Company:	San Diego Gas & Electric Company (U 902 M)
Proceeding:	2024 General Rate Case – Track 3
Application No.:	A.22-05-016
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ERRATA SUPPLEMENTAL TESTIMONY OF

JENNIFER KAMINSKY

ON BEHALF OF SAN DIEGO GAS & ELECTRIC COMPANY

(TRACK 3 – ASSET MANAGEMENT AND INSPECTIONS)

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

SDGE™

April 2026

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I. INTRODUCTION AND QUALIFICATIONS

Q. Ms. Kaminsky, please state your name and explain your involvement in SDG&E's Track 3 cost recovery proceeding.

A. My name is Jennifer Kaminsky. I am the Senior Manager of Electric Assets and Compliance at San Diego Gas & Electric Company (SDG&E). In that role, I oversee SDG&E's asset management and inspection programs for distribution electric facilities, joint use management, California Public Utilities Commission (Commission or CPUC) incident reporting and investigations, and select electric distribution inspection execution. From 2019-2022, I was the Project Manager of the Drone Investigation Assessment and Repair (DIAR) program. I continue to oversee the management of SDG&E's DIAR program and the Risk-Informed Drone Inspection (RIDI) program that began in 2023 as further discussed below. I have prepared narrative related to electric infrastructure drone inspections and asset management and inspection program for SDG&E Wildfire Mitigation Plans (WMP) since 2019, and I supported the Wildfire Mitigation department in WMP compliance and implementation.

Q. Ms. Kaminsky, please summarize your professional experience.

A. I have a Juris Doctorate with a focus in Environmental & Energy Law from Chicago-Kent College of Law, a Bachelor of Science in Environmental Policy and Behavior from the University of Michigan and am a Licensed Attorney. I have close to two decades of experience in the energy sector, overseeing complex electric utility programs, large capital construction projects, and multi-agency regulatory processes. Prior to starting work at SDG&E, I worked for an engineering and consulting firm from 2007-2016 and built a strong foundation in environmental compliance and permitting for complex energy, transmission, and industrial projects and programs. I joined SDG&E in 2016 as a Principal Land Planner / Environmental Project Manager where I managed environmental compliance for major capital projects, coordinating across engineering, construction, regulatory agencies, and municipal partners. In 2018, I became a Project Manager for SDG&E where I led high-profile and complex transmission and substation projects and in 2019, started the DIAR program. In 2021, I took on the role of Senior Manager of Electric Assets and Compliance, which expanded my management of electric infrastructure drone inspections into overseeing the implementation of SDG&E's electric distribution corrective maintenance program. In addition, my department manages the joint use of our electric assets by third party attachers (including, but not limited to, communications providers) and provides support in CPUC electric safety incident investigations, complaints and audits. I am recognized as a trusted subject-matter expert in CPUC investigations and "Person Most Knowledgeable" in legal matters related to our distribution asset inspections and maintenance programs, with strong capability to bridge technical, operational, legal, and regulatory domains.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide clarification and additional details for SDG&E's Asset Management and Inspections (AM&I) budget categories from 2019 through 2022, as described in Track 2 of SDG&E's General Rate Case, A.22-05-016 ("Track 2"), as well as provide similar details for costs incurred to implement SDG&E's 2023 Wildfire Mitigation Plan, as requested in Track 3 of SDG&E's General Rate Case (GRC) ("Track 3"). The Commission's Final Decision (D.) 26-01-021, addressing SDG&E's Track 2 request, approved the majority of costs associated with seven initiatives under the AM&I budget category, but reserved the question of the reasonableness of SDG&E's costs associated with the DIAR program subject to additional testimony, and required SDG&E to:

- Submit specific and detailed supplemental testimony addressing both the inspection and repair costs associated with the DIAR program.
- Serve supplemental testimony providing a breakdown of all AM&I costs except circuit ownership on any annual basis for the 2019-2022 period in the following categories: (1) repair costs, (2) inspection costs, (3) capital expenditures, and (4) operations and maintenance (O&M) expenses.[1]
- Provide supplemental testimony providing a breakdown of all AM&I costs for 2023 in the following categories: (1) repair costs, (2) inspection costs, (3) capital expenditures, and (4) O&M expenses.[2]

In accordance with the Commission's requirements, my testimony and the supporting workpapers found in SDG&E-T3-WMPMA-07-E provide a detailed cost breakdown of SDG&E's drone inspection and repair programs in effect from 2019-2022 (DIAR) and 2023 (RIDI), including asset inspections, repairs, and technology to support ongoing cost efficiencies such as Intelligent Image Processing (IIP) and machine learning. Additionally, my testimony and workpapers provide the required information and cost breakdown for six additional AM&I initiatives:

- Detailed Inspections of Distribution Equipment
- Detailed Inspections of Transmission Equipment (Distribution Underbuild)
- Infrared Inspections of Distribution Infrastructure
- Intrusive Pole Inspections

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[1] D.26-01-021 at 110.

[2] *Id.* at 111 ("In future applications for recovery of asset management and inspection costs and GRCs, SDG&E shall provide additional evidence regarding how inspection programs are coordinated to avoid or account for overlapping activity and associated O&M and capital costs. SDG&E shall also detail the staffing employed, their cost, and the justification for the additional cost in coordination with other inspection programs, including their risk benefit cost ratios.").

- HFTD Tier 3 Inspections
- Patrol Inspections of Distribution Equipment
- Drone Assessments of Distribution Infrastructure (DIAR) for 2019-2022, and Risk Informed Drone Investigations for 2023 (RIDI)

For each of these programs, I provide a cost breakdown between the inspections performed for each of these initiatives and the combined costs associated with repairs resulting from inspections from 2019-2023. I also provide additional information regarding the justification and scope of these inspection programs and repairs performed on SDG&E's overhead electric distribution facilities in the High Fire Threat District (HFTD) and higher risk Wildland Urban Interface (WUI) areas. In addition, I provide a breakdown and explanation of work performed related to technology and artificial intelligence/machine learning model development to support SDG&E's inspection and repair programs, and a breakdown of the costs in this area.

My testimony establishes that SDG&E's drone inspection and repair programs were an invaluable component of SDG&E's wildfire mitigation strategy from 2019-2023, and all costs associated with these programs, including the associated repairs, are just and reasonable for recovery.

II. SDG&E'S ASSET MANAGEMENT AND REPAIR PROGRAMS

Q. Generally, can you please describe the intent and governance of SDG&E's Asset Management and Inspection (AM&I) Programs?

A. SDG&E's AM&I Programs are governed by the corporate Asset Management Policy, which establishes the guiding principles for how SDG&E manages its assets across people, processes, and technology. The policy explicitly aligns asset management activities with corporate strategy, regulatory compliance, safety, service quality, and risk-informed decision-making. Specifically, the purpose of the policy is to:

- Maintain compliance with regulatory directives and internal standards;
- Reinforce SDG&E's commitment to safety and service quality;
- Enable risk-informed operating decisions and investment allocations; and
- Optimize asset safety, performance, risk, and cost over the asset lifecycle.

Inspection programs function as an integral input to SDG&E's broader asset management system rather than as stand-alone activities. My team operates within a structured governance model with core responsibilities including, but not limited to the following:

- Oversight of inspection execution;
- Regulatory reporting and audit support;
- Governance and oversight of corrective maintenance (*i.e.*, repairs) resulting from inspection findings; and
- Quality assurance and quality control (QA/QC) processes.

Further details regarding each of SDG&E's AM&I programs is provided in the sections below.

Q. How do SDG&E's AM&I programs operate in the context of SDG&E's Wildfire Mitigation Plan?

A. SDG&E's Asset Management Policy expressly requires SDG&E people, process and technology to incorporate regulatory directives as outlined in Senate Bill (SB) 901 and Assembly Bill (AB) 1054, and approved regulatory strategies, including inspection enhancements and expanded inspection programs to address wildfire risk and described in SDG&E's Wildfire Mitigation Plans. SDG&E's suite of inspection programs are used to support wildfire risk reduction by identifying asset conditions that could contribute to ignition risk, while remaining grounded in the broader asset management and compliance framework. The Asset Management Policy is periodically reviewed and updated to account for new requirements and programs.

