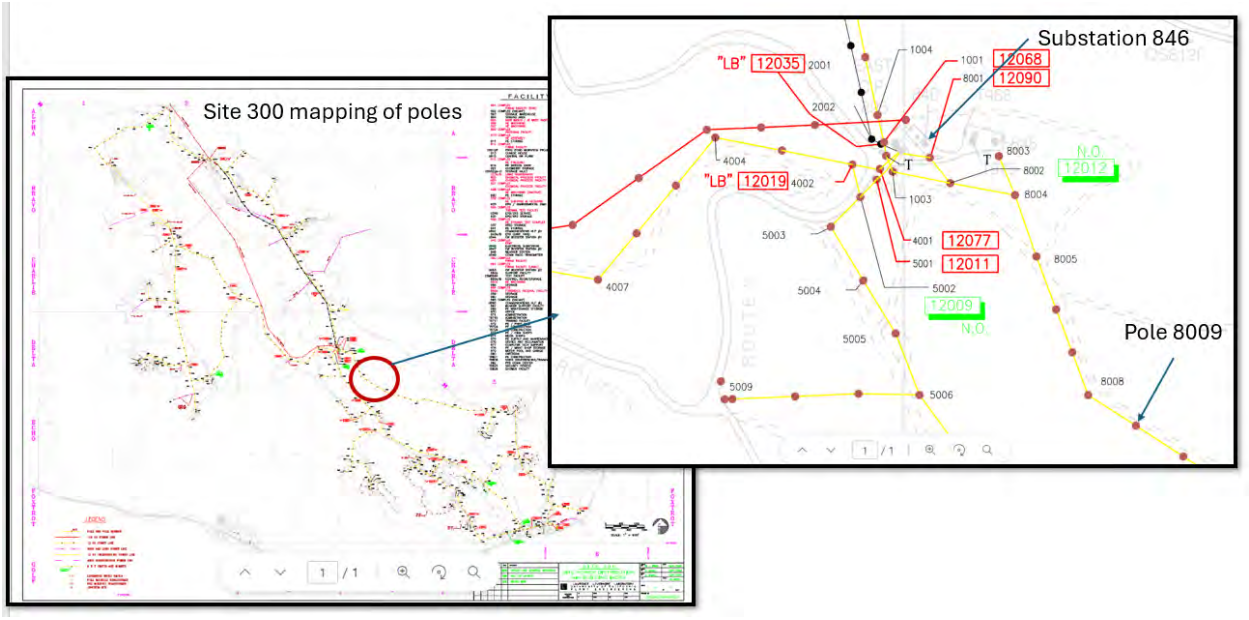
Background Information

LLNL owns and manages 478 12kV high voltage (HV) distribution poles and associated equipment at S300. S300 is an experimental test site situated on 7,000 acres in rural foothills approximately six miles southwest of downtown Tracy and 15 miles southeast of Livermore. Portions of feeders 4 and 8 are the highest points of the 12kV distribution system at S300, running north to south on the tallest ridgelines and therefore experience the site's highest wind speeds (Figure 1).

The Corral Fire started near 12kV distribution pole 8009, the ninth pole in feeder 8, located southeast of Substation 846. Pole 8009 was installed in 1958. Figure 2 shows the location of pole 8009 with respect to all of S300 and Substation 846.

Figure 1. High Wind Ridgelines at S300 Highlighted (Portions of Feeders 4 and 8)

Figure 2. S300 mapping of poles and location of pole 8009 and Substation 846



Pole 8009 is a raptor design with the middle conductor (conductor B) installed higher than the A and C conductors. EUD started installing raptor construction in 2016. Pole 8009 and its associated equipment involved in this event are made up of:

- The wooden 12kV HV distribution pole (pole 8009), installed in 1958
- Wooden cross arm
- Three aluminum-conductor steel-reinforced (ACSR) #2 conductors: A-phase (eastside), B-phase (middle), and C-phase (westside) lines
- Three insulators molded from gray, track and UV resistant, high-density polyethylene, one under each conductor at the cross arm
- The #4 American Wire Gauge (AWG) bare soft drawn aluminum wire (i.e., the hand tie) used to secure the B-phase conductor to the insulator
- The steel F-neck connectors on the A- and C-phase lines, used to secure the conductor to the insulator
- Vibration dampers installed on all three conductors on both sides of the insulators
- Bump sleeve splices installed on both sides of the insulators on A-phase and B-phase lines.

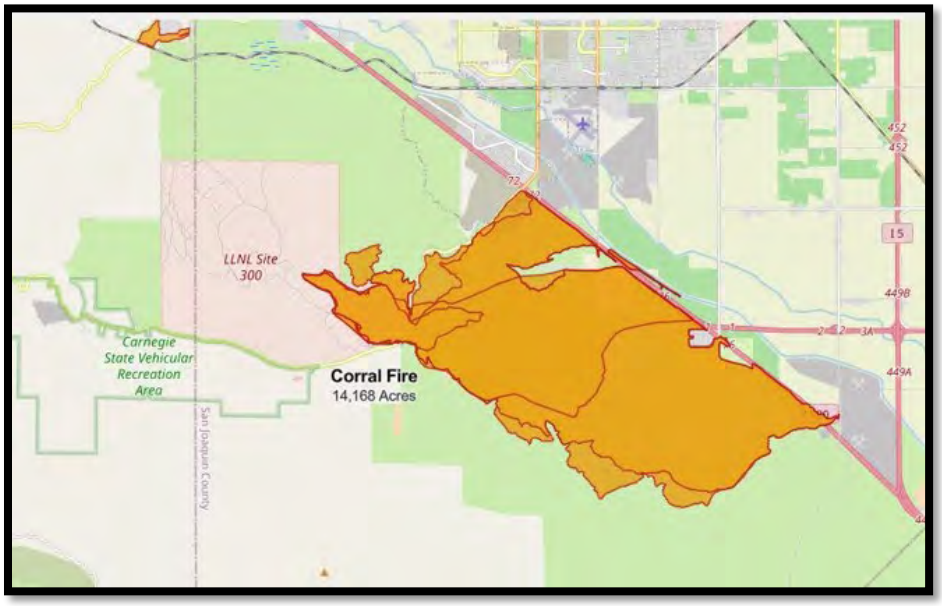
Pole 8009 did not break in this event. No structural damage was observed to any of the above items of equipment, except for the aluminum hand tie that failed on the B-phase line. Some burn marks, likely due to high temperature exposure from electrical arcing of conductors, were observed on the A-phase insulator. Similar marks were observed on the A- and B-phase conductors, in addition to pits where melting of the conductors occurred.

The wind speed on June 1, 2024, was recorded by the S300 met tower that is approximately 1,200 feet northeast of Substation 865. The average wind speed from 2:00 p.m. to 3:00 p.m. on June 1st, measured

at 10, 23, and 52 meters above ground was 32.7 mph, with a wind gust average of 43.1 mph. The wind direction averaged 226°, which is coming from the southwest.

The Corral Fire was first reported on June 1, 2024, at 2:23 p.m. east of Building 892. It was later determined that the fire started southeast of S300's Substation 846 near distribution pole 8009 and moved southeast of pole 8009, through part of S300 and then continued offsite, burning 14,168 acres. Figure 3 shows the affected areas of the Corral Fire.

Figure 3. Corral Fire Affected Areas



The S300 Emergency Report completed by one of the maintenance mechanics with information provided by an EUD lineman noted that, "Fire started by the 846 substation. Power outage on feeder 8 on the ridgeline between 846 and 834. The center phase of the line broke free of insulator on Pole 8009 and started making contact with the outside causing sparks and causing a fire." Buildings noted on the emergency report as affected were 846, 834, 832, 836, on Route 1. Although sparking was not observed, evidence of sparking includes, SCADA data showing that the conductors made contact as well as damage to equipment, including pits where melting occurred, deposits of molten material, and charring. It is known that molten metallic material is expelled during electrical faults based on laboratory controlled electrical fault testing for arc flash.

Based on SCADA data, there were 21 faults on feeder 8 between 2:16:32 p.m. to 5:31:15 p.m. that tripped the breaker open. The following describes breaker reclosing, a type of protection put in place on overhead lines for reliability with regards to tree, vegetation, animal, and other temporary fault conditions. When there is a fault, the breaker opens and de-energizes the system. Three seconds later, the breaker closes, and the system re-energizes. If the fault remains, the breaker opens again and closes in 20 seconds. If the fault condition is still present, the breaker opens one final time and locks out. If the fault does not remain when the breaker closes, the reclosing timer is reset.

The following S300 buildings experienced intermittent power from 2:16:32 p.m. until 5:31:15 p.m. when the breaker tripped for the third time and locked open, resulting in full loss of power until re-energized at 8:20:22 p.m.: All of feeder 8, 848, 832, M-52, 834, 833, 836, 835, 837, 830, M70, tanks 8 & 11, 843, ERD, 875, 876, 878, 872, 875, 873, 879, 874, 870, 871, 877, 891, 880, 889, 890, main gate.

Methods to Install Conductors to Insulators

Conductors are installed to the cross arm's insulator using one of three methods (pictures are shown in Figures 4 - 6 below):

1. Hand Tie – Use of #4 AWG bare soft drawn aluminum wire that is wrapped around the conductor and insulator by hand or using hot line tools. Installed hand ties include buttons, where the hand tie is wrapped around the conductor on each side of the insulator (See Figure 4). EUD performs all hand tie installations on de-energized lines by hand.
    a. This method meets California Public Utilities Commission (CPUC) General Order 95 (GO95) and is covered by local utility standards. The purpose of the rules within GO95 is to "formulate, for the State of California, requirements for overhead line design, construction, and maintenance, the application of which will ensure adequate service and secure safety to persons engaged in the construction, maintenance, operation or use of overhead lines and to the public in general."
    b. A hand tie requires skill of the craft to use a #4 aluminum wire spool, cut wire to a specific length, shape and wrap wire, attaching the conductor to the insulator.
    c. This method has been widely used in the utility industry in the western United States including Pacific Gas and Electric (PG&E).
2. F-neck – a pre-formed steel tie that is also installed by hand (Figures 5 and 7).
    a. This method meets GO95 and is covered by local utility standards.
    b. The F-neck requires less skill of the craft since the F-neck is pre-shaped (i.e., there is only one way to install it) for the specific conductor size. The F-neck is newer technology, and the pre-formed steel's tensile strength is 8-18 times stronger than the aluminum wire hand tie, according to the Manufacturer's Technical Memorandum (TM)-166-E, Preformed Distribution Tie and confirmed with LLNL Materials Engineering Division (MED) tensile strength testing described in a memo dated August 27, 2024, titled "Hand Tie Product Testing."
    c. This method began to be utilized at S300 prior to 2014.
3. INSULIGN Vise Top Pin Type Polymer Insulator (i.e., vise clamp) - utilizes a polymer clamp mechanism and nylon torque bolts to secure the conductor with a break-away ring (Figure 6).
    a. This method is not specifically covered in GO95.
    b. The vise clamp requires little skill of the craft as the ring is tightened until it breaks at the correct torque, making it quick and easy to install conductors.
    c. This method has been installed on some poles in S300's feeder 4 for evaluation purposes as insulators were found needing replacement following previous supervisor attendance of The Electric Utility Expo. Such installations began in 2018-2019.

Figure 4. Fastening Method: Hand Tie and Depiction of a Button

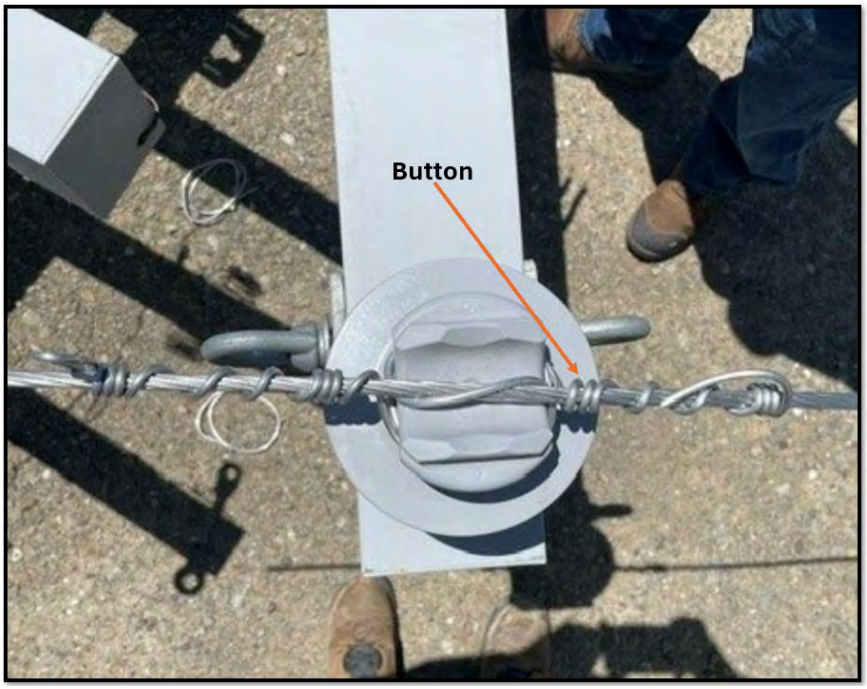
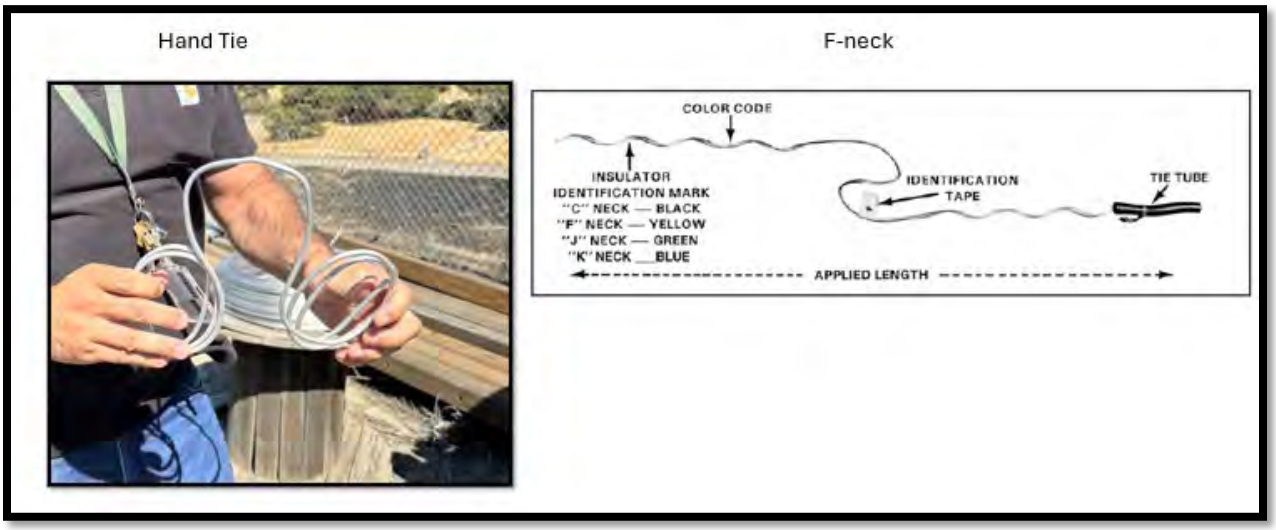


Figure 5. Fastening Method: F-neck

Figure 6. Fastening Method: INSULIGN Vise Top Pin Type Polymer Insulator (i.e., vise clamp)

Figure 6. Hand Tie and Preformed F-Neck Connection Prior to Installation



Utilities Requirements Flow Down

LLNL's ES&H Manual Document 16.1, "Electrical Safety Program" includes a section on Utility Power Systems, section 4.2.1 and states, "Utility power systems include electrical power distribution and transmission systems with more than 600 V (i.e., substations, vaults, transformers, switchgear) that furnish electrical power to buildings and facilities through an electric service entrance. These systems are to be maintained and operated *only* by qualified Central Facilities and Infrastructure Department personnel (or their designees). Refer to the *High Voltage Distribution System Operations Manual* for guidance and requirements." The *High Voltage Distribution System Operations Manual* includes several topics, but no processes that are considered barriers to the event being analyzed.

The LLNL Electric Utility Division (EUD) follows National Electrical Safety Code (NESC) consensus standard that is used in whole or in part by statute, regulation, or consent as the standard (or basis of the standard) of safe work practice for public and private utilities in the United States. The NESC is American National Standard C2. Portions of the NESC code are similar to the National Fire Protection Association (NFPA) 70 E which is incorporated into Occupational Safety and Health (OSHA) law. Both pertain to safe work practices where the NESC relates to electric utility workers as opposed to the NFPA 70 E pertaining to commercial, industrial, and residential electrical workers. The NESC is incorporated into OSHA 1910.269 which refers to electric utility operation and maintenance safe work practices. OSHA also includes 1926 Subpart V - Electric Power Transmission and Distribution. OSHA 1926, Subpart V covers requirements related to keeping workers safe when performing work on transmission and distribution systems, not requirements for maintaining and inspecting those systems.

The EUD is required to follow the CPUC GO95 for *Overhead Electric Line Construction,* as the minimum requirements and utilities typically create their own design standards based off the GO requirements. Parts of the NESC are also incorporated into GO95. Utilities in California are required to follow the CA GO95. GO95 defines requirements "for overhead line design, construction, and maintenance, the application of which will ensure adequate service and secure safety to persons engaged in the construction, maintenance, operation or use of overhead lines and to the public in general."

LLNL EUD Linemen also implement the local utility Overhead Standard specific requirements for how to install a hand tie to a conductor and insulator, as many LLNL EUD Linemen are former longtime local utility employees.

Maintenance and Inspection

GO95 points to GO165 for inspection requirements. GO165, *Inspection Requirements for Electric Distribution and Transmission Facilities,* defines distribution inspection cycles for overhead conductors and cables in rural areas not to exceed one year for patrol and five years for detailed. For wood poles that have passed intrusive inspection, their inspection cycle is not to exceed 20 years for rural areas. Maintenance requirements are defined in section 12.2 of the GO95, which points to section 44.3, *Replacement.* Section 44.3 states that, "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 44.1 and in Grade 'C' construction to less than one-half of the safety factors specified in Rule 44.1. Poles in Grade 'C' construction that only support communication lines shall also conform to the requirements

of Rule 81.3–A." Due to the lack of clarity from GO95 on this topic, the NESC Table 261-1 was referenced for clarification. Referring to the strength factor table (NESC Table 261-1), which specifies strength requirements for specific equipment at installation, deterioration is addressed in the footnotes and the statement is made, "Footnotes specify deterioration allowed, if any." The footnote specifically for support hardware states, "Deterioration during service shall not reduce strength capabilities below the required strength." One interpretation is that deterioration is not considered as a component that reduces the strength factor with regards to the support hardware (insulators and fasteners) and other items associated with that footnote. Another interpretation is that deterioration occurs, and the component needs to be replaced before they deteriorate lower than the strength factor. The original design strength factors must be maintained or improved upon when replacing support hardware components as well as system modifications or additions. Periodic maintenance and inspections, as minimally determined by GO165, are still required to identify wear, tracking, and other signs requiring support hardware component replacement.

LLNL performs weekly visual inspections (i.e., patrol) on all poles and detailed maintenance on each feeder once every four years, which exceeds the GO165 requirement of one visual inspection per year and detailed maintenance once every five years. The weekly line inspections are performed every Monday and include inspections of all 478 12kV distribution poles at S300. Substations are also checked. The line inspections take 2-4 hours and are divided amongst HV personnel. HV personnel get off road permission to go on ridgelines; if permission is not granted due to weather or closed areas from muster or remote operations or biologist restrictions, then HV personnel use binoculars, "glass out", to inspect the pole lines and perform a visual review on all inaccessible poles. Patrol inspection of the lines include:

- Check for loose hardware
- Check for floating/loose phases and jumpers
- Check for blown fuses
- Check for broken or missing signage
- Check for loose or missing cross arm braces
- Check for new bird nests
- Check splits in pole top and cross arms
- Check the bottom of the pole to ensure the foundation hasn't eroded
- Check for leaning poles
- Check for signs of tracking or flashovers
- Check for mylar balloons anywhere near the lines or on the property
- Check for damaged guy wires and anchors
- Check for burned jumpers and line
- Check condition of grounds
- Check condition of risers
- Check condition of transformers

The visual inspections have proved effective and have found the following issues in the last year that have been repaired:

- Dropped out cross arm brace
- Cross arm floating from missing braces
- Tracking on pole 4073 that lead to pole replacement
- Multiple mylar balloons

- 50+ bird nests and removed nests with permission from biologist
- Disconnected pole ground on p1050
- Loose two-hole straps securing pole riser on p5038 and p1001
- Eroded dirt from rain runoff near pole and had laborers fill in
- Missing nut securing cross arm to p4043
- Loose brush that had blown up into the lines
- Loose cotter key on dead end shoe
- Missing cotter key and backed out pin on part four clevis holding up service to building

Feeder maintenance (i.e., detailed) is performed on one feeder per year completing all four feeders in four years via a work order, which exceeds requirements in GO95. In this effort, EUD linemen get a closer look at the poles and their associated equipment by using bucket trucks to raise them up to the pole top equipment on each pole. The EUD linemen perform all items below on each pole on the line, moving down the line one pole at a time. In addition, where applicable and able, EUD replaces portions of the conductor to remove bump sleeves (splices) during maintenance activities.

Feeder maintenance activities include:

- Tighten all related hardware
- Tighten all fuse holders and conductors (add bird guard as needed)
- Tighten all cut out brackets, cut outs and bonding/grounding condition
- Tighten all lightning arrestor hardware and add/replace bird guard as needed
- Replace broken or missing signage
- Tighten all cross arm braces (top and bottom braces)
- Check condition cross arms (replace as needed)
- Check the bottom of the pole to ensure the foundation hasn't moved
- Verify all primary conductors have not had tracking or flashovers
- Tighten all guy wires and anchors
- Tighten all grounds on pole including bonding, ground rods and case grounds
- Check condition of risers add/replace all U molding, cover up and lag bolts
- Tighten all transformer connections (primary and secondary bushings)
- Tighten all transformer brackets, cross arms and verifying all bolt covers are in place (replace as needed)
- Visual inspection on all insulators, fastenings, kingpins, and dead-end insulators (replace as needed)
- Visual inspections on all dead-end shoes, bail type shoes and verify all associated hardware is in place (replace as needed)
- Adding or replacing bushing covers on primary side of transformers
- HV switches – exercise handle, tighten all related hardware, tighten all dead-end shoes, tighten grounds/paddles and proceed with same maintenance as poles

Every five years, LLNL hires an outside subcontractor to inspect wood utility pole physical properties and evaluate decay of all wood poles at both sites 200 and 300, which exceeds the GO165 requirement for every 10 years if not previously inspected and every 20 years if previously inspected. The last sitewide inspection was in 2023 with a reject rate of 4.7% of the 747 poles. Priority rejected poles are replaced first and other rejected poles are replaced following the priority rejected poles. The strength of partially rejected poles is considered acceptable, but they are replaced as a third priority.

Vegetation is also maintained around all distribution poles with a 15-foot radius of clearance around each pole, to prevent pole damage during prescribed burns or onsite fires. The Corral Fire did not initiate at the base of pole 8009. Pole 8009's vegetation was controlled around the base of the pole and the base of pole 8009 was unharmed by the fire. Only one of the 478 distribution poles at S300 was damaged in the Corral Fire; the damaged pole was the only pole that did not have the 15-foot vegetation control; it was somehow missed.

EUD has made a number of improvements over time to inspection and maintenance processes. Figure 8 shows how these improvements have affected the number of outages or faults. Due to the EUD's efforts and improvements the frequency and the severity of electric utility outages have drastically decreased. As seen in Figure 8, the PG&E transmission utility outages have a large effect on the impact of unscheduled outages. Looking at Figure 9, removing PG&E utility outages, the most significant outages labeled with the apparent cause can be seen. If we remove the final large outage, which was sustained due to inability to access the site for over 24 hours due to flooding, it is clear from 2018 that the focused efforts to use bird and animal guards, insulated jumpers, updated composite cross arms, replacing insulators, and weekly line inspections have reduced the number and duration of unplanned outages and increased reliability, without compromising safety. The bird and animal caused outages have been greatly reduced. Weekly line inspections have found mylar balloons and other issues prior to causing a fault. Consistent maintenance with high standards has reduced equipment caused outages. As time goes on, the EUD continues to make system improvements, track, and correct any failure modes seen. The EUD is working hard to make the current system as reliable as possible, utilizing best utility practices and implementing new technology where applicable and where it will make a positive impact.