SDG&E's AM&I programs operate inside the WMP as both: (1) the "baseline" compliance inspection and repair engine that follows traditional inspection requirements mandated by General Order (GO) 165; and (2) the platform SDG&E uses to add "enhanced/discretionary" assessments and new technologies focused on wildfire risk reduction—all organized around identifying conditions, prioritizing work based on risk, completing corrective actions, and meeting WMP reporting and compliance requirements, and continuous improvement.

SDG&E's AM&I programs are tracked and reported upon in SDG&E's WMPs, which list annual targets related to inspections in the HFTD and other high-risk areas such as the WUI. Upon the Office of Energy Infrastructure Safety's (Energy Safety) approval of its WMPs, SDG&E is required to comply with approved WMP targets pursuant to Public Utilities Code Section 8386.3 and safety certificate requirements pursuant to Public Utilities Code Section 8389. Consistent with the Commission's approval of SDG&E's 2019 WMP, as well as SDG&E's Wildfire Mitigation Plan Memorandum Accounts (WMPMA), authorized and actual costs related to SDG&E's AM&I programs are tracked in SDG&E's WMPMA.

Q. Are there specific SDG&E standards governing SDG&E's AM&I programs?

A. Yes. SDG&E's Electric Distribution Corrective Maintenance Program (CMP) Manual and associated Electric Safety Practices and Business Process documents (collectively referred to SDG&E's CMP), as well as SDG&E's approved WMPs outline SDG&E's internal requirements related to electric distribution inspections and repairs.

Q. What AM&I programs were included in SDG&E's CMP from 2019-2023?

A. SDG&E's CMP was updated in 2018 and 2023 and covers inspection and repair requirements for distribution electric facilities and streetlights in SDG&E's entire service territory. As the CMP applied to facilities covered by the WMP (generally defined as electrical infrastructure within the HFTD or other high risk areas of the service territory), from 2018-2023, SDG&E's CMP included inspection and repair requirements related to Detailed Overhead Inspections of Distribution Equipment, Patrol Inspections of Distribution Equipment, Intrusive Pole Inspections, and HFTD Tier 3 Inspections, as well as repairs resulting from these inspection programs. The CMP also includes repairs to electric distribution equipment resulting from transmission inspection findings (referred to as Transmission Inspections of Distribution Underbuild).

In 2023, SDG&E's CMP was updated to transition HFTD Tier 3 Inspections to Risk-Informed Drone Inspections, as discussed in more detail later in my testimony. All other inspection and repair requirements for the other inspection programs including Detailed Overhead Inspections of Distribution Equipment, Patrol Inspections of Distribution Equipment, Intrusive Pole Inspections, and repairs resulting from these inspection programs continued to be included in SDG&E CMP.

Q. Which AM&I programs are not included in SDG&E's CMP from 2019-2023?

A. Infrared Inspections of Distribution Equipment and Drone Inspections of Distribution Equipment performed through DIAR and RIDI were not included in SDG&E's CMP Manual and internal standards. These inspection programs were developed to address the growing threat of wildfire risk recognized by SB 901 and AB 1054, and supplemented SDG&E's existing inspection programs.

Q. Do SDG&E's AM&I programs Reduce Wildfire Risk?

A. Yes. SDG&E's AM&I Programs reduce wildfire risk by identifying and correcting hazardous asset conditions that could lead to ignition, and by doing so within a structured, risk-informed, and compliance-driven framework described in SDG&E's WMP.

Q. How do these programs reduce wildfire risk?

A. Inspections alone do not reduce risk; the risk reduction occurs when inspection findings initiate corrective repairs or are used to provide situational awareness and inform other mitigation decisions, such as Public Safety Power Shutoffs during extreme fire weather conditions. Accordingly, AM&I is one component of a layered wildfire mitigation strategy, operating alongside vegetation management, system hardening, situational awareness, and operational mitigations.

Historically, SDG&E has incorporated the cost of inspections as well as repairs into its GRC forecasts,[3] to reflect the overall risk reduction benefits of inspections and repairs as a comprehensive effort.[4] Thus, SDG&E's original presentation of authorized costs in Track 2 and Track 3 for any AM&I programs included the authorized costs of both inspections and repairs. The workpapers found in SDG&E-T3-WMPMA-07-E prepared in support of my testimony provide additional detail regarding the breakdown of costs within these programs.

Q. Please provide an overall breakdown of the inspection costs for each of SDG&E's AM&I programs from 2019-2023.

A. The total costs of inspections performed under each respective AM&I program are included in the table below in direct dollars ($000s). These costs are O&M expenses associated with performing inspections. Additional details regarding these costs are provided in my workpapers found in SDG&E-T3-WMPMA-07-E.

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[3] A.17-10-007, Exhibit SDG&E-15-2R, Second Revised Direct Testimony of William Speer on Behalf of SDG&E (Electric Distribution O&M) (May 7, 2018) at WHS-40 through WHS-48.

[4] Per D.26-01-011, SDG&E will present AM&I costs broken down by inspections and repairs in future GRC requests.

Table JK- 1:: 2019-2023 Total Inspection Costs Breakdown by Program (Direct $000s)

Inspection Type	2019	2020	2021	2022	2023	Total
Drone	$13,479	$17,452	$15,658	$13,242	$7,399	**$67,230**
Detailed	$0	$179	$362	$344	$374	**$1,259**
HFTD Tier 3	$568	$401	$352	$409	$0	**$1,730**
Intrusive	$1,256	$886	$806	$39	$108	**$3,095**
Infrared	$98	$175	$146	$159	$330	**$908**
Patrol	$0	$295	$287	$287	$331	**$1,200**
Total	**$15,401**	**$19,388**	**$17,611**	**$14,480**	**$8,542**	**$75,422**

Q. Please provide the unit cost per inspection for each program.

A. The average per pole inspection cost in direct dollars ($000s) for each inspection type is presented in the table below. Additional details regarding these costs are provided in my workpapers found in SDG&E-T3-WMPMA-07-E.

As seen within the table, as SDG&E's drone inspection programs matured, SDG&E was able to and continues to realize reduced inspection costs by finding efficiencies and implementing informed program adjustments to reduce costs while maintaining program intent and effectiveness. Changes made based on program learnings that contributed to these cost reductions are discussed throughout my testimony.

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Table JK- 2:: 2019-2023 Per Pole Inspection Costs Breakdown by Program

Inspection Type	2019	2020	2021	2022	2023	Average (Based on 2019-2023 totals)
Drone	$1,281	$652	$678	$510	$486	**$662**
Detailed	N/A	$10	$16	$19	$32	**$18**
HFTD Tier 3	$37	$34	$30	$33	$0	**$34**
Intrusive	$64	$61	$92	$41	$104	**$69**
Infrared	N/A	$13	$9	$13	$28	**$17**
Patrol	N/A	$3	$3	$3	$4	**$3**

Taking the total direct dollar inspection costs across all AM&I programs, including drones, and dividing by the total number of poles within the HFTD and higher risk WUI areas (~90,000 poles), the table below shows the dollars spent to perform inspections on a per pole basis for each of the subject years.

Table JK- 3: 2019-2023 Total SDG&E Inspection Spend Per HFTD/WUI Pole

	2019	2020	2021	2022	2023	Average 2019-2023
Cost/Pole	$171	$215	$196	$161	$95	**$167**

Q. What factors impact the costs of AM&I inspections?

A. Factors that drive the cost of inspections include, but are not limited to the following:

- Labor rates, including increases in labor costs over time,
- Vehicle and fuel costs associated with field inspections,
- Costs for equipment, tools and materials needed,
- Vendor costs for inspections performed by contractors, such as wood pole intrusive inspections and drone inspections,
- Support services for public safety, worker safety, and compliance. This support includes, but is not necessarily limited to:
    - Traffic control and flagging support in roadways or populated areas

- Helicopter support for limited inspections where ground access is not feasible
- Safety or security personnel to support field work when there are hazards, especially employee safety concerns related to hostile customers
- Environmental and land support, including biological, Tribal or cultural monitors, for inspections in sensitive areas
- Customer coordination resources to manage notifications, access, and impacts
- Permitting for both traffic control and where permits or authorization are required (*e.g.*, Department of Defense or United States Forest Service)

• In addition, support and coordination is needed for scheduling and dispatch of inspection crews, tracking inspection completion and compliance intervals, and reporting.

Many of these costs were subject to significant inflationary pressures due to the economic conditions present during the COVID-19 pandemic and a period of record inflation from 2020-2023.

Q. Please provide any additional details related to the inspection support and cost drivers that were unique for SDG&E's Drone Inspection Programs, DIAR and RIDI.

A. Besides the technology needs related to the performance of these inspections that I will discuss later in this testimony, because DIAR was a new program in 2019, SDG&E had to develop new technical qualifications, training, and process documents that required additional support from various groups at SDG&E. All of this work contributed to the costs to start up the DIAR program.

In July 2014, SDG&E became the first utility to receive a Special Airworthiness Certificate for small Unmanned Aircraft System (UAS), allowing the utility to research, test, and train flight crews on the UAS in a sparsely populated airspace in Eastern San Diego County.

Since that time, SDG&E's UAS program continues to mature and evolve. In 2019 prior to the start of DIAR, and to ensure external drone pilots had the requisite skills and certifications required, we developed and implemented a training and pilot vetting program. We also obtained required Federal Aviation Administration (FAA) authorizations and operational waivers to perform flights in controlled airspace and/or where operations would occur over people or moving vehicles. Drone operations also required continuous FAA coordination so that drone flights did not interfere with other airspace restrictions.

To ensure that pilot teams followed the required federal, state, local and SDG&E's Aviation Safety Operations Procedures requirements for drone operations, we deployed Field Safety Observers through an external vendor to perform daily crew checks. Field Safety Observers were licensed pilots under FAA Section 107 and familiar with SDG&E operations. During early program development from 2019-2020, the ratio of Field Safety Observers to drone crew was 1:3. The ratio was initially conservative due to the number of drone crews deployed (over 60 crews were operating across SDG&E's service territory in a diverse geographic area), limited communication in remote areas with difficult access and uncertainty regarding customer-interaction, and the pilots' limited experience working around distribution electric facilities. Prior drone programs at other utilities were limited to transmission inspections and benchmarking discussions with other utilities highlighted safety issues such as, drone caused line strikes and crashes. SDG&E was one of the first utilities to perform drone inspections around distribution electric equipment and there were few drone pilots available with the expertise to address the particular challenges associated with distribution infrastructure locations, which have a greater number of attachments than transmission, are typically closer to residential properties and are in areas with more vegetation density.

Starting in 2021-2022, the ratio of field support for drone inspections was reduced to 1:5 due to the maturity of the program, increased pilot experience and pairing of the drone pilot with a Qualified Electrical Worker (QEW) during field inspections. This change was a deliberate program design modification to drive cost reductions with no loss of safety and compliance benefits.

In addition, there were numerous requirements in place from 2019-2023 for drone inspections performed within federal, Tribal, state, or local agency jurisdictions. This coordination was mandatory, jurisdiction-specific, and often resource-intensive, directly affecting scheduling, labor needs, and program cost. Below is a summary of some of the requirements related to the various landowners within SDG&E's service territory.

- Department of Defense: Drone operations required the highest level of coordination and approval, including submission of a formal unmanned aircraft use application through local base commanders, regional base commanders, and the Department of the Navy in Washington, D.C.. Approval by the Navy Board was also required prior to flight authorization and daily coordination with base operations, range operations to clear restricted airspace and there was a mandatory military approved escort required to accompany drone crews during inspections. Finally, photos required review by the local base commander before they could be uploaded for inspection.
- Tribal Lands: Tribal lands require sovereign-to-sovereign respect and direct coordination with each Tribe, including advance notification (typically 10–17 days depending on Tribe) and submission of maps identifying SDG&E facilities, inspection schedules, public outreach materials for distribution to Tribal members, positive confirmation of approval before entering the Reservation, daily check-in with Tribal offices or Tribal Law Enforcement, mandatory Tribal monitors or escorts accompanying inspection crews and coordination of other SDG&E activities (inspection, vegetation, construction) to minimize repeat access.

- California State Parks: Drone inspections within California State Parks and state-managed lands required agency-specific permissions and operational controls. Coordination steps included: Obtaining a Drone Use Permit where required, providing facility location maps, flight schedules, Naming County or State Parks as additional insured, providing 72-hour advance notice to park rangers and coordinating on-site presence or agency monitors, when requested.
- California Department of Fish and Wildlife (CDFW) and U.S. Fish and Wildlife Service (USFWS): Drone inspections on land owned by these agencies required formal notification, facility mapping, demonstration flights, compliance with environmental and wildlife constraints, and agency-approved monitors when necessary.
- Federal Land Agencies (USFS and BLM): BLM granted access within SDG&E rights-of-way with no notification required, once standing permission was in place. U.S. Forest Service / Cleveland National Forest (USFS/CNF) require annual notification of flights, ongoing coordination through standing meetings, and compliance with eagle buffer zones and other environmental restrictions.
- Local jurisdictions: County Parks required drone use permits, proof of insurance listing the county as additionally insured, facility maps and inspection schedules, and 72-hour notice to park rangers. City Parks required 24-hour advance notice prior to inspections.

Finally, because drone inspections were new to the public and drone pilots experienced negative customer interactions early in the program that posed significant safety concerns to employees and the public, such as shooting down drones, SDG&E implemented multiple layers of proactive public engagement, security resources and customer notification. Security personnel were deployed in specific regions to quickly respond to customer escalations and safety events as well as accompany crews to known locations with security concerns. Postcard mailers were sent in advance of flights to customers in areas scheduled for inspections that explained the program, described what customers could expect during drone flights, provided links for additional information and included a Public Affairs Hotline phone number for questions or concerns. SDG&E also used its internal customer notification systems to issue pre-recorded voice calls to all customers potentially impacted by scheduled drone flights. Notifications were typically issued within the week prior to the scheduled flight. Customers identified as sensitive based on SDG&E's knowledge (*e.g.*, livestock owners, privacy concerns, prior complaints) received direct outreach through phone calls, emails and text messages.

Customer and community outreach regarding upcoming inspections was typically performed no more than one week and no less than 24 hours prior to the scheduled drone flight. Inspection teams also conducted in-person outreach through door-hangers or outreach materials left at residences. Fact sheets were made available in multiple languages and were also made available online at https://www.sdge.com/diar-fact-sheet. A dedicated Public Affairs Hotline was also maintained throughout the program with available video references online.[5] Additionally, notifications were not limited to the inspection phase. Additional outreach (postcards and direct contact) continued during design, construction and repair activities resulting from drone inspection findings.

Q. Please provide an overall breakdown of the repair costs associated with each of SDG&E's AM&I programs from 2019-2023.

A. Below is a breakdown of repair costs associated with SDG&E's AM&I programs, excluding repairs following and resulting from DIAR or RIDI drone inspections. This includes repair costs resulting from inspection findings from Detailed Inspections of Distribution Equipment, Detailed Inspections of Transmission Equipment requiring repairs of distribution

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[5] Informational videos are made available to the public at https://youtu.be/fzmI6iXIlE4 and https://youtu.be/_ep5oaRAO-o and https://youtu.be/9EQjUj68Vs8.

underbuild, HFTD Tier 3 Inspections, Infrared Inspections of Distribution Infrastructure, Intrusive Pole Inspections, and Patrol Inspections of Distribution Equipment. Repairs resulting from drone inspections were tracked separately and are discussed further in my testimony below.