Figure 7. All S300 Sustained Unscheduled Outages Including the PG&E Utility Caused Outages

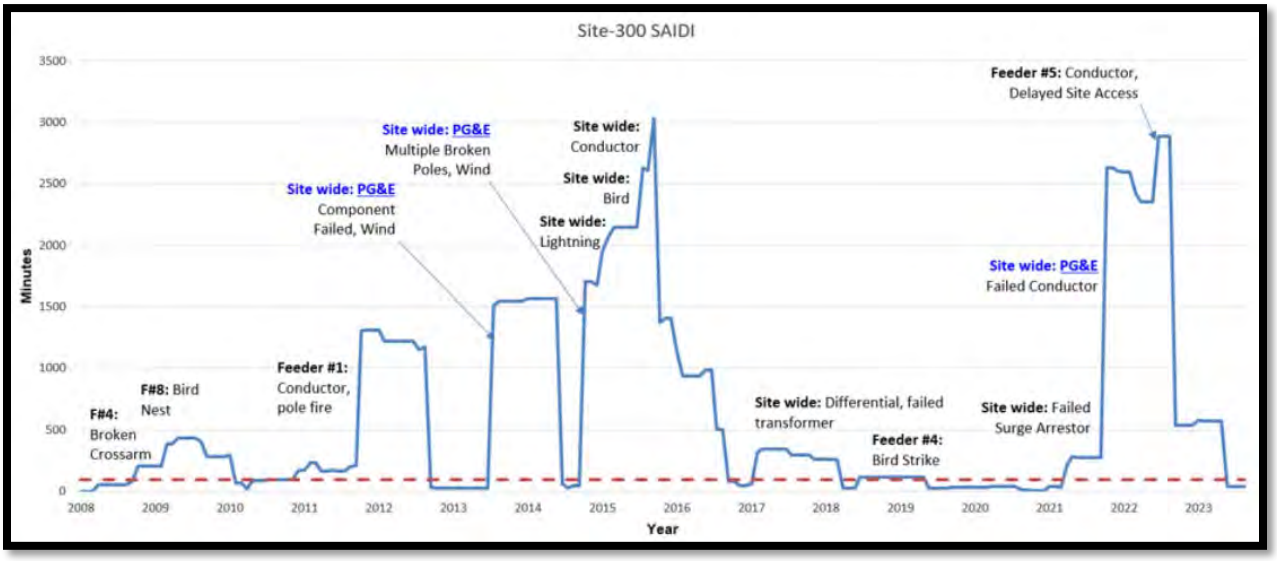
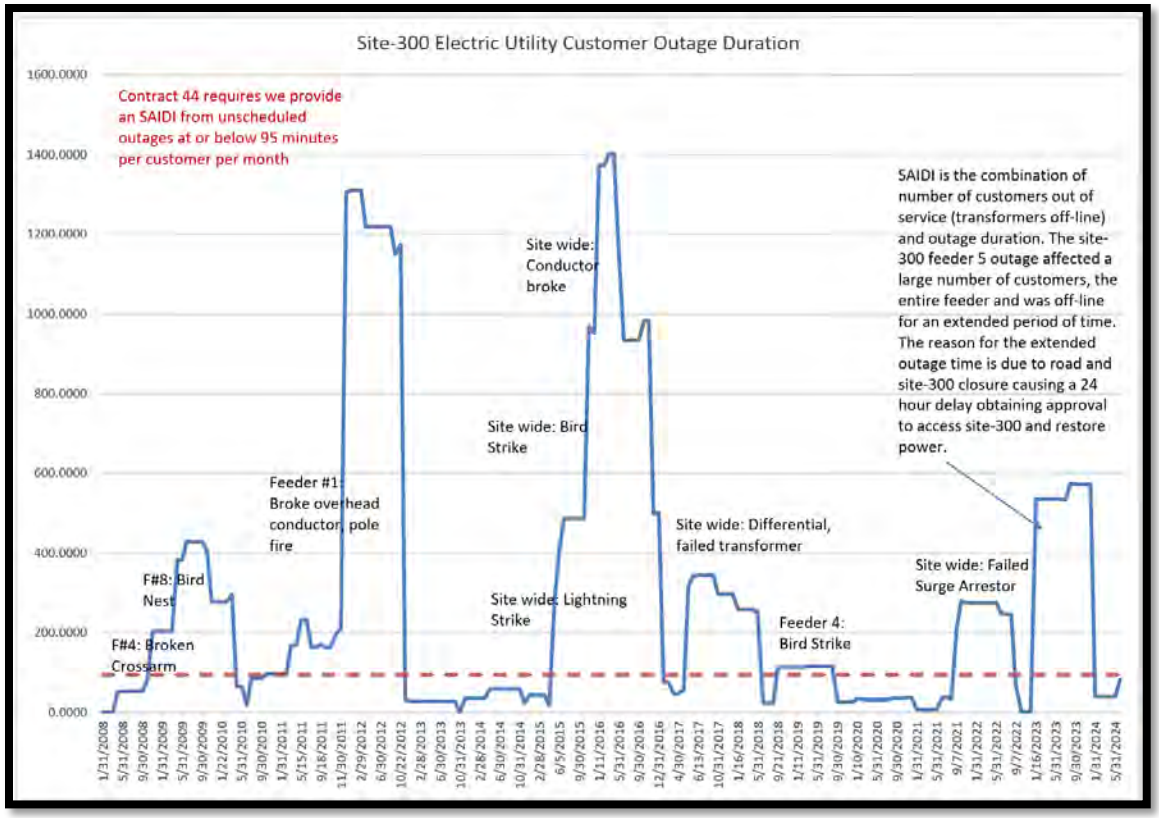


Figure 8. All S300 Sustained Unscheduled Outages Excluding the PG&E Utility Caused Outages



Work Control

LLNL HV Electricians have a competent worker program, documented as role CW HVOLT ELECTRICIAN with an associated job hazards analysis (JHA) and assigned training courses. The JHA for role CW HVOLT ELECTRICIAN includes a core task, TRADE116 v.2.0.0, "CW Core - High Voltage Electrician." This task includes, "Install, operate, maintain, test & troubleshoot, inspect, repair, and replace medium and high voltage electrical systems and equipment, including switches, circuit breakers, switchgear, transformers, relays, distribution lines, cables and cable terminations operating above 600V."

There is also a work control document (WCD) (No. 100142) for, *High Voltage Power Pole Inspection, Installation and Removal, Using Digger/Derrick line Truck,* for installing new power poles.

The completion of certain tasks, such as connecting conductors to insulators on cross arms are covered by training provided by offsite providers and/or LLNL on-the-job training (OJT) competent worker programs.

Training

Prior to 2021, LLNL hired journeymen already skilled to perform overhead installation and maintenance activities. Multiple personnel hired at LLNL came directly from outside local utilities.

Since 2021, EUD has implemented training for new unqualified personnel to include completion of a four-year program at Northwest Lineman College, in which one EUD linemen is currently enrolled. EUD

has also created an OJT validation, "*High Voltage Lineman One-the-Job Training (OJT) Validation*" for evaluating probational employees for specific work tasks and competent worker qualification. There is a line item in the OJT for "Pole replacement and equipment installation (#21)." Line item 21 covers the general practice of replacing a pole and its associated equipment including attaching conductors to insulators using one of the three fastening methods described above. Since 2021, two EUD linemen were signed off on the OJT.

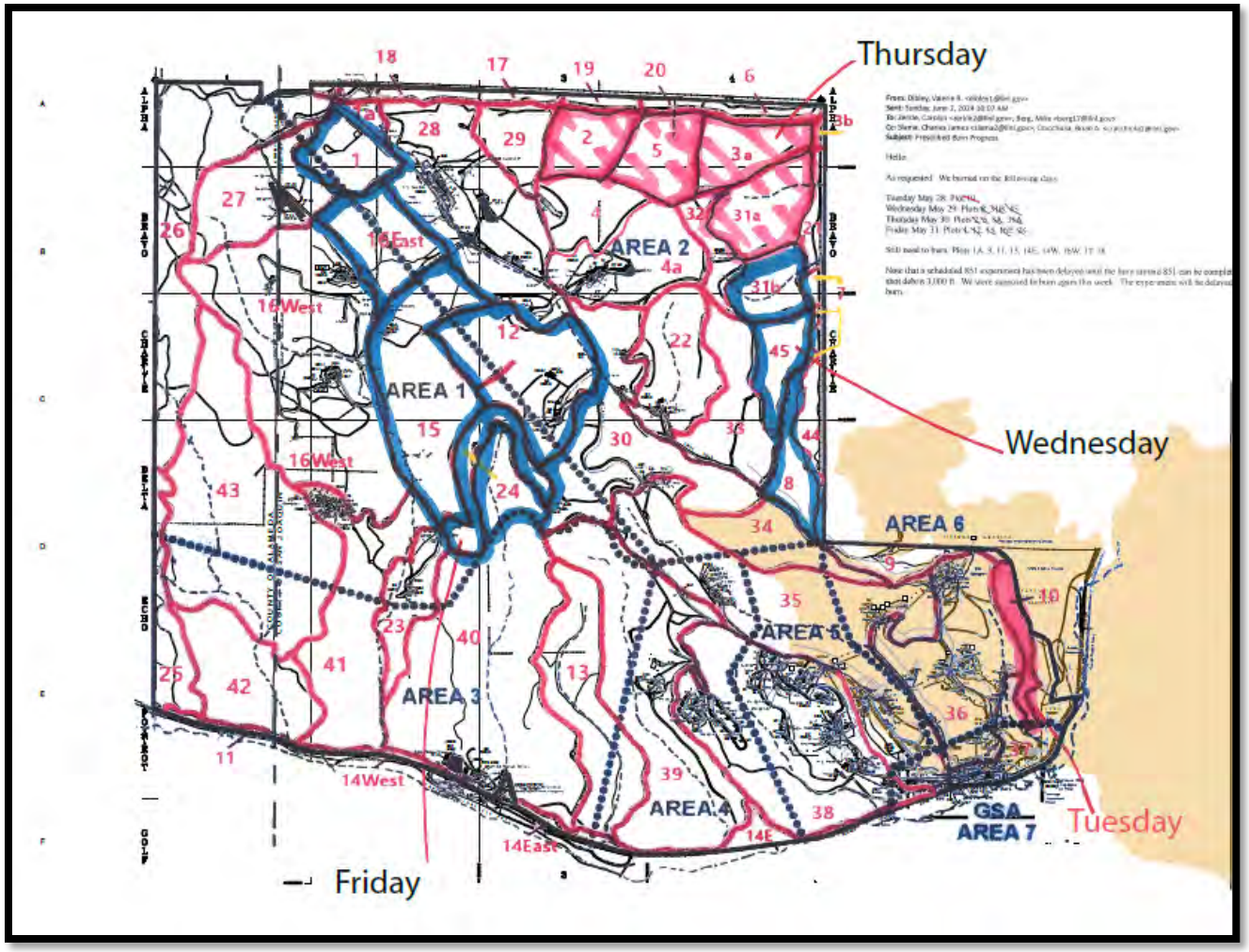
Two applicable training courses exist, formally tracked by LLNL's Livermore Training Records and Information Network (LTRAIN), PE9880, *High Voltage electrician 9703-15 Skill of the Craft,* and PE5245, *High Voltage Power Pole Maintenance Installation and Removal.* PE9880 was developed before the OJT validation, and documents completion of specific requirements in the OJT course. PE5245 is an EUD lineman group discussion of the objective topics including the associated hazards and safety equipment and practices utilized when performing specific tasks.

Prescribed Burns at S300

LLNL has a *Wildland Fire Management Plan* that complies with federal policies and standards. The plan includes two subsidiary documents related to S300, *Site 300 Explosive Test Facility Prescribed Burn/Smoke Management Plan* and *Prescribed Burning Smoke Management Plan, LLNL – Site 300*. The *Wildland Fire Management Plan* describes the S300 wildland fire hazard that extends across the entire site and is generally classified as "Low" according to NFPA standards. The plan mentions that alternative methods to mitigate the hazard have been explored but prescribed burning is considered the most effective. Prescribed burns at S300 are authorized annually after a review and preparation cycle, with approval from air quality agencies and the Livermore Field Office. The prescribed burn area typically covers around 2,300 acres divided into 24 plots. The plan also includes instructions to ensure vegetation along Corral Hollow Road is mowed and sprayed if necessary, and to work with the Environmental Functional Area (EFA) for protected species briefings and activity surveys. Additionally, the San Joaquin County Department of Public Works is responsible for mowing vegetation along Corral Hollow Road to maintain a safe boundary.

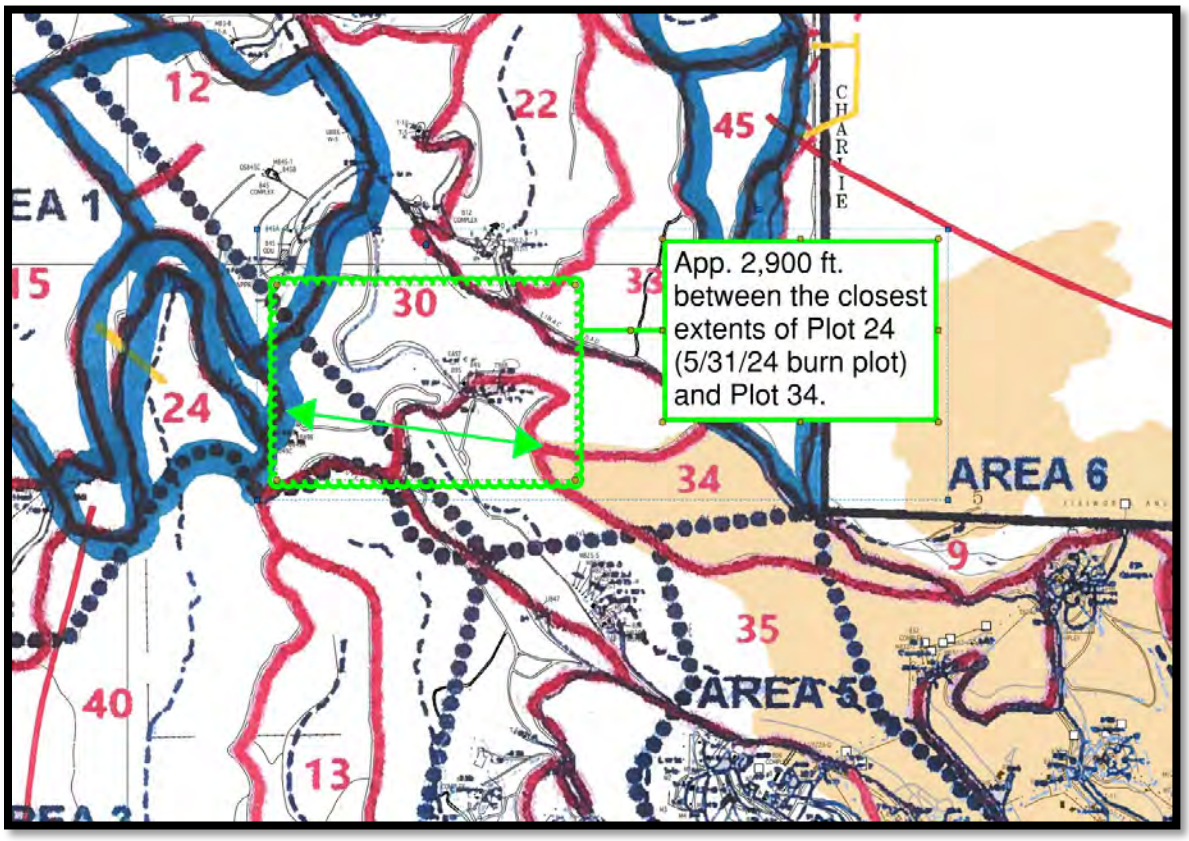
For 2024, the prescribed burn included 1,911 acres over the course of 12 days from May 2024 – August 2024. The 2024 prescribed burn included plots, 1, 1A, 2, 3A, 5, 8, 9, 10, 12, 13, 14E, 14W, 15, 16E, 16W, 17, 18, 24, 31A, 31B, and 45. Prior to June 1, 2024, Figure 10 shows the plots that were burned on Tuesday (May 28, 2024) – Friday (May 31, 2024), with plots 1A, 9, 11, 13, 14E, 14W, 16W, 17, and 18 still left to burn. Note that even though plot 9 in Area 6 was not burned prior to the Corral Fire, the fire went around plot 9 altogether. Figure 10 appears to show fire in plot 9, but that is a result of the shading efforts.