Table JK- 4: AM&I Program Repair Costs (excluding DIAR and RIDI) ($000s)

Description	2019		2020	2021	2022	2023	Total
Capital Repairs Direct ($000)	12,727		12,431	16,835	15,621	10,837	**68,452**
Capital # of Repairs	755		681	730	631	470	**3,267**
Capital Cost/Unit ($,0)	$16,857		$18,254	$23,061	$24,757	$23,058	**$20,953**
O&M Repairs Direct ($000)	**-**		22	744	381	454	**1,601**
O&M # of Repairs	-		5	97	127	82	**311**
Capital Cost/Unit ($,0)	-		$4,473	$7,666	$3,003	$5,535	**$5,148**

Additional detail regarding the costs presented in the above table is provided in supporting workpapers found in SDG&E-T3-WMPMA-07-E.

III. SPECIFIC ASSET MANAGEMENT AND INSPECTION PROGRAM DETAILS

1. DISTRIBUTION OVERHEAD DETAILED INSPECTIONS

Q. Please describe the scope of this inspection program.

A. Distribution overhead detailed inspections are mandated by GO 165 and are intended to identify equipment conditions and infractions on overhead distribution structures that do not meet GO 95 requirements or internal standards and specifications.

Inspections are typically performed from the ground, and include a thorough visual assessment of the pole, attachments, conductor, and cables. Where appropriate, individual pieces of equipment may be opened, tested, or operated to assess their condition. If warranted, the use of infrared or other tools (*e.g.*, binoculars, measurement devices, or drones) may also be utilized to facilitate access if a pole cannot be accessed for inspection. If drones are used to supplement a distribution overhead detailed inspection, that support was performed on an ad hoc basis and the inspectors generally do not save the imagery as they would during the DIAR or RIDI processes.

Distribution overhead detailed inspections were performed primarily by internal QEWs that met the training requirements to be qualified inspectors. Certain detailed inspections also require support services to access and inspect facilities, including but not limited to traffic control, safety, security, environmental, land rights, Tribal monitors, permitting, and customer coordination personnel. This support is necessary to safely perform inspections without compromising public safety, worker safety, or environmental compliance.

If an inspection results in a finding, or identification of an issue requiring corrective action, the inspector documents the condition in SDG&E's inspection program by assigning the applicable condition code, attaching photographs if required, and recording relevant details regarding the observed condition. Completion of the inspection with a documented condition automatically generates a corrective maintenance notification in SDG&E's work management system, indicating that follow up action is required.

If the identified condition poses an immediate safety or wildfire risk, the inspector is required to notify the on-duty construction supervisor while still in the field. The supervisor will discuss the condition and determine whether the issue requires emergency repair. For emergency conditions, crews may be dispatched immediately, and the inspector may be required to remain on-site until the condition is stabilized or repaired.

For non-emergency conditions, the finding is prioritized based on location and compliance requirements, including applicable General Orders (such as GO 95, GO 128 – underground equipment - and GO 165) and SDG&E standards. Each condition is assigned a required completion date, and a work order is created to perform the repair. Corrective work may include repair, reinforcement, replacement, or other mitigation actions, depending on the nature of the condition and engineering requirements. The scope of work is reviewed and executed by qualified personnel, and factors such as constructability, access, environmental requirements, permitting, and outage coordination are incorporated into work planning.

SDG&E maintains inspection records that include the circuit, area, facility or equipment inspected, the inspector's name, the date of the inspection, and any issues (items requiring corrective action) identified during each inspection, as well as the compliance due date for the corrective action.

Q. What is the purpose of this program?

A. By identifying nonconformances, corrective repairs can be made to resolve compliance conditions and reduce the likelihood of a fire, safety, or reliability event from happening. These inspections are also required for compliance with CPUC General Orders.

Q. What is the frequency of inspections under this program?

A. Inspections are performed on a 5-year routine schedule, as mandated by GO 165. Structures are grouped into functional locations to support efficiency of inspections and compliance deadlines are tracked to ensure inspections are completed as required. Accordingly, the number of inspections fluctuates from year to year based on the number of overhead structures due within that inspection interval.

Q. Where do these inspections take place?

A. Distribution Overhead Detailed Inspections are performed on all overhead distribution electric facilities within SDG&E's service territory, including HFTD and non-HFTD areas.

Q. Are there any WMP targets associated with this program? If so, please provide the targets and actuals for any applicable WMP cycle.

A. The following table provides the WMP targets aligned with the number of planned Distribution Overhead Detailed Inspections in the HFTD for the respective years in question, with actuals reflecting inspections performed in the HTFD.

Year	2019	2020	2021	2022	2023
Target Units (Inspections)	N/A	17,500	22,269	18,177	11,100
Actual Units (Inspections)	N/A	17,977	22,354	17,935	11,755

Inspections were performed in 2019 under this program, however no specified WMP target was provided for 2019, given the WMP submission guidelines applicable at the time.

Q. Are these inspections coordinated with other programs?

A. Strict timelines imposed by GO 165 related to the definition of year and inspection interval have created challenges when trying to combine inspection programs. As SDG&E continues to refine its inspection processes and incorporate more data to move certain programs to a risk-based schedule, SDG&E plans to work with the CPUC to determine whether modifications to GO 165 could allow for a more proactive, risk-informed approach to inspections.

While drone inspections and detailed inspections did overlap on occasion from 2019-2022, drone inspections were limited to potential fire and safety risks only and thus did not include identification of all GO 95 and SDG&E nonconformances within the scope of Detailed Inspections of Distribution Equipment, such as missing/damaged high voltage signs. Therefore, performing a drone inspection did not satisfy the requirements for a Detailed Inspection during this time period, and no other inspection program satisfied the scoping requirements of a Detailed Inspection.

Q. Are the repairs associated with these inspections coordinated with other programs?

A. SDG&E tracks electric distribution inspection findings collectively, regardless of the inspection program that identified the issue, with the exception of drone inspection findings from 2019-2022, which were separately tracked. Resolution and repairs arising from any inspection findings are tracked through to either cancellation (if the issue can be remediated without repair or no repair is needed) or completion of a repair. Some issues are cancelled due to overlap with other programs or through QA/QC reviews to confirm that the issue was properly identified and requires repair or other corrective action. Repairs are typically assigned to internal engineering, planning, and construction groups to design and execute. While external engineering, support, and construction may be utilized, the majority of the work is typically performed by SDG&E employees.

SDG&E also performs QA/QC reviews to confirm that repairs were completed appropriately and that records accurately reflect the work performed. This process promotes the systematic processing of inspection findings into corrective actions that support regulatory compliance, wildfire risk reduction, and the safe and reliable operation of SDG&E's electric system**.**

2. DETAILED INSPECTIONS OF TRANSMISSION EQUIPMENT (DISTRIBUTION UNDERBUILD)

Q. Please describe this inspection program.

A. For purposes of SDG&E's WMPs and cost tracking within the WMPMA, this program is related only to the repairs made to distribution underbuild on a transmission facility, following identification of a damage or defect during inspections of overhead transmission infrastructure and requiring repair of the distribution-related underbuild. SDG&E did not include inspection costs for this program in its original Track 2 request since the transmission structure inspections are recovered through SDG&E's Federal Energy Regulatory Commission (FERC) approved rates. In compliance with the requirements of D.26-01-011, SDG&E is providing the costs associated with the repair or replacement of the distribution equipment on the transmission structure, which is properly allocated to CPUC costs.

Q. What is the purpose of this program?

A. Overall, the replacement or repair of the distribution level equipment on these transmission lines improves the health of the facility and reduces the likelihood of an ignition, fault, or other safety event from occurring.

Q. What is the frequency of inspections under this program?

A. Detailed transmission asset inspections are performed on a 3-year cycle; patrols are performed on an annual basis.

Q. Where do these inspections take place?

A. Detailed Inspections of Transmission Equipment are performed on all overhead transmission electric facilities within SDG&E's service territory, including HFTD and non-HFTD areas.

Q. Are there any WMP targets associated with this program? If so, please provide the targets and actuals for any applicable WMP cycle.

A. SDG&E does not establish WMP targets related to repairs arising from AM&I programs, as the number of findings from inspections is variable. Thus, there was not a target specifically related to the number of repairs to distribution underbuild on transmission structures. For context regarding SDG&E's transmission inspection program targets, the following table provides the

WMP targets and actuals associated with the Transmission Overhead Detailed Inspections program:

Year	2019	2020	2021	2022	2023
Target Units (Inspections)	N/A	298	1,680	2,087	2,387
Actual Units (Inspections)	N/A	286	1,957	2,323	1,928

Inspections were performed in 2019 under this program, however no specified WMP target was provided for 2019, given the WMP submission guidelines applicable at the time.

Q. Are these inspections coordinated with other programs?

A. Because detailed transmission inspections occur on a 3-year cycle versus the 5-year cycle for electric distribution assets and are performed by different personnel, transmission inspections were not coordinated with distribution inspections during this period. SDG&E notes, however, that inspection costs are not included in the Track 2 or Track 3 requests.

Q. Are the repairs associated with these inspections coordinated with other programs?

A. Yes. While transmission repairs resulting from transmission inspections are generally tracked separately from distribution repairs, SDG&E's transmission and distributional operational teams review overlaps to reduce redundancy and aim to perform repair work on the same facility and coordinate where feasible and appropriate.

3. INFRARED INSPECTIONS OF DISTRIBUTION INFRASTRUCTURE

Q. Please describe this inspection program.

A. Infrared Inspections use thermal imaging technology to identify abnormal heat signatures on electrical equipment that may indicate deterioration, overloading, loose connections, or impending failure. These inspections provide condition-based insights that are not visible through standard visual inspections.

Infrared inspections are conducted by qualified thermographers using handheld devices, vehicle mounted systems, or aerial platforms, depending on location and accessibility. Identified anomalies are documented in SDG&E's work management system, indicating that follow up action is required.

If the identified condition poses an immediate safety or wildfire risk, the inspector is required to notify the on-duty construction supervisor while still in the field. The supervisor will discuss the condition and determine whether the issue requires emergency repair. For emergency conditions, crews may be dispatched immediately, and the inspector may be required to remain on-site until the condition is stabilized or repaired.

For non-emergency conditions, the finding is prioritized based on location and GO 95 and SDG&E CMP requirements. Each condition is assigned a required completion date, and a work order is created to perform the repair. Corrective work may include repair, reinforcement, replacement, or other mitigation actions, depending on the nature of the condition and engineering requirements. The scope of work is reviewed and executed by qualified personnel, and factors such as constructability, access, environmental requirements, permitting, and outage coordination are incorporated into work planning.

Inspection records are maintained that include the circuit, area, facility or equipment inspected, the inspector's name, the date of the inspection, and any issues (items requiring corrective action) identified during each inspection, as well as the compliance due date for the corrective action.

Q. What is the purpose of this program?

A. The purpose of Infrared Inspections of Distribution Infrastructure was to proactively identify conditions that could lead to equipment failure, ignition risk, or service interruptions, enabling corrective action before a risk event occurs. Infrared devices are used in support of investigating undetermined faults and troubleshooting issues identified through sensors and Supervisory Control and Data Acquisition (SCADA). This program was intended to survey higher risk distribution circuits in the HFTD and WUI for thermal anomalies that could result in equipment failure and subsequent ignition.

Q. What is the frequency of inspections under this program?

A. Infrared inspections were developed as a component of SDG&E's WMP and performed on a targeted, risk informed basis. These inspections were scheduled independently and in conjunction with other inspection activities. Specifically, the thermographers that performed infrared inspections on distribution equipment from 2020-2023 also performed transmission infrared inspections and patrols of transmission facilities.

In 2023, SDG&E applied an added risk-informed overlay using analytics to identify higher risk structures and circuit segments for inspection. This approach did not reduce planned inspections, but rather modified inspection location scheduling and approach with the intention of further identifying whether data analytics could better leverage infrared technology and improve the identification of structures where thermal anomalies may be more prevalent.

The find rate from 2020-2023 remained relatively low, at approximately 0.2% with 0 findings in 2023. In December 2023, SDG&E submitted a change order to Energy Safety to reduce the program's target to 350 poles located in the WUI with higher forecasted peak loads in summer months.[6] Office of Energy Infrastructure Safety (OEIS) rejected SDG&E's change

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[6] OEIS Docket No. 2023-2025 WMPs, San Diego Gas & Electric 2023 Change Order Report (Dec. 19, 2023) available at https://www.sdge.com/sites/default/files/regulatory/2023-12-19_SDGE_2023_Change%20Order%20Report_R1.pdf.

request based on a conclusion that reducing the number of inspections did not reduce risk.[7] Thus, SDG&E was required to continue this program at originally stated targets or face a finding of non-compliance with its WMP.

Q. Where do these inspections take place?

A. These inspections were performed on select overhead distribution equipment throughout the HFTD and higher risk WUI areas.

Q. Are there any WMP targets associated with this program? If so, please provide the targets and actuals for any applicable WMP cycle.

A. The following table provides the WMP targets and actuals associated with the program:

Year	2019	2020	2021	2022	2023
Target Units (Inspections)	N/A	8,500	18,000	12,000	9,578
Actual Units (Inspections)	N/A	13,077	17,068	12,264	11,900

Inspections were performed in 2019 under this program, however no specified WMP target was provided for 2019, given the WMP submission guidelines applicable at the time.

Q. Are these inspections coordinated with other programs?

A. From 2020-2022, SDG&E targeted facilities for infrared inspections that were not otherwise scheduled for Detailed Inspections to reduce redundancy. However, when improved analytics were employed in 2023, SDG&E experienced some overlap with other inspections. Because infrared inspections recognize heat signatures and were intended to identify issues that

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7 Letter from Suzie Rose, Program Manager, Electrical Safety Policy Division, OEIS to Dan Skopec, SVP & Chief Regulatory Officer, SDG&E (May 31, 2024) San Diego Gas & Electric Company's Change Order Request in relations to its 2023-2025 Base Wildfire Mitigation Plan, available at https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=56751&shareable=true.

could not otherwise be observed visually, they were not coordinated other inspection programs that target other issues. Further, we did investigate the potential to perform infrared inspections and drone inspections concurrently, but the drone could not support the load of the high-resolution camera to take images of the poles and the thermal camera at the same time.

Q. Are the repairs associated with these inspections coordinated with other programs?

A. As with other AM&I programs, resolution of the findings was tracked through cancellation or completion. Some issues are cancelled due to overlap with other programs or through QA/QC reviews to confirm that the issue was properly identified and requires repair or other corrective action. Repairs are typically assigned to internal engineering, planning, and construction groups to design and execute. While external engineering, support and construction may be utilized, the majority of the work is typically performed by internal resources.

If a repair cannot be completed within the required timeframe, a formal deferral process is required, including documentation of the reason for delay and assignment of a revised completion date.

SDG&E also performs QA/QC reviews to confirm that repairs were completed appropriately and that records accurately reflect the work performed. This process supports the systematic processing of inspection findings into corrective actions that support regulatory compliance, wildfire risk reduction, and the safe and reliable operation of SDG&E's electric system.

4. INTRUSIVE POLE INSPECTIONS

Q. Please describe this inspection program.

A. Wood pole intrusive inspections are mandated by GO 165 and are a component of SDG&E's CMP and WMP. These inspections involve physical testing of utility poles by drilling into the pole and removing soil from around the base of the pole below the ground surface to assess internal condition, groundline condition, structural integrity, and remaining service life. The inspections also involve the application of chemical treatment to the interior of the pole. Many wood poles—especially Western species like Douglas-fir and Western red cedar—have large untreated heartwood zones. These interior zones are highly susceptible to fungal decay, even when the exterior of the pole looks sound. Fumigants applied inside drilled holes treat parts of the pole that surface treatments cannot reach. Further, the portion of the pole exposed during subsurface excavation is treated with a preservative paste that arrests fungal decay and a wrap that keeps the preservative in place and acts as a moisture barrier.