Figure 9. Plots Burned as part of the Prescribed Burn Prior to June 1, 2024



The distance from the edge of Plot 24, the last prescribed burn that took place on Friday, May 31, 2024, and Plot 34, the western edge of the Corral Fire, is estimated to be 2,900 feet, as shown in Figure 11. The prescribed burn is not analyzed in this report as a barrier or control to prevent ignition of the fire, since that is not the purpose of the prescribed burn, to prevent ignition. However, based on the time and distance between the last prescribed burn and the start of the Corral Fire, there is no evidence that the 2024 prescribed burns ignited the Corral Fire.

Figure 10. Estimated Distance Between the Last Prescribed Burn (May 31, 2024) and Corral Fire (June 1, 2024)



Timeline

The LLNL Emergency Management Department developed a timeline (Attachment 1) that was reviewed and approved by affected personnel and formally recorded in LLNL's Information Management System. The timeline titled, "June 1-3, 2024, Timeline and Maps for LLNL Corral Fire Response" is provided as Attachment 1 in this report. Additional timeline details are documented below, but not repeated.

Table 1. Chronology of actions/conditions:

When	What
1989	Electric Utilities Division was created.
June 19, 2009	Around pole 1007, a 12 kV overhead distribution line Circuit 12001 developed a short circuit that caused a power outage to eight buildings and may have precipitated a wildland grass fire. In this instance, the insulator, with the aluminum conductor still tied to it, separated from its steel pin.
Prior to 2014	EUD begins to install F-neck ties on the S300 distribution system poles with a plan to replace them over time.
2016	EUD started installing raptor construction for S300 utilities.
2018-2019	Following supervisor Electric Utility Expo attendance and introduction to new distribution technology, EUD installed the new technology vise clamp insulators on Feeder 4 poles 4011-13, 4017, 4019-21, 4024, 4029, 4065, 4106, 4107, 4110 to evaluate their performance in the wind, with no problems to date.
2023	Hand tie melted and failed, on P5054, in an extreme rainstorm with flooding where two separate lines flashed over.
May 2023	Third party inspection of 747 poles at S300 (including pole 8009). Inspection found a 4.7% rejection rate, pole 8009 was not one of the rejected poles.
10/11/2023 – 10/20/2023	Planned maintenance performed on feeder 8 via a work order; pole 8009 and associated equipment was included in the maintenance. **This is the last time work was performed on pole 8009.**
12/23/2023	Performed maintenance on feeder 8, poles 8056 – 8075. Pole 8009 was not a part of this maintenance activity.
1/5/2024	Performed maintenance on feeder 8, poles 8056 – 8075. Pole 8009 was not a part of this maintenance activity.
Tuesday, May 28, 2024	S300 prescribed burn for plot 10 completed (southeast corner of S300).
Wednesday, May 29, 2024	S300 prescribed burn for plots 8, 31B, and 45 completed (east side of S300).
Thursday, May 30, 2024	S300 prescribed burn for plots 2, 5, 3A, and 31A completed (northeast corner of S300).
Friday, May 31, 2024, 2:52 p.m.	Email confirming that the S300 prescribed burn for plots 1, 12, 15, 16E, and 24 were completed (northwest of pole 8009). The 2:52 p.m. email noted that Station 21 was going to be patrolling the burn area throughout the afternoon.
June 1, 2024	
2:15 p.m.	S300 Maintenance Mechanic (MM) on duty in building 875 saw power suddenly dip and restore three times over the course of a minute.
2:16 p.m.	Site-200 SCADA and text to EUD personnel: 2:16:32 p.m. datalink failed (relay event report confirms, first line to line contact and breaker trip). Note: datalink failed means that the main communication hub connecting S300 to the outside lost power.
2:18 p.m.	Site-300 SCADA reported: 12008 tripped. Note several trips and closures showed from 2:18-2:23 along with datalink failures from 2:18:26-2:58:19.
2:23:39 p.m.	Site-200 SCADA and text to EUD personnel: U846 annunciator alarm.
2:23 p.m.	Sergeant (Sgt.) on Duty attempted to call MM and reached MM via radio to report a fire along Route 3.

When	What
2:29 p.m.	Alameda County Fire Department (ACFD) crew resident to S300 responded to fire and notified Alameda County Regional Emergency Communication Center (ACRECC) of vegetation fire. ACRECC dispatches a large number of units.
8:39 p.m.	EUD lineman repaired equipment and the A- and B-phase conductors on pole 8009. Due to conductor damage from arcing, the A- and B-phase conductors were replaced where the damage occurred (damage centered at pole 8009). Both A- and B-phase conductors were cut, new sections installed and spliced, using bump sleeves, to connect to the existing conductors. Finally, the conductors were secured to the existing B-phase insulator with a F-neck and the A-phase insulator was replaced and the A-phase conductor secured with a F-neck to the insulator. EUD lineman performed a visual inspection of all 478 distribution poles at S300; no issues were found.
**** See Attachment 1 for further timeline and details on the event and following days****	
6/3/2024	Verbal notification went out for the Occurrence Report for the Corral Fire.
6/4/2024	Lessons Learned meeting about the event held with S200 engineers and electricians.
6/5/2024	HV team figured out that there are 18 pole with hand ties left to replace at S300.
	Written notification went out for the Occurrence Report, NA—LFO-LLNL-LLNL-2024-0020, *Corral Fire Disrupts Operations at Site 300.*
6/6/2024	Lessons Learned meeting about the event held with S300 HV team.
6/6/2024	EFA confirmed no reporting required for the following: 1. Natural Resources – Spadefoot toad found but as they are only proposed candidate for listed and not yet listed species we won't report 2. Drinking water 3. Stormwater 4. SPCC (e.g. for transformers) 5. NESHAPs 6. Non-rad air permitted sources 7. Untreated groundwater release
6/21/2024	EFA determined that more than the reportable quality of asbestos was released from a shingled awning that was burned at S300; additional verbiage was added to Occurrence Report NA—LFO-LLNL-LLNL-2024-0020.
6/27/2024	EFA determined that there was an additional release above reportable quantities of pentachlorophenol due to the pile of unused power poles that burned in the fire.
7/1/2024	Additional verbiage was added to Occurrence Report NA—LFO-LLNL-LLNL-2024-0020 to address the release from the pile of unused power poles.
7/26/2024	Ten (10) of the 18 poles with remaining hand tie connections were updated to F-neck. The 10 poles that were updated include, 1040, 1061, 4043, 4046, 4047, 5084, 8029, 8035, 8057, 8087. The eight remaining poles to be updated are, 1001, 1004, 1027, 4076, 4082, 5071, 5073, 5074.

Immediate Actions Taken in Response to Event

Access to S300 was restricted by S300 Management, and the LLNL Emergency Operations Center (EOC) was activated and staffed throughout the weekend and well into Monday. Normal fire, security, and maintenance personnel remained onsite at S300. All site personnel were accounted for, and there were

no injuries reported among onsite personnel. However, two Alameda County firefighters sustained minor to moderate injuries associated with the fire offsite.

Power to all affected facilities was restored Saturday evening.

Recovery and restoration efforts were initiated as of Monday, June 3, 2024. Entry to B830, which has structural damage, was and is prohibited. There are no current threats to any Laboratory facilities and operations, and no onsite or offsite contamination has been reported.

Analysis and Results

Interviews were performed with EUD linemen, a maintenance mechanic, a Protective Force Division Officer, those that plan, organize, and approve LLNL prescribed burn processes, and Corral Fire's recovery manager. A barrier analysis was conducted and is described below to analyze for apparent cause. Barriers are controls that could have had a positive effect on the issue, initiation of the fire. Barriers are analyzed to determine how they performed, as expected or not, unknown or not applicable. Not applicable means the barrier was not an applicable control, but worthy of discussion in the analysis. Barriers that perform have no effect on the issue and are not considered causes, they worked or were implemented as expected. Barriers that do not perform and have no effect on the issue, are not causes of the issue, but could be a separate, unrelated issue. Barriers that do not perform and there is an effect on the issue are considered causes.

A why/because analysis was then used to supplement the results of the barrier analysis to identify root cause(s). Each apparent cause identified from the barrier analysis was analyzed using the why/because methodology and why the apparent causes exist is analyzed and discussed. Sometimes the why/because questioning led to a root cause and sometimes it led to a stopping point that is not a root cause. Root causes are depicted with bold text and [ROOT] at the end of the root cause description.

Barrier Analysis:

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
Method to secure the conductor to the cross arm's insulator	Did not perform as intended	The hand tie holding the B-phase line to the insulator failed, the tie was no longer holding the conductor to the insulator, see Figure 12 [Direct Cause].	Since the hand tie failed, the A- and B-phase lines were able to contact one another during the high winds on June 1, 2024, potentially causing sparks to fly and land on the east side of pole 8009.
F-neck conductor constraint design	Did not perform, but is not required	F-neck design was not installed on the B-phase line of pole 8009 [Apparent].	Based on manufacturing testing [TM-166-E], and LLNL MED tensile strength testing described in a memo dated August 27, 2024, titled "Hand Tie Product Testing," the steel F-neck is 8-18 times the tensile strength of the aluminum tie wire. Had the F-neck been installed on the B-phase line of pole 8009, it is possible that the F-neck would not have or would have been less likely to fail on June 1, 2024.

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
Vise Clamp constraint design	Did not perform, but is not required	Vise Clamp design was not installed on the B-phase line of pole 8009 [Apparent].	Had the vise clamp been installed the mechanical stress would have been different and potentially resulted in no failure or a different failure mode.
[Design] Hand tie wires are 4 AWG – soft drawn aluminum based on Table 7 of GO95 and 5'8" in length (As trained and confirmed on the local utility overhead standards).	Performed as intended	It was visually and comparatively confirmed by installers that the hand tie in question is 4 AWG, soft aluminum. Based on observation of the remaining material, the installation appears correct compared to the mockup installation.	N/A
Procurement of hand tie aluminum wire material.	Unknown	Unknown when the hand tie material in question was procured and which reel it came from. It is known that the current cable reel in the current storage unit is a 2,000 ft reel of #4 AWG soft drawn aluminum tie wire that was procured as a Quality Level (QL)-3 procurement. QL-3 is the lowest level of rigor or formality that must be applied to the procurement of an item or service, which is not in itself problematic, given this material tends to be standard. Based on the label on the spool in storage, LLNL received what was ordered. The last time a 2,000 ft reel of #4 AWG soft drawn aluminum tie wire was purchased was in 2021.	With the information that is known, there appears to be no effect and the hand tie material procured was the material received.