These inspections and treatments go beyond visual assessments and are designed to identify internal decay, deterioration, or defects that are not externally visible and extend the structural service life of poles that remain otherwise sound.

Intrusive inspections are performed by external contractors trained and certified in these testing and chemical treatment methods. Results are documented in SDG&E's work management system, and poles that do not meet required standards are scheduled for corrective action, which generally included reinforcement or replacement. QA/QC audits of the inspections were also performed at a rate of approximately 10% to ensure inspections are being performed by external contractors per SDG&E standards.

If an identified condition poses an immediate safety or wildfire risk, the inspector is required to notify the on-duty construction supervisor while still in the field. The supervisor will review the condition and determine whether the issue requires emergency repair. For emergency conditions, crews may be dispatched immediately. For non-emergency conditions, repair of the finding is prioritized based on location and GO 95 and SDG&E CMP requirements. The issue is assigned a required completion date, and a work order is created to perform the repair.

SDG&E maintains inspection records that include the circuit, area, facility or equipment inspected, the inspector's name, the date of the inspection, and any issues (items requiring corrective action) identified during each inspection, as well as the compliance due date for the corrective action.

Q. What is the purpose of this program?

A. The purpose of wood pole intrusive inspections is to test and treat wood poles to confirm the structural soundness of wood poles, reduce the risk of pole failure, support informed decisions regarding pole repair, reinforcement, or replacement and to extend the service life of the pole by minimizing fungal decay or damage from other pests, such as termites. Industry research[8,9,10] collectively demonstrates that testing (inspections) and treating (remedial preservatives / restoration) of wood poles improves the utility infrastructure, thus reducing wildfire risk by reducing the chance of pole failure (*e.g.*, pole leaning, breaking or falling) that could cause a correlated equipment failure, safety event such as an ignition, and/or outage.

Q. What is the frequency of inspections under this program?

A. From 2019-2022, intrusive inspections were performed on a 10-year cycle with the exception of poles aged 15 years or more that have undergone a non-routine inspection within

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[8] *See* USDA. 2013. Rural Utilities Service Bulletin 1730B 121 – Wood Pole Inspection & Maintenance. Available at: https://www.rd.usda.gov/files/UEP_Bulletin_1730B-121.pdf.

[9] Grid Deployment Office, Berkeley Lab. 2024. Utility Pole Maintenance and Upgrades, Resilience Investment Guide. Available at https://www.energy.gov/sites/default/files/2024-11/111524_Utility_Pole_Maintenance_and_Upgrades.pdf.

[10] Morrell, J.J. Estimated Service Life of Wood Poles. North American Wood Pole Council Technical Bulletin, No. 16-U-101. Available at https://woodpoles.org/wp-content/uploads/TB_ServiceLife.pdf.

the last 5 years, as required by GO 95, Rule 44.2. That rule requires that poles undergoing reconstruction or modification have an updated pole loading calculation to validate compliance with required safety factors. One of the inputs necessary to perform the pole loading calculation is the pole's current remaining strength, which requires an intrusive inspection result that is no more than 5 years old. Thus, some poles were inspected more frequently than 10 years if an inspection was needed to perform a pole loading calculation to verify safety factors under GO 95, Rule 44.2. QA/QC audits are performed within 1-2 months after the inspection is completed.

Q. Where do these inspections take place?

A. These inspections are performed on wood poles throughout SDG&E's overhead distribution system across both HFTD and non HFTD areas. For efficiency, the routine inspections are grouped by areas of SDG&E's service territory (*i.e.,* districts), which results in large fluctuations in the number of intrusive inspections performed in the HFTD from year to year as shown in our WMP targets and inspection results from 2019-2023.

Q. Are there any WMP targets associated with this program? If so, please provide the targets and actual units for any applicable WMP cycle.

A. The following table provides the WMP targets and actuals associated with the program, which are associated with wood pole intrusive inspections performed in the HFTD:

Year	2019	2020	2021	2022	2023
Target Units (Inspections)	N/A	18,000	9,796	350	50
Actual Units (Inspections)	19,729	14,450	8,721	967	1,038

No specified WMP target was provided for 2019, given the WMP submission guidelines applicable at the time

Q. Are these inspections coordinated with other programs?

A. Intrusive inspections are unique and performed by personnel trained to test and treat the poles. As the contractors are not qualified to evaluate the health or status of other electrical equipment, these inspections are not coordinated with other inspection efforts.

Q. Are the repairs associated with these inspections coordinated with other programs?

A. As previously addressed, with the exception of repairs associated with the DIAR and RIDI programs, all electric distribution inspection findings are tracked together, regardless of the inspection program that identified the issue. Resolution of findings are tracked through cancellation or completion. Some issues are cancelled due to overlap with other programs or through QA/QC reviews to confirm that the issue was properly identified and requires repair or other corrective action.

Repairs resulting from wood pole intrusive inspections generally result in the installation of a steel reinforcement or replacement of the pole. If reinforcement was recommended and approved by the SDG&E construction supervisor, then the contractor that performed the inspection is issued an order to install the reinforcement as per SDG&E standards. If a pole replacement is the recommended corrective action, then the repair is typically assigned to internal engineering, planning, and construction groups to design and execute.

If a repair cannot be completed within the required timeframe, a formal deferral process is required, including documentation of the reason for delay and assignment of a revised completion date. SDG&E also performs QA/QC reviews to confirm that repairs were completed appropriately and that records accurately reflect the work performed. This process promotes the systematic processing of inspection findings into corrective actions that support regulatory compliance, wildfire risk reduction, and the safe and reliable operation of SDG&E's electric system.

5. HFTD TIER 3 INSPECTIONS

Q. Please describe this inspection program.

A. HFTD Tier 3 distribution pole inspections were initially required by a settlement agreement adopted by the CPUC in Decision D.10-04-047. These inspections were performed by inspecting a third of the assets in the identified area each year over a three-year cycle. Pursuant to that settlement, SDG&E incorporated these inspections into our CMP and conducted HFTD Tier 3 inspections to meet the settlement obligation that started in 2010 and ended in 2016. After 2016, SDG&E elected to proactively continue HFTD Tier 3 inspections as part of its broader inspection efforts to reduce wildfire ignition risk. HFTD Tier 3 inspections were performed by internal QEWs that received specialized CMP training and the inspection was focused on only potential conditions that could result in an ignition or safety risk. The inspection included a visual assessment of infrastructure and use of specialized tools where appropriate.

Based on available information obtained during the implementation of the DIAR program from 2019-2022, including the proven effectiveness of drone inspections as further discussed below, SDG&E elected to discontinue the Tier 3 inspections in 2023. In 2023, SDG&E incorporated the HFTD Tier 3 Inspection program in conjunction with development of SDG&E's risk informed drone inspection program, RIDI. Thus, this program had no WMP targets in 2023 and SDG&E is not requesting inspection costs associated with the program in Track 3.

Results of the inspections were documented in SDG&E's work management system, and poles that did not meet required standards were scheduled for corrective action. If the identified condition poses an immediate safety or wildfire risk, the inspector is required to notify the on-duty construction supervisor while still in the field. The supervisor will review the condition and determine whether the issue requires emergency repair. For emergency conditions, crews may be dispatched immediately, and the inspector may be required to remain on-site until the condition is stabilized or repaired.

For non-emergency conditions, the finding is prioritized based on location and GO 95 and SDG&E CMP requirements. The issue is assigned a required completion date, and a work order is created to perform the repair. Inspection records were maintained that include the circuit, area, facility or equipment inspected, the inspector's name, the date of the inspection, and any issues (items requiring corrective action) identified during each inspection, as well as the compliance due date for the corrective action.

Q. What is the purpose of this program?

A. By continuing to perform these inspections beyond the settlement agreement timeframe, SDG&E maintained another inspection layer in the HFTD Tier 3 with the purpose of identifying and remediating hazardous conditions sooner (three-year cycle as compared to a five-year CMP cycle) and reducing the likelihood that undetected defects could lead to wildfire ignition. The program also supported SDG&E's WMP and compliance with approved WMP targets.