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Design and Installation] Insulators spacing is required by the 2023 NESC to be 13.6", Table 235.1, 17.5", per 2020 GO95 Table 2 Case 15, and 18", per 2020 GO95 Table 1 Case 8. Insulator material must meet NESC requirements, voltage rating, mechanical strength, and distance.	Performed as intended	Insulator spacing and material meet requirements for pole 8009. Pole 8009's insulators are estimated to be a minimum of 38" apart based on raptor design and 8' cross arm and the material is a 15kV rated insulator. Insulator material on pole 8009's B-phase line meets NESC requirements. It was a 15kV rated insulator, a Hendrix Tie Top Insulator molded from a proprietary blend of gray, track and UV resistant, high-density polyethylene. The insulator exceeds ANSI C29.5 Class 55-4; properties can be found on the data sheet with a cantilever strength of over 3000lb. There was no observed damage to the B-phase insulator, which remained on the pole and in service. The A-phase insulator showed signs of arc damage due to this event and was replaced.	N/A
[Design and Installation] Conductor size is chosen based on ampacity required.	Performed as intended	Pole 8009's conductor size meets requirements. LLNL uses #2 ACSR, 184A rated for all overhead distribution feeder conductors.	N/A
[Design and Installation] Distance between A, B, and C cables. 2023 NESC requires 13.6", per Table 235.1, 2020 GO95 requires 17.5", per Table 2 Case 15 or 16, and 2020 GO95 requires 18", per Table 1 Case 8.	Performed as intended	LLNL meets or exceeds GO95 requirements for conductor phase to phase required distance. The insulators on pole 8009 are estimated to be a minimum of 38" apart based on the raptor design and 8' cross arm.	N/A

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Installation] Sag and Tension of the B phase line based on NESC and GO95	Performed as intended	No known issues identified with sag or tension on the B-phase line or pole 8009. For sag and tension during replacement or maintenance, the conductors cannot exceed 50% tension of line rating and sag to meet distance requirements from conductors, ground, buildings and other structures. The span from pole 8008 to 8009 is 240' and from pole 8009 to 8010 is 249'. If distance requirements based on sag are considered using NESC Table 235-3 12.47kV and the extreme case of a sag of 240" or 20' is considered, the horizontal clearance between conductors is 40" and our distance in this case is approximately 38". Note that the extreme case of 20' sag mentioned above is not applicable in this instance as the sag is less than 20'. Therefore, the 38" horizontal clearance between insulators on pole 8009 is sufficient distance for these lines, as well as the associated conductors, spans, sag, and tension.	N/A

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Installation] Proper tying or method used to hand tie B-phase line onto the cross arm's insulator. [Guidance from local utility Overhead Standard]	Unknown	Unknown if the proper tying method was used to install the hand tie on the B-phase line of pole 8009. It appears that part of the hand tie is missing due to possible arcing and loss of material. The missing portion includes some of the hand tie between the two buttons closest to the insulator (Figure 4). Missing material was not found at the scene. The sections of hand tie recovered at the scene and still attached to the B-phase line appear to have the appropriate number of buttons on each side of the insulator, indicating proper installation.	Unknown, but there is no evidence that installation of the hand tie played a role in the cause of the fire. If the hand tie was installed on the insulator overlapping itself, this could have created a wear point where abrasion may have occurred, but no evidence was observed of this occurring.
[Training] Training on hand tie installation	Unknown	Unknown when the hand tie was installed and by which HV linemen to then check their training. The hand tie may have been installed by a lineman that is no longer employed at LLNL. However, three current HV linemen have met the requirements for the HV Electrician role and competency program including LTRAIN courses; one is currently attending the four-year Northwest Linemen College, and two EUD linemen were signed off on the OJT validation since it was implemented in 2021. As there was no observable issue in the installation of the hand-tie, there likely was no training issue.	Unknown, but there is no evidence that training played a role in the cause of the fire.

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
Independent verification of hand tie installation	Did not perform, but is not required	Independent verification, as defined by DOE Order 422.1, "Conduct of Operations," is not performed on the installation of hand ties (or now F-necks), but it is not required. LLNL's ES&H Manual Document 3.5, "LLNL Conduct of Operations," which flows down requirements for DOE Order 422.1, states that structures, systems, components, operations, and programs requiring independent verification must be established and implemented by the facility. The ridgeline where pole 8009 is located does not have a formal facility classification. However, the closest facility to pole 8009, Substation U846 has a LLNL Facility Screening Report associated with it for S300 Electrical Substations. This screening report categorizes S300 Electrical Substations as Light Science & Industry (LSI). ES&H Manual Document 3.5 notes that, "Conduct of Operations matrices do not need to be developed for office buildings or other non-nuclear facilities categorized as LSI and Low hazard." Also, the SD Conduct of Operations Manual states, "there are no SSCs in SD non-nuclear facilities that require independent verification, and human error is mitigated through other programs or requirements to the extent necessary." Therefore, it is concluded that independent verification is not required for the installation of fastenings, including hand ties and F-necks.	Unknown since it is unknown why the hand tie failed, but there is no evidence that lack of an independent verification of installation of the hand tie played a role in the cause of the fire. The hand tie was physically inspected in October 2023 as part of the four-year feeder maintenance and is inspected weekly; any installation errors should have been caught by these processes.
[Training] LLNL attendance at the Overhead Electric Utility Equipment Conference. (The Utility Expo, Louisville, KY)	Performed as intended	EUD S300 Supervisor attends this conference to evaluate newest equipment and technology to address various failure modes (e.g., bird strikes, broken conductors and/or jumpers etc.) that have occurred in the S300 distribution system.	N/A

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Maintenance/Inspection] Maintenance every 4 years on each of the feeders, in this case, feeder 8.	Performed as intended	For feeder 8, pole 8009, the four-year maintenance was completed in October 2023. Note – during maintenance linemen always work in pairs (one in the bucket and one on the ground). EUD corrects identified issues during maintenance on the spot, but does not record what was fixed/replaced etc. Therefore, it is unknown if there were any issues with pole 8009 in October 2023.	N/A
[Maintenance/Inspection] Weekly visual inspection of poles and associated equipment from ground with use of binoculars when certain locations are inaccessible due to location closures.	Performed as intended	Since 2021, visual inspections have been completed for pole 8009 and all distribution poles at S300 every week, on Monday. Unknown if any issues were identified with pole 8009 during routine weekly inspections in the past, since detailed distribution line inspection and maintenance records are not kept/recorded for specific issues identified in the field and corrections made [Issue]. However, if any issues were identified with pole 8009, they were corrected at the time of the inspection or scheduled.	N/A

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Maintenance] Requirements from GO95 from Section 44.3, Replacement, "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 44.1 and in Grade "C" construction to less than one-half of the safety factors specified in Rule 44.1. Poles in Grade "C" construction that only support communication lines shall also conform to the requirements of Rule 81.3–A."	Performed as intended	LLNL goes above and beyond required inspection periods and therefore meet the requirements from Section 44.3 of GO95 on safety factor and deterioration with detailed inspections.	N/A
[Maintenance] 5-year pole inspection by 3rd party contractor (Exo) *[Not a true barrier to prevent this event, but important to capture the inspection conducted]*	Performed as intended	Exo, a subcontractor, completed the pole inspection on 747 wood poles at both sites 200 and 300 on 5/12/2023. Exo identified no issues with pole 8009 during their inspection.	N/A

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[LLNL Work Control] Controls in the competent worker HVOLT ELECTRICIAN WCD and WCD No. 100142, *High Voltage Power Pole Inspection, Installation and Removal, Using Digger/Derrick line Truck*.	N/A	Controls in the WCDs are not specific on how to install hand ties, which is appropriate. The WCD includes control for the task of performing maintenance and inspection with and without the use of a bucket truck.	N/A
[Controls to help with wind] Installation of vibration dampers. Note, vibration dampers on high-voltage lines can reduce the vibration of the wires caused by the wind, thereby reducing the probability of accidents.	Performed as intended	Vibration dampers were installed on all A, B and C-phase lines around pole 8009 (on both sides of the insulator). There is no indication that the vibration damper did not perform as intended. The B-phase line did not fail in this instance, it did not fall to the ground or break, which is what the vibration damper is meant to prevent (flexing at the point of installation on the B-phase line).	N/A
[Controls to help with wind] Use of spacer bars and increased insulator spacing (referenced in GO95 to help with high winds)	N/A	Spacer bars are installed between phases when changing orientation from vertical to horizontal, which is not applicable to this pole 8009 in this instance.	N/A
	Performed as intended	Insulator spacing: see above.	N/A

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Controls to help with wind] Turning off reclosers during extreme wind to ensure that during the first fault, the breaker opens and stays open (i.e., de-energizes).	Did not perform, but is not required	Reclosers are currently on at S300 and are not turned off during extreme wind and therefore are set to reclose after the first fault [Apparent].	Unknown if turning the reclosers off would have prevented this event because it is unknown if sparks/fire started after the first fault or subsequent faults. If the breaker stayed open and sparks ignited the fire due to the first fault, the fire would still have ignited even with the breaker remaining open.
[Controls to help with wind] Relocation of feeder 8 out of high wind area.	Did not perform, but is not required	Feeder 8 is positioned on a ridge at S300 that makes it susceptible, at times, to high winds [Apparent].	Since feeder 8 is located on a ridge at S300, the poles can be exposed to S300's higher winds.
[Controls to help with wind] Installation of underground lines	Did not perform, but is not required	All lines at S300 are above ground, an acceptable practice [Apparent].	Since S300 lines are above ground, the poles in feeder 8 can be exposed to S300's higher winds.

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
[Controls to help with wind] Insulated overhead distribution cables	Did not perform, but is not required	All lines at S300 are non-insulated, an acceptable practice [Apparent].	Without using insulated cables, cables can flashover dirty insulators or arc when in contact with each other or ground, but only when some failure of the system, as designed, permits these conditions to occur. Uninsulated lines are standard throughout the state.

Barrier	Barrier Perform?	Why did the barrier not perform?	Effect
Public Safety Power Shutoff (PSPS) program - Utilities may temporarily turn off power to specific areas to reduce the risk of fires caused by electric infrastructure. This action is called a Public Safety Power Shutoff (PSPS) [Ca Public Utilities Commission] In 2012, the CPUC ruled that California Public Utilities Code Sections 451 and 399.2(a) give the electric IOUs authority to shut off the electric power to protect public safety. This allows the electric IOUs (San Diego Gas & Electric, Pacific Gas and Electric, Southern California Edison, Liberty Utilities, Bear Valley Electric Service, and PacifiCorp) to shut off power to prevent catastrophic wildfires when strong winds, heat events, and related conditions are present.	Did not perform, but is not required	LLNL is not implementing the PSPS on our utilities, nor is PSPS required by GO95 or the NESC [Apparent].	Without implementation of the PSPS, wires remain live and are susceptible to high winds and arcing under fault conditions.

The following direct/apparent causes were identified from the barrier analysis:

- The hand tie holding the B-phase line to the insulator failed on pole 8009 [Direct Cause]. Note that the hand tie is a common type of fastening used by LLNL and other utility companies in similar applications and approved for use under applicable codes.
- Other fastening methods, the F-neck and vise clamp designs were not installed on the B-phase line of pole 8009.
- Additional controls to protect electrical utilities against high winds have not been implemented at S300. Additional controls include, but are not limited to, turning reclosers off during extreme wind, relocating feeder, moving feeder 8 electrical utilities underground, insulating feeder 8 conductors, and/or implementing PSPS at S300.

There are a number of unknowns described in the barrier analysis and summarized below. There is no evidence any of these unknowns played a role in the initiation of the fire.

- **Procurement of the hand tie material in question** – It is unknown when the hand tie material in question was procured (and installed) and which reel it came from. It is known that the current cable reel in the current storage unit is a 2,000 ft. reel of #4 AWG soft drawn aluminum tie wire that was procured as a QL-3 procurement, the lowest level of rigor or formality that must be applied to the procurement of an item or service. Based on the label on the spool in storage, LLNL received what was ordered. The last time a 2,000 ft. reel of #4 AWG soft drawn aluminum tie wire was purchased was in 2021.
- **Proper tying method of the hand tie** – It is unknown if the hand tie was or was not tied properly to the insulator. There is no evidence, however, that when the hand tie was installed, the tie overlapped itself around the insulator. An overlap of the tie material can become a wear point due to abrasion, as stated in installation procedures, creating a potential weak point. This seems unlikely, as the equipment on the cross arm was subject to routine maintenance in October 2023, when any abnormality from prior installation would have been identified and addressed. Based on what is left of the hand tie, the remaining portion appears to have the appropriate number of buttons on either side of the insulator (See Figure 4 for a visual description of a button).
- **Training on hand tie installation** – It is unknown when the hand tie was installed and by which HV lineman to then confirm that the lineman was trained properly. There is no evidence, however, that improper training played any role in the failure of the hand tie. The hand tie could have been installed at any point in or after 2016 when EUD started adding raptor construction to S300 utilities. The EUD believes that the raptor construction on pole 8009 was installed in or close to 2016 as this is one of the easier spans to de-energize and access for raptor construction installation. However, it is unknown if the hand tie was replaced after 2016. EUD has created an OJT validation for training and confirmation of qualifications for new EUD linemen. There is a line item in the OJT for “Pole replacement and equipment installation (#21).” This covers the general practice of replacing a pole and/or its associated equipment to include how to install a hand tie on a conductor and insulator.
- **Independent verification of hand tie installation** – Since it is unknown if the hand tie was or was not installed correctly, it is unknown if an independent verification of installation would

have made a difference in this event. However, independent verification is not required (as discussed in the barrier table) and there are other efforts implemented that can catch improperly installed hand ties, the inspection and maintenance performed (discussed in the background section).

Discussion of Direct Cause

Figure 12 shows the state of distribution pole 8009 on June 1, 2024, after the fire had initiated, with the B-phase line resting within what appears to be inches away from the A-phase line, no longer attached to its insulator. It is known that the B-phase line hand tie failed, as remaining parts of it were still attached to the conductor and can be seen in Figures 13 - 15. Based on the evidence of pits where melting occurred, deposits of molten material, and charring on the parts that are left over (Figures 13 -15 below), when the hand tie failed on the B-phase line conductor, the B-phase line was able to come in contact, multiple times, with the A-phase line's conductor. This contact is believed to have caused sparks to fly and land on the east side of pole 8009 (across the fire trail), igniting the grass. Figure 12 shows the B-phase line close to and almost touching the A-phase line insulator. The A-phase line's (roadside line) insulator was damaged, along with portions of the A- and B-phase lines and their associated vibration dampers. The C-phase line was untouched (on the west side of line B), along with its insulator and vibration damper. The insulator for the B-phase line was also undamaged.

Figure 11. Condition of Pole 8009 on June 1, 2024, after the Fire Initiated (A- and B-phase lines in close proximity)

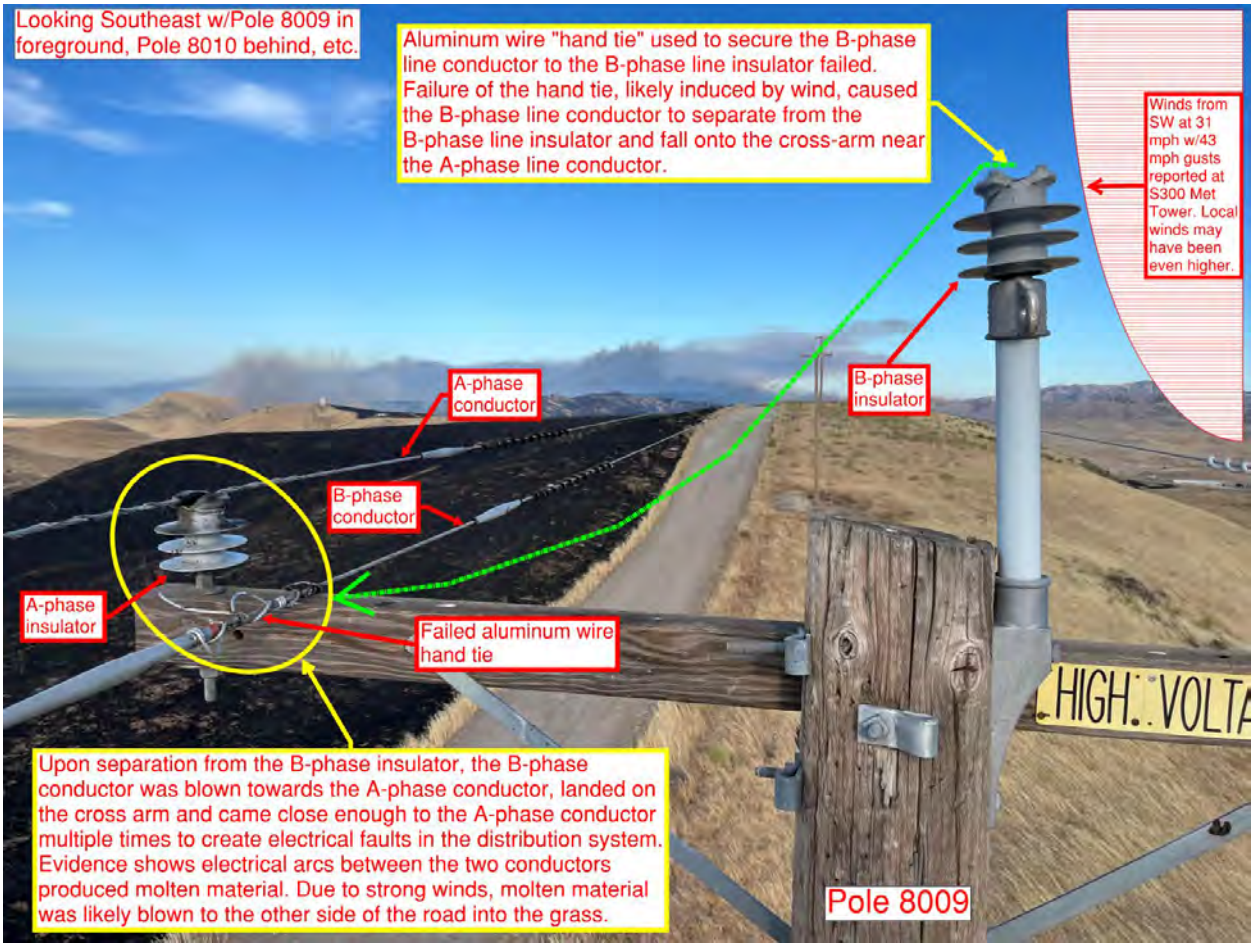


Figure 12. Damage to Pole 8009's B-phase Line Equipment

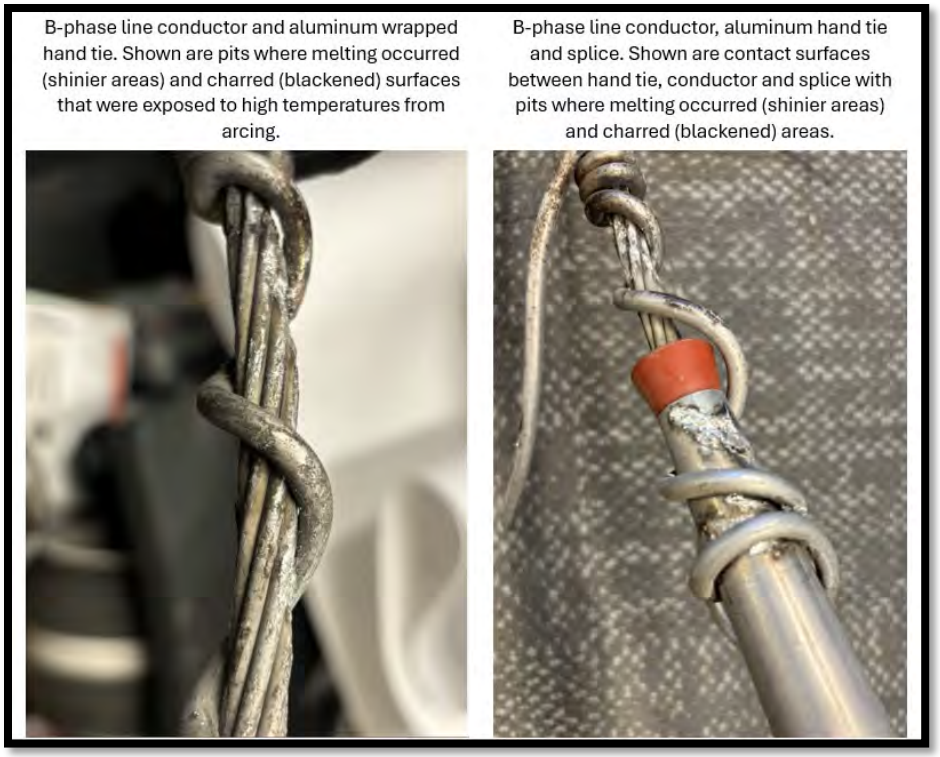


Figure 13. Damage to Pole 8009's A-phase Line Equipment

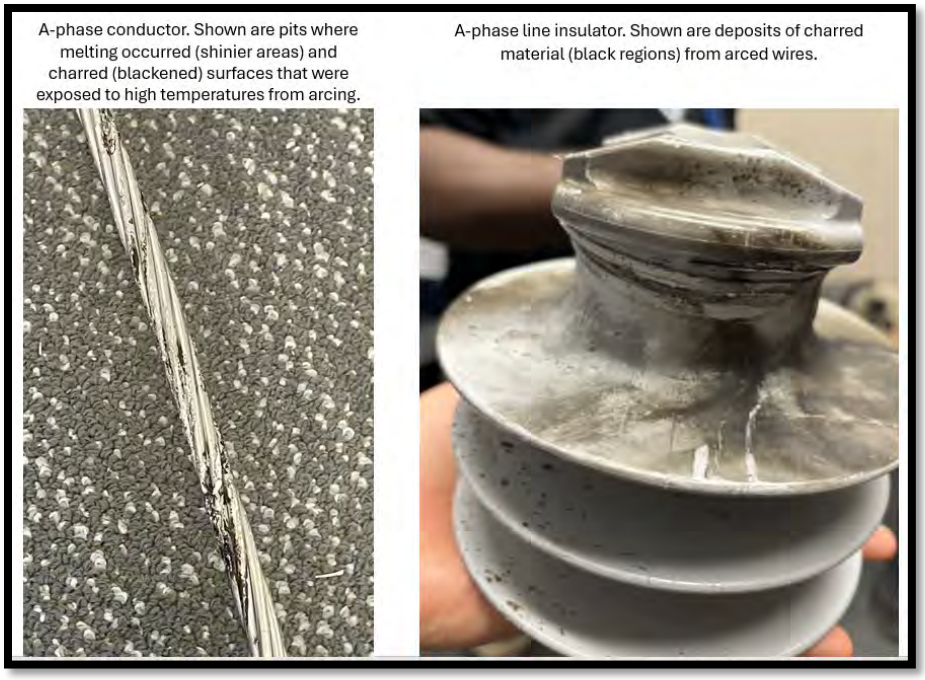
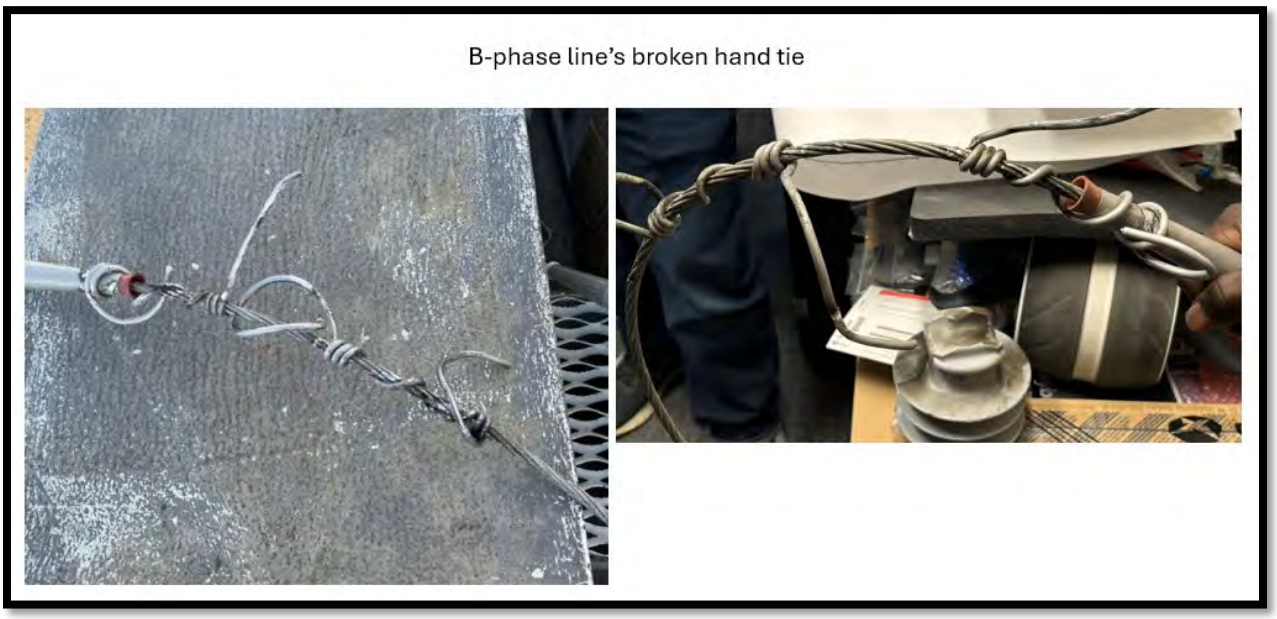


Figure 14. B-phase Line's Failed Hand Tie



Why/Because Analysis:

The why/because analysis was used to supplement the barrier analysis to identify root cause(s). Each apparent cause from the barrier analysis was analyzed further asking why the apparent causes exists. Some why/because analyses led to a root cause, depicted below in bold font, and some did not, when an additional why question led to a stopping point.

Why did the hand tie holding the B-phase line to the insulator fail?

It is unknown for sure why the hand tie failed. It is suspected that the high wind speeds on the day of the fire contributed to the hand tie failing. The average wind speed on June 1, 2024, from 2:00 p.m. to 3:00 p.m., measured at 10, 23, and 52 meters above ground was 32.7 mph, with a wind gust average of 43.1 mph. There was no evidence of an arc related failure, as was seen in an event that occurred in 2023 where the hand tie melted. It is unknown if the portion of the hand tie that was secured to the insulator was or was not installed correctly, since it is unaccounted for. Based on what is left of the hand tie, the remaining portion appears to have the appropriate number of buttons on either side of the insulator (Figure 14), indicating proper installation.

Why was the F-neck design not installed on the B-phase line of pole 8009?

The F-neck design to hold the conductor to the insulator was not installed on pole 8009 because the hand tie was not replaced with the F-neck. The F-neck is not the only option allowed by GO95; the hand tie installed on the B-phase line atop pole 8009 complies with GO95 and is an acceptable method of securing the conductor to the insulator. Electric utilities throughout California use the hand tie installation method among others.

- **Why was the hand tie on pole 8009 not replaced with the F-neck?** It is unknown why the B-phase line's hand tie was not replaced with the F-neck design during maintenance that occurred on pole 8009 in October 2023.
    - It could be that maintenance activities did not find any issues requiring replacement of the hand tie. Replacing hand ties on all distribution poles has not been a priority since LLNL has not seen this failure mode before.
        - **Why wasn't installation of the F-neck prioritized?** Because there was no indication a prioritized replacement was needed – **this is the first failure mode of this kind, a hand tie failing in high winds, allowing conductors to make contact. [ROOT]**
    - It is also possible that the splice installed on the B-phase line was too close to the insulator to allow for the F-neck installation at the time of maintenance in October 2023 (See Figures 10-12 for location of the splice). Note that during this analysis it was identified that another utility company that LLNL follows requires in their specification document a minimum of two feet from a splice to a distribution pole's conductor support. Pole 8009's B-phase line did not meet the minimum of two feet; the hand tie was wrapped around the splice seen in Figures 12-14. This is considered an issue that was identified as part of this analysis.
        - **Why was the splice installed so close to the insulator?** It is unknown why the splice was installed so close to the insulator. It is believed that the location of

the splice had nothing to do with the failure of the hand tie since the remaining portion of the hand tie from the insulator to the splice appears to be appropriately installed and is still in place.