In addition, the performance of these inspections was a compliance requirement of SDG&E's CMP, which is mandated by GO 165. So, while this inspection type is not specifically required by GO 165, it was incorporated into SDG&E's compliance obligations prior to 2023.

Based on available information obtained during the implementation of the DIAR program from 2019-2022, including the proven effectiveness of drone inspections as further discussed below, SDG&E elected to discontinue the Tier 3 inspections in 2023 to streamline efficiencies and avoid any potential program redundancy.

Q. What is the frequency of inspections under this program?

A. HFTD Tier 3 inspections were designed to only identify potential fire and safety hazards and were performed every three years on all overhead electric facilities within the Tier 3 HFTD. The goal was to complete all scheduled HFTD Tier 3 inspections by June 1 annually, facilitating completion of any higher risk repairs prior to the region's peak fire and PSPS season in the fall and winter.

Q. Where do these inspections take place?

A. HFTD Tier 3 inspections were limited to overhead distribution facilities located within designated High Fire Threat Districts.

Q. Are there any WMP targets associated with this program? If so, please provide the targets and actuals for any applicable WMP cycle.

A. The following table provides the WMP targets and actuals associated with the program:

Year	2019	2020	2021	2022	2023
Target Units (Inspections)	N/A	11,500	10,815	12,268	0
Actual Units (Inspections)	15,176	11,864	11,535	12,263	0

No specified WMP target was provided for 2019, given the WMP submission guidelines applicable at the time

Q. Are these inspections coordinated with other programs?

A. HFTD Tier 3 inspections were satisfied by the five-year Detailed Inspections of Distribution Equipment if the HFTD Tier 3 inspection was due in the same calendar year as the Detailed Inspection. This reduced redundancy of inspections between the HFTD Tier 3 and Detailed Inspection programs.

Q. Are the repairs associated with these inspections coordinated with other programs?

A. As previously described, with the exception of drone inspection findings from 2019-2022, all electric distribution inspection findings are tracked together, regardless of the inspection program that identified the issue. And resolution of the findings are tracked through cancellation or completion. Some issues are cancelled due to overlap with other programs or through QA/QC reviews to confirm that the issue was properly identified and requires repair or other corrective action. Repairs are typically assigned to internal engineering, planning, and construction groups to design and execute. While external engineering, support and construction may be utilized, the majority of the work is typically performed in house.

If a repair cannot be completed within the required timeframe, a formal deferral process is required, including documentation of the reason for delay and assignment of a revised completion date. SDG&E also performs QA/QC reviews to confirm that repairs were completed appropriately and that records accurately reflect the work performed. This process promotes the systematic processing of inspection findings into corrective actions that support regulatory compliance, wildfire risk reduction, and the safe and reliable operation of SDG&E's electric system.

Q. Is SDG&E requesting any costs associated with this program in Track 3?

A. SDG&E is not requesting costs associated with HFTD Tier 3 inspections in Track 3. SDG&E's Track 3 request is limited to repairs performed in 2023 that followed HFTD Tier 3 inspections in prior years. Repairs under this program were coordinated with repairs related to other AM&I programs, excepting drone inspection repairs.

6. PATROL INSPECTIONS OF DISTRIBUTION EQUIPMENT

Q. Please describe this inspection program.

A. Overhead patrols are a compliance-driven inspection mandated by GO 165, GO 95 and SDG&E's CMP. GO 165 defines a patrol as a visual inspection intended to identify obvious hazards and requires utilities to patrol overhead distribution facilities on prescribed intervals. GO 165 was revised in December 2017 to require patrol inspections in rural areas to be performed once per year in Tier 2 and Tier 3 of the HFTD. Accordingly, starting in 2018, SDG&E performed patrols annually across its service territory, exceeding the minimum GO 165 requirements in some areas, to ensure consistent compliance and documentation. Patrol inspections were performed primary by internal QEWs from the ground or by vehicle and focus on obvious issues, such as damaged poles, leaning structures, broken crossarms, conductor clearance issues, or other visible abnormalities.

If an inspection results in a finding, or identification of an issue requiring corrective action, the inspector documents the condition in SDG&E's inspection program by assigning the applicable condition code, attaching photographs where required, and recording relevant details regarding the observed condition. Completion of the inspection with a documented condition automatically generates a corrective maintenance notification in SDG&E's work management system, indicating that follow up action is required. If the identified condition poses an immediate safety or wildfire risk, the inspector is required to notify the on-duty construction supervisor while still in the field. The supervisor will discuss the condition and determine whether the issue requires emergency repair. For emergency conditions, crews may be dispatched immediately, and the inspector may be required to remain on-site until the condition is stabilized or repaired.

For non-emergency conditions, the finding is prioritized based on location and compliance requirements, including applicable General Orders (such as GO 95, GO 128 –

underground equipment - and GO 165), and SDG&E standards. Each condition is assigned a required completion date, and a work order is created to perform the repair. Corrective work may include repair, reinforcement, replacement, or other mitigation actions, depending on the nature of the condition and engineering requirements. The scope of work is reviewed and executed by qualified personnel, and factors such as constructability, access, environmental requirements, permitting, and outage coordination are incorporated into work planning.

Inspection records are maintained that include the circuit, area, facility or equipment inspected, the inspector's name, the date of the inspection, and any issues (items requiring corrective action) identified during each inspection, as well as the compliance due date for the corrective action.

Q. What is the purpose of this program?

A. Patrol inspections are compliance driven and required under GO 165 to provide continuous system awareness between more detailed inspection cycles. These inspections serve as the first line of defense for identifying obvious structural problems and hazards on overhead electric facilities that could present safety, wildfire, or reliability risks. Without patrols, emerging hazards could go undetected until the next scheduled detailed inspection, which can be a period of three to five years.

Q. What is the frequency of inspections under this program?

A. Patrols are required to be performed within 12 consecutive calendar months, starting with the first full calendar month after the prior patrol, plus an allowable grace period of up to three additional full calendar months, but not to exceed the end of the calendar year in which the next patrol is due. This definition ensures compliance with GO 165's inspection interval requirements while allowing limited scheduling flexibility.

Q. Where do these inspections take place?

A. Patrol inspections are performed on all overhead and underground distribution facilities throughout SDG&E's service territory, including both HFTD and non-HFTD areas.

Q. Are there any WMP targets associated with this program? If so, please provide the targets and actuals for any applicable WMP cycle.

A. The following table provides the WMP targets and actuals associated with the program:

Year	2019	2020	2021	2022	2023
Target Units (Inspections)	N/A	86,000	86,000	86,490	86,880
Actual Units (Inspections)	N/A	86,075	86,490	86,821	85,847

Inspections were performed in 2019 under this program, however, no specified WMP target was provided for 2019, given the WMP submission guidelines applicable at the time

Q. Are these inspections coordinated with other programs?

A. While overhead patrol requirements may be satisfied by another qualifying inspection—such as a detailed overhead inspection or a drone inspection—provided the inspection occurs within the applicable patrol interval, the inspection interval prescribed under GO 165 affords limited scheduling flexibility. As a result, in 2019-2022, patrols were performed in addition to other inspection activities. SDG&E does look to implement efficiencies for patrol inspections where possible. For instance, patrols are typically conducted by Electric Trouble Shooters as part of their routine field duties and are frequently completed contemporaneously with those activities, which promotes cost efficiency and a lower cost per inspection.

Q. Are the repairs associated with these inspections coordinated with other programs?

A. As previously discussed, with the exception of repairs from the DIAR and RIDI programs, all electric distribution inspection findings are tracked together. And resolution of the findings are tracked through cancellation or completion. Some issues are cancelled due to overlap with other programs or through QA/QC reviews to confirm that the issue was properly identified and requires repair or other corrective action. Repairs are typically assigned to internal engineering, planning, and construction groups to design and execute. While external engineering, support and construction may be utilized, the majority of the work is typically performed internally.