Why was the vise clamp method not installed on the B-phase line of pole 8009?

The vise clamp design to hold the conductor to the insulator was not installed on pole 8009 because the hand tie was not replaced with the vise clamp. The vise clamp design is not the only option allowed by GO95; the hand tie is an acceptable method for connecting conductors to the insulators. Electric utilities throughout California use the hand tie installation method among others.

- **Why was the hand tie on pole 8009 not replaced with the vise clamp?** Because feeder 8 was not identified for full replacement using the vise clamps.
    - **Why was feeder 8 not identified for full replacement using the vise clamps?** Because no insulators on feeder 8 were identified as needing replacement. Installation of vise clamps requires the full replacement of the insulator whereas the F-neck is a direct replacement of the hand tie and does not require replacing the insulator. In 2018-2019, vise clamps were installed on Feeder 4 poles 4011-13, 4017, 4019-21, 4024, 4029, 4065, 4106, 4107, 4110 because their insulators needed replacing and EUD wanted to evaluate performance of the vise clamp in the wind. Installation of the vise clamps on some of feeder 4's distribution poles was not prioritized and was considered a trial to see how they performed.
        - **Why wasn't installation of the vise clamps prioritized?** Because there was no indication a prioritized replacement was needed – **this is the first failure mode of this kind, a hand tie failing in high winds, allowing conductors to make contact. [ROOT]**

Why are additional controls to protect electric utilities against high winds not implemented at S300 (additional controls include, but are not limited to, turning reclosers off during extreme wind, relocating feeder 8 including underground, insulating feeder 8 conductors, and/or implementing PSPS at S300)?

Because none of the other controls noted in the barrier analysis, besides installation of the F-neck and vise clamps, are incorporated into EUD's current processes.

- **Why are additional controls described above not incorporated in EUD's current processes?**
    - Because none of the controls mentioned in the barrier analysis are required by standards that LLNL follows, GO95 and NESC.
    - Because **the failure mode seen in this event, a hand tie failing in high winds, allowing conductors to make contact, has only been recorded as occurring in this event (records go back to 2008). Because of that and the additional resources/equipment required to implement controls to protect against high winds, such controls to prevent this failure mode are not incorporated in EUD processes and therefore, are not implemented. Potential controls to protect against high winds include, but are not limited to, installation of F-necks or Vise clamps, turning off reclosers, installing**

insulated lines, relocating feeder 8 off the ridge and or underground, implementing PSPS. [ROOT]

Further discussion on the root cause

There is limited public information published by regulators on failure modes. The DOE has ORPS reports for safety incidents shared with all entities. Electric utilities do not have this requirement or transparency for fault or failure modes and keep their data internal. Therefore, research into common failure modes or how to address certain types of failure modes is performed on an individual company or utility basis. Full utility failure mode transparency would greatly benefit the industry and public as a whole.

Recall that there are a number of unknowns in this analysis: when the hand tie was installed, if the material installed was procured correctly, if the hand tie was properly tied to the insulator without any overlap, who installed the hand tie and if they were properly trained, why the splice was installed so close to the insulator on the B-phase line of pole 8009, and if independent verification of the hand tie installation would have made any difference in the hand tie failing. EUD has implemented controls to protect against common failure modes seen at S300 that are considered temporary because power can be restored quickly after the failure occurs. These temporary failure modes include bird strikes, bird nests, mylar balloon contacts, tree branches falling, and other animals interfering the electric utilities. Because these are temporary failure modes, the three second wait time before power is restored, provided since reclosers are currently on, is suitable. Each potential control would require more resources, which are discussed below.

- **Turning off reclosers:** Turning off reclosers would result in more frequent call outs, lengthen power outages and disrupt operations and during off hours would require on call personnel to re-energize, which would require a switching order (requires review) and second person to perform re-energization. It would also affect the reliability numbers calculated and required by contract 44 which requires LLNL to have unscheduled outages less than 95 minutes/customer/month calculated over one year.
- **PSPS:** There are a number of reasons why LLNL does not implement the PSPS: (1) it is not required by GO95 nor NESC; (2) because of the effect on programmatic down time it would cause, if the power is shut off during high wind events; (3) because of the extra manpower and resources that would be needed for the process if de-energizing/re-energizing, bringing facilities back online, use of a generator and staff to refuel, etc.
- **Re-positioning feeder 8 off ridge or underground:** Repositioning feeder 8 would require an increase in cost, environmental support, and manpower. Note that feeder 8 has always been on the ridgeline for decades, since at least 1958, and there are no historical incidents of this kind of failure. The rough terrain would also make it difficult to get power to specific locations. Underground distribution could be installed from north U865 to U846 to main site buildings near Corral Hollow Rd with overhead offshoots to key locations. This would require a study to determine the ideal path based on current and future needs, as well as current underground mechanical utilities.

- **Installing insulated lines:** Installing insulated lines would require an increase in cost and weight, poles would have to be oversized, insulators would have to be oversized and a special type to hold insulated cables, and the distance between poles would have to be significantly shortened possibly up to 1-2 additional poles between current spans. This would double or more the number of poles in locations of insulated cables.

Extent of Condition

The identified condition to measure the extent is the use of hand ties as the mechanism to anchor the conductor to the insulator at sites 200 and 300.

Prior to 2014, LLNL's EUD HV Linemen have been working to replace hand ties with F-neck fastenings on all 478 12K distribution poles at S300. As of July 26, 2024, there were eight poles with hand ties left to replace and no hand ties left to replace at S200. Based on available records since 2008, this is the first time EUD has seen a hand tie fail in high winds, as it did in this event. There was a storm in 2023 where two separate lines flashed over, one line failed and dropped to the ground and the other flashed over the insulator resulting in a failed hand tie dropping the line off the insulator; however, it is surmised that the flashover caused the hand tie to melt and fail.

Review of Past Events

Two past events at S300 were discussed as part of this analysis to determine if any commonalities existed, a fire that occurred in 2009 and a storm in 2023 that resulted in a hand tie melting and failing.

On June 19, 2009, there was a 12kV overhead distribution line outage and coincident wildland fire. Circuit breaker 12001 at the Main Substation Switchgear opened, reclosed, and then locked out when the outage persisted. HV personnel saw that the western most phase's porcelain insulator with the aluminum conductors still tied to it had separated from its steel pin on pole 1007. The increased sag plus high wind speeds of 36.7 mph, gusting up to 45.6 mph, caused the B- and C-phase lines to come in contact with each other, resulting in a phase-to-phase fault, sparking, and igniting a fire. The root cause of the outage was that the steel pin's lead threads were damaged making the insulator and conductor assembly loose. The cause of the thread damage was the uplift due to the tensioning of the conductor on an uphill slope, expansion and contraction due to cold weather, and vibrations caused by winds.

In 2023 there was a storm where two separate lines flashed over or created a high voltage electric discharge around an insulator. Flashover means sparking across a gap, high current flow creating bright arc and heat between conductor and ground going over/around/past the insulator. One line failed and dropped to the ground and the other line flashed over the insulator, resulting in a melted hand tie that failed and allowed the line to drop off the insulator. Basically, the arc, high current going from the conductor to ground caused high heat which melted the hand tie holding the conductor in place allowing the line to fall off the insulator and hang free below the attachment point (insulator) and cross arm.

In reviewing these two events, the reasons for the disconnected conductors are different than the event analyzed in this analysis that occurred in June 2024 where the hand tie failed in high winds, no longer holding the conductor to the insulator. In 2009, the ceramic insulator separated from its pin; LLNL no

longer installs ceramic insulators and has only two poles remaining with ceramic insulators to be replaced in 2024. In 2023, the hand tie melted due to a flashover, which is not thought to have occurred in the June 2024 event.

Summary

A fire initiated at S300 on June 1, 2024, that disrupted operations. The aluminum hand tie holding the B-phase line to the insulator failed on pole 8009, the hand tie was no longer holding the conductor to the insulator. This failure allowed the A- and B-phase lines to come in contact with one another, potentially sparking and igniting the fire. This is the direct cause. The barrier analysis identified the following apparent causes:

- Other fastening methods, the F-neck and vise clamp designs were not installed on the B-phase line of pole 8009.
- Additional controls to protect electrical utilities against high winds have not been implemented. Additional controls include, turning reclosers off during extreme wind, relocating feeder, moving feeder 8 electrical utilities underground, insulating feeder 8 conductors, and/or implementing PSPS at S300.

The failure mode seen in this event, a hand tie failing in high winds, allowing conductors to make contact, has only been recorded as occurring in this event (records go back to 2008). Because of that and the additional resources/equipment required to implement controls to protect against high winds, such controls to prevent this failure mode are not incorporated in EUD processes and therefore, are not implemented. Potential controls to protect against high winds include, but are not limited to, installation of F-necks or Vise clamps, turning off reclosers, installing insulated lines, relocating feeder 8 off the ridge and or underground, and implementing PSPS.

Table 2 summarizes the causes, issues, and associated recommendations.

Table 2 Recommended Actions for Cause and Issues

Causes and Issues	Recommended Action
[Direct Cause] The hand tie holding the B-phase line to the insulator failed on pole 8009, the tie was no longer holding the conductor to the insulator.	• [Completed] Electric Utility Division Leader held internal lessons learned meetings immediately following the event; one on June 4th at S200 and June 6th at S300. The group discussed: the response to the power outage including what went well and two minor improvements; discuss this rare occurrence of this failure and similar failures; different types of connections to the insulators; connectors used for high wind areas and whether any failures have been seen with the F-neck and vise clamp connections; turning off reclosers. • [Completed] Poles close to pole 8009 were reviewed to determine if any of them still had a hand tie installed and if so, if any concerns or wear was present. Pole 8029 was the only pole identified close to pole 8009 with a hand tie. Pole 8029 is 20 poles from pole 8009 and not in the high wind zone; the hand tie was examined with no issues found and was replaced with an F-neck fastening. No other poles close to pole 8009 were identified with a hand tie installed. • Replace all hand ties with F-necks at S300. Note there are eight poles with hand ties left to replace on distribution poles at S300 as of July 26, 2024. This effort, to replace hand ties with F-necks started prior to 2014. • [Completed 8-12-24] All S200 distribution poles were reviewed to determine if any hand ties remained. The review found no hand ties remaining at S200; all S200 distribution poles use F-necks.
[Apparent Cause] Other fastening methods, the F-neck and vise clamp designs are not installed on the B-phase line of pole 8009.	• [Completed] The B-phase line hand tie on pole 8009 was replaced with the F-neck design on June 1, 2024.
[Root Cause] The failure mode seen in this event, a hand tie failing in high winds, allowing conductors to make contact, has only been recorded as occurring in this event (records go back to 2008). Because of that and the additional resources/equipment required to implement controls to protect against high winds, such controls to prevent this failure mode are not incorporated in	• EUD to present additional potential controls to protect against high winds for S300 ridgeline distribution poles to Operations and Business (O&B) Management and determine a path forward. Not related to this event and not discussed in this analysis, an additional potential wind control is implementation of high impedance fault detection. Include this control in the discussions.

Causes and Issues	Recommended Action
EUD processes and therefore, are not implemented. Potential controls to protect against high winds include, but are not limited to, installation of F-necks or Vise clamps, turning off reclosers, installing insulated lines, relocating feeder 8 off the ridge and or underground, and implementing PSPS.	• O&B and other LLNL Management to determine a path forward based on the EUD presentation of additional controls to protect against high winds for S300 ridgeline distribution poles. The determined path forward will be added as an action in the LLNL Issues Tracking System (ITS).
[Issue] It is unknown when the hand tie was installed, by whom and if they were properly trained to wrap the hand tie around the conductor and insulator.	• Add note to installation and hardware section of the OJT that addresses, (1) appropriate fastenings used to connect conductors to insulators and (2) installation of splices at least one-foot or more away from insulators as to not hinder installation of F-neck. • [Completed 8-12-24] All S200 distribution poles were reviewed to determine if any hand ties remained. The review found no hand ties remaining at S200; all S200 distribution poles use F-necks. • Replace all hand ties with F-necks at S300. Note there are eight poles with hand ties left to replace on distribution poles at S300 as of July 26, 2024. This effort, to replace hand ties with F-necks started prior to 2014.
[Issue] It is unknown why the splice on pole 8009's B-phase line was installed so close to the insulator with the hand tie wrapped around the splice. Local utilities standards that LLNL follows, require splices to be installed at a minimum distance of two feet from splice to the pole's conductor support.	• Add note to installation and hardware section of the OJT that addresses, (1) appropriate fastenings used to connect conductors to insulators and (2) installation of splices at least two feet or more away from insulators as to not hinder installation of F-neck. • Inspect and confirm all splices on S200 and S300 distribution poles are a minimum of two feet away from insulators.
[Issue] Detailed distribution line inspection and maintenance records are not kept/recorded for specific issues identified in the field and corrections made.	• [Completed] Implemented use of EUD FileMaker Pro App to improve maintenance records, capturing before and after photos with equipment names/dates for each pole as feeder maintenance is performed. • Document maintenance and inspection processes using the appropriate mechanism, e.g., work order etc.

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12. **Exo Group pole follow-up list.** (2023). May 1, 2023 – May 15, 2023.
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23. **LLNL Facility Screening Report (SCR) for S300 Electrical Substations.** (2023). June 2023.

24. **LLNL High Voltage Electrician Competent Worker Mentor Guide.** (2023). April 2023; Version 2.0.0.
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Attachment 1 – June 1-3, 2024, Timeline and Maps for LLNL Corral Fire Response

Lawrence Livermore National Laboratory

June 1-3, 2024, Timeline and Maps for LLNL Corral Fire Response

June 2024

Planning & Preparedness Division
Emergency Management Department

Controlled by: (b) (6)
Planning & Preparedness Division
Leader, LLNL

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RESPONSE TIMELINE

Members of the Emergency Response Organization and the Emergency Management Department completed a preliminary review of documents generated during the response to the Corral Fire. The timeline was restricted to those actions involving Site 300. The timeline does not cover the response to the entire incident.

Saturday June 1, 2024

14:15 Site 300 Maintenance Mechanic (MM) on duty was in building 875 when power suddenly dipped and restored 3 times over the course of a minute.

14:19 MM called High Voltage (HV) on-call technician who was working at Site 200 but indicated he would respond as soon as possible.

14:23 Sergeant (Sgt.) on Duty attempted to call MM and reached MM via radio to report a fire along Route 3.

14:28 HV On-call technician confirmed he was about to leave for Site 300 via phone.

14:29 Alameda County Fire Department (ACFD) crew resident to Site 300 responded to fire and notified Alameda County Regional Emergency Communication Center (ACRECC) of vegetation fire. ACRECC dispatches a large number of units.

14:31 First Protective Force Division (PFD) officer arrived on-scene.

14:32 ACRECC notified CalFire.

14:34 MM contacted HV Supervisor and MM Supervisor for briefing.

14:34 Site 300 Manager received initial notification of fire from Site 300 on duty Protective Force Division Sgt.

14:37 Engine 320 reported to ACRECC that live power lines were down.

14:39 ACFD responded to the vegetation fire located off Route 1. The fire was located near a High Voltage Ridge Line Pole (8009) between Building 846 substation and Building 834.

14:41 MM contacted Site 200 MM to request Heavy Equipment on-call operator to assist generator.

14:41 Incident Command Post (ICP) reported that the fire was 4 acres.

14:41 Site 300 Manager attempted to contact Laboratory Emergency Duty Officer (LEDO).

14:43 Site 300 Manager called Strategic Deterrence Associate Deputy Director for Operations.

14:47 Tracy Fire reported to S300.

14:47 ICP reported a 30-acre fire.

14:48 MM contacted Heavy Equipment supervisor for additional support with generators.

14:48 Site 300 Manager called LFO representative.

14:51 PFD reported traffic control established.

14:56 LLNL Agency Representative in route.

15:04 ICP established on Route 1.

15:08 HV EUD Lineman checked in with MMs, EUD lineman performed site line patrol looking for SCADA indicated feeder 8 issue, following overhead fault detectors, issue was located at p8009.

15:13 Livermore-Pleasanton Fire Department (LPFD) Battalion Chief arrived at ICP.

15:18 EMDO contacted LEDO about the wildfire, and they evaluated the situation.

15:19 ICP moved to B836.

15:23 MM contacted Site 300 Deployed Team Manager.

15:30 EMDO notified the EMD/Response & Support Division Leader (RSDL).

15:32 MM provided photos to S300 Manager.

15:32 O&B PAD received call from IMUD Department Head notifying of fire. IMUD resources on site and more called in. IMUD DH headed to the site.

15:38 O&B PAD call to LEDO to inform of fire.

15:38 EMDO informed the RSDL via text that Cal Fire fixed wing aircraft were over the fire.

15:40 O&B PAD call to PFD to inform of fire.

15:41 RSDL called the LFO EM POC to inform them of the fire and discuss a courtesy notification to the DOE HQ Watch Office

15:47 LEDO texted S300 Manager about hazards at the B834 Complex.

15:53 "Watch Duty" app indicating fire was at 450 acres and had jumped a control line.

15:56 EUD Leader in contact with EUD Lineman

16:00 Heavy Equipment operator arrived at S300.

16:00 Fire damaged transfer piping resulting in release of 6,000 gallons of untreated groundwater.

16:03 Site 300 Manager called Engineering Test Facility Manager (FM).

16:04 Site 300 Manager called Engineering Test Facility Point of Contact (FPOC).

16:15 Infrastructure Maintenance Utilities Department Head arrived at S300.

16:16 Principal Deputy Director (PDD) asked on the "Fire Notification" text LEDO for "trigger" for EOC activation. LEDO stated if a LLNL facility became involved the EOC would be activated.

16:17 HV staff identified the problem and began preparing the switching order procedure.

16:33 LEDO sent a text on "Fire Notification" that the fire had crossed Corral Hollow and was on a southeast trajectory.

16:35 Fire reported to jump over West Corral Hollow Road.

16:40 Site 300 Manager called LEDO.

16:41 LLNL Principal Deputy Director and O&B PAD called the RSDL to discuss EOC activation triggers. They directed the RSDL to activate the EOC in at least a monitoring level.

16:46 RSDL called the LEDO to inform them of the decision to activate the EOC.

16:46 Damaged poles from fire reported at B843.

16:49 Site 300 Manager called NNSA LFO representative to update.

17:00 EMDO issued AtHoc notification to the Emergency Response Organization (ERO) to activate LLNL Emergency Operations Center (EOC).

17:14 Fire on roof of B830 reported.

17:21 Public Information Officer (PIO) called LEDO to provide an update.

17:23 ICP requested 2 helicopters and 4 ambulances.

17:25 ICP moved to Station 21.

17:31 2 firefighters reported injured offsite.

17:32 HV technicians called MM to indicate they were ready to make the corrective maintenance repair on power pole 8009. This repair involved reconnecting the B-phase to the insulator.

17:36 East Bay Incident Management Team requested to respond to Station 21.

17:48 Pacific Gas and Electric (PG&E) reported on-scene.

17:49 LLNL EOC declared staffed and operational at Level 3 by LEDO, now Emergency Director (ED). Positions filled included ED, Liaison Officer, Livermore Field Office (LFO), Operations Chief (Ops Chief), Operations Chief Aide (Ops Chief Aide), Emergency Management Coordinator (EMC), EOC Coordinator, Planning and Intelligence Chief (P&I Chief), Information Lead (Info Lead), Information Specialist (Info Specialist), Public Information Officer (PIO), Administration, Logistics, and Finance Chief (ALF Chief), and Significant Events Specialist. Security Lead and ES&H, including Consequence Assessment (CQT) staff were added to the required staffing later.

18:05 Site 300 Manager called the LLNL Environmental Restoration Department Head (ERD DH).

18:15 Site 300 Manager called second ERD representative.

18:32 ERD DH provided preliminary remediation system damage information to LFO CERCLA Remedial Project Manager (RPM) via text.

18:36 California Highway Patrol on-scene at Site 300.

18:55 ED authorized HV Supervisor to restore power at his discretion.

20:39 HV corrective maintenance repair was completed, and power was restored. HV staff then performed line patrols throughout the area.

21:32 PIO issued communication to all LLNL employees on incident status.

21:35 Reduced EOC staffing to ED, Ops Chief, Ops Chief Aide, EMC, EOC Coordinator, Info Lead, Info Specialist, and remote PIO.

22:00 EOC staff attained permission to allow remaining LLNL responders to leave S300.

23:30 EOC conducted shift change of Ops Chief and LEDO.

Sunday, June 2, 2024

02:11 Fire reported on northeast of B834.

02:13 Additional fire units arrived at Station 21.

02:59 PFD escorts fire units to fire near B834.

03:00 EOC produced Action Plan.

05:30 EOC conducted shift change and adjusted staffing to ED, Liaison Officer, LFO, Ops Chief, EMC, and remote PIO.

06:00 EOC conducted situation briefing to management.

08:09 EOC issued employee communication via AtHoc.

09:00 EOC conducted situation briefing to management.

10:05 LFO CERCLA RPM sent notification email to CERCLA regulators (USEPA, CA DTSC, CA RWQCB-CV).

12:54 LivIT staff completed a map identifying employee homes forced to evacuate.

13:21 EOC staff contacted two of the three employees forced to evacuate their homes.

15:00 EOC conducted situation briefing to management.

15:30 LLNL Management authorized drone usage to look for hotspots.

17:00 Shifted EOC to Level 3 unstaffed.

Monday June 3, 2024

06:00 EOC conducted shift change. Positions included ED, remote Liaison Officer, LFO, Ops Chief, Ops Chief Aide, EMC, EOC Coordinator, Info Lead, remote PIO, ALF Chief, and Significant Events Specialist.

07:30 EOC conducted situation briefing to management.

07:30 EOC identified potential Recovery Manager and Coordinator.

08:00 ED and on-coming LEDO/ED transferred responsibilities.

08:27 EOC finished contacting all employees impacted by Corral Fire evacuation order.

09:48 Newsline articles to workforce released (resources available and S300 information).

08:09 EOC verified status of all unconfirmed-status employees from AtHoc communication.

08:50 EOC verified deconfliction of LLNL drone team with CalFire air operations.

09:00 LLNL drone surveys commenced.

08:27 EOC finished contacting all employees affected by Corral Fire evacuation order.

10:45 Hotspots identified at S300 by drone surveys; fire department investigating.

11:30 Smoldering items extinguished by fire department after drone identification; no hazardous materials involved.

12:45 Recovery Manager assigned.

15:25 EOC developed Recovery Plan Outline.

15:35 Recovery Coordinator assigned.

15:45 EOC completed Termination Checklist.

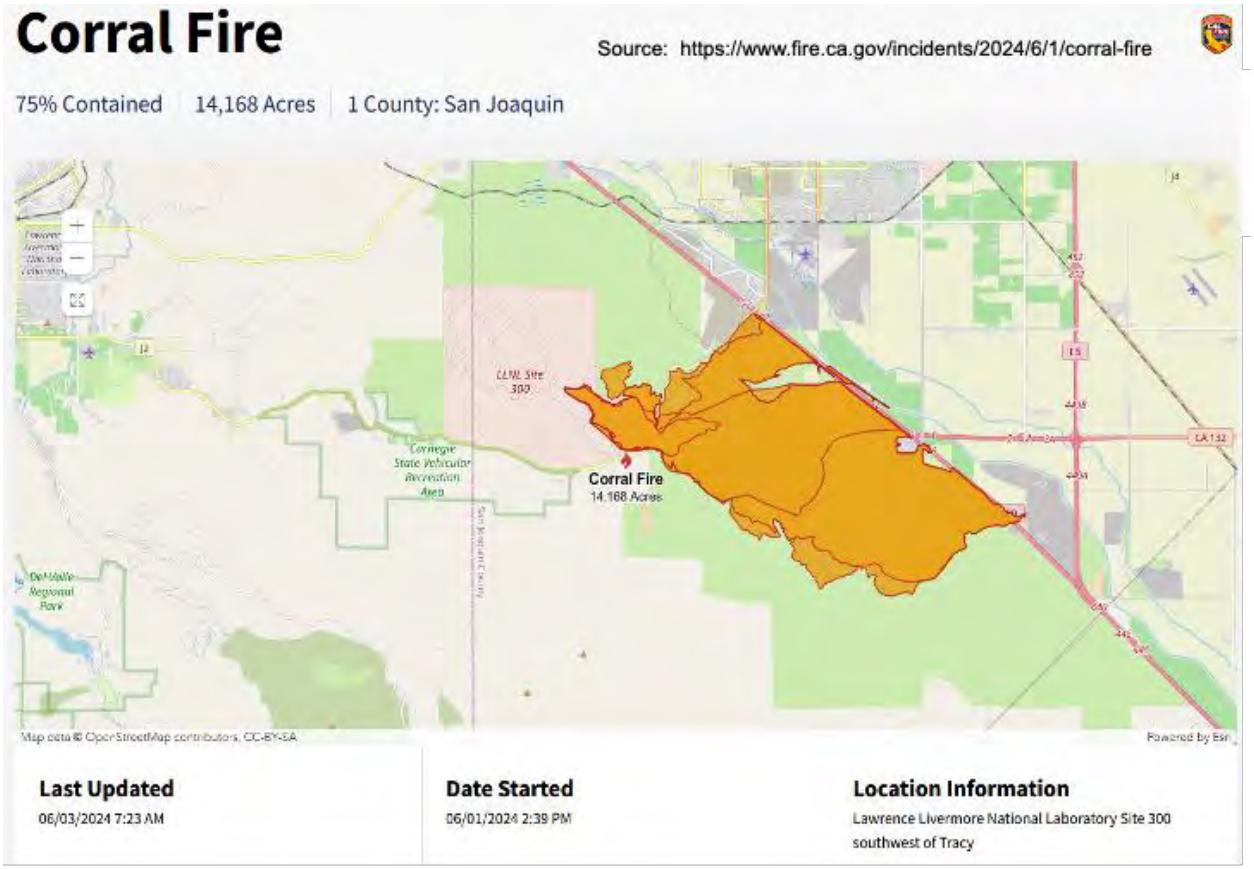
15:50 LLNL Policy Group concurrence with EOC termination and transition to Recovery.

16:00 LLNL EOC terminated and transitioned to Recovery.

16:26 EOC conducted Offsite Notification and deactivated.

17:15 LLNL EOC reset and ready for operations.

CalFire Internet Map of the Pear Fire Area



Map Showing Impacted Area of Site 300

Detailed Map Showing Impacted Area of Site 300