If a repair cannot be completed within the required timeframe, a formal deferral process is required, including documentation of the reason for delay and assignment of a revised completion date. SDG&E also performs QA/QC reviews to confirm that repairs were completed appropriately and that records accurately reflect the work performed. This process promotes identification of inspection findings and corrective actions that support regulatory compliance, wildfire risk reduction, and the safe and reliable operation of SDG&E's electric system.

7. DRONE ASSESSMENTS OF DISTRIBUTION INFRASTRUCTURE(DIAR AND RIDI)

Q. Please describe the scope of SDG&E's WMP Drone Assessment Programs.

A. The DIAR Program involves flight planning, drone flight and image capture, field observations, image assessment, determination of findings, and repair and remediation. Imagery collected by drones improves upon traditional ground inspections by providing inspectors with a "birds eye view" of overhead facilities, as well as high resolution imagery of overhead equipment and components. The use of drones to collect imagery also enhances an inspector's ability to identify potential fire hazards related to certain types of issues or where conditions such as terrain and vegetation density make full detailed inspections difficult. Through its experience developing and implementing the DIAR program, SDG&E discovered that drone inspections more readily observed issues including damaged arresters, damaged insulators, issues with pole top work, issues with armor rods, crossarm or pole top damage, exposed connections, loose hardware, improper splices, and damaged conductors.

SDG&E's drone inspection programs are comprised of two phased programs. The first, DIAR, was in effect from 2019-2022, and consisted of the following activities:

(1) Collecting imagery using drones of all overhead distribution electric facilities in the Tier 2 and Tier 3 HFTD and higher risk WUI areas,
(2) QEWs performing associated inspections of overhead distribution facilities using imagery and field observations,
(3) Repairing issues observed during inspections,
(4) Utilizing the images collected and damages identified by the QEWs to develop Intelligent Image Processing (IIP) capabilities in the form of ML models that could perform automated asset identification and damage detection, and
(5) Operationalizing ML models to perform QA/QC of drone inspections performed.

The first phase of DIAR included drone inspections of all distribution infrastructure in Tier 3 of the HFTD, starting in 2019. Within the first few months of flights, drone inspections identified 24 emergency issues and the overall infraction find rate was approximately 30% of poles inspected. Based on the success of these initial results in identifying potential wildfire risk and safety conditions, SDG&E continued the DIAR program in Tier 3 through 2020. Ultimately the DIAR program expanded to include drone inspections of all overhead infrastructure in Tier 2 of the HFTD and higher risk WUI areas in subsequent years.

Corresponding with the development of the DIAR program, SDG&E's digital innovation team explored whether advancements in image recognition capabilities could enable Machine Learning models to identify assets and detect damages on overhead electric facilities. The drone program presented a unique opportunity with a statistically significant sample size to take advantage of the collection of millions of images that would be labeled by inspectors in their ordinary scope of work that could then be leveraged to train Machine Learning models and develop an innovative capability that could benefit customers in the form of reduced inspection costs for years to come.

From 2019-2020, DIAR scope included inspections of approximately 39,000 overhead electric distribution poles and associated infrastructure in the Tier 3 of the HFTD. Each inspection included image collection by drone pilots paired with a visual observer, identification of potential fire/safety hazards by QEWs, and repair of issues identified through the inspection. To promote cost efficiencies, approximately 2,000 poles were removed from the scope of DIAR inspections because they had recently been replaced through other programs. The images collected by the drone pilots were reviewed by QEWs via desktop to identify potential fire and safety hazards, which then initiated work orders to remediate the identified hazards. All work necessary to manage, engineer, and construct the repairs identified was included in the scope of the program.

In 2021-2022, SDG&E modified the inspection methodology to enable QEWs to work as a team in the field with the drone pilots to perform image collection and identification of potential fire/safety hazards for approximately 50,000 overhead electric distribution poles in the Tier 2 of the HFTD and the higher risk WUI areas. With QEWs in the field with the drone pilots, DIAR inspections included both traditional ground observations along with the use of images taken by the pilot to identify potential hazards. This modification allowed QEWs to aid in identifying emergency conditions sooner and achieve additional efficiencies, since QEWs also performed minor repairs to poles during their field inspections, including replacing signage and pole tags, fixing guy guards and removing climbing steps.

During this time period of Tier 2 DIAR inspections, poles were also removed from the scope of inspections due to age (*i.e.,* pole less than 1 year old) or overlap with projects anticipated to replace the pole within the next 12 months. With QEWs in the field with the drone pilots, DIAR inspections included both traditional ground observations along with the use of images taken by the pilot to identify potential hazards. The work necessary to manage, engineer and construct the repair of issues identified in both Tier 2, Tier 3 and WUI was ongoing during this timeframe and included in the scope and costs of the Program.

Starting in 2023, SDG&E's drone program consisted of ongoing repair work of potential fire hazards identified through the DIAR inspections occurring from 2019-2022 and implementation of a newly created Risk-Informed Drone Inspection Program. RIDI involved the following:

(1) The development and implementation of a risk informed inspection prioritization model, which is described in more detail later, to identify the highest risk poles in the HFTD and WUI for inspection on an annual basis;

(2) Collecting imagery of overhead distribution electric facilities using drones in the Tier 2, Tier 3 HFTD and WUI areas using a risk informed inspection prioritization model;

(3) Having QEWs paired with drone pilots to perform inspections of overhead distribution facilities using both imagery and field observations;

(4) Repairing issues observed during inspections;

(5) Utilizing the images collected and damages identified by the QEWs to enhance our Intelligent Image Processing (IIP) capabilities in the form of machine learning models that perform automated asset identification and damage detection; and

(6) Operationalizing those damage detection models to perform QA/QC of drone inspections performed.

To further promote efficiencies, QEWs also performed minor repairs to poles during their field inspections, including replacing signage and pole tags, fixing guy guards and removing climbing steps.

Q. What is the purpose of this program?

A. Compared to traditional inspection programs, the use of drone technology offered the potential to obtain high-resolution, close-range, and top-down imagery and identify non-obvious issues that traditional ground or patrol inspections performed by inspectors observing from the ground cannot consistently achieve. This is especially relevant for certain types of overhead electric components such as insulators and arresters, crossarm and pole-top damage, exposed or loose connections, improper splices and armor rod issues, and damaged conductors and hardware. Additionally, drone inspections allowed safer inspection of infrastructure in locations where traditional inspections are constrained by steep or rugged terrain, dense vegetation and remote or limited-access.

Further, as previously addressed, use of drone image collection has also allowed for IIP capabilities and Machine Learning to identify and detect damaged equipment in a more streamlined manner than traditional inspection methods.

SDG&E has continuously monitored this program to assess comparisons between drone and other inspection methods. Upon these reviews, it became obvious that drone inspections enabled the identification of more fire hazards than traditional inspections, as further discussed later.

The DIAR inspections and associated repairs performed from 2019-2022 established a comprehensive baseline of the status of SDG&E's system within the HFTD, as well as a structure for facilitating and performing repairs of any assets within required timeframes.

SDG&E's DIAR program was unique across any similar effort in that it assessed the health of all assets in the HFTD over a four-year period and quickly addressed wildfire risk conditions. Further, as discussed elsewhere, this baseline of knowledge informed SDG&E's situational awareness capabilities, allowing for more targeted and informed system operating decisions, including during PSPS events. No other California utility has undertaken a similar effort; distribution drone inspections performed by Pacific Gas & Electric Company (PG&E) and Southern California Edison Company (SCE) are newer and more limited in scope.

After SDG&E completed its HFTD-wide inspections as part of DIAR, it was reasonable to reduce the annual scope of the program and transition to performing fewer inspections on a risk-based selection of poles under RIDI. Continuing its drone program in a risk informed manner allowed SDG&E to continue effective wildfire risk reduction but with fewer inspections on an ongoing basis. SDG&E's risk-informed models show that a subset of poles drive a large share of ignition risk based on characteristics such as asset age, historic inspection results, location (*e.g.*, elevation) and environmental factors (*e.g.*, terrain, vegetation). By prioritizing inspections based on probability and consequence of failure—rather than inspecting every asset on a fixed cycle—SDG&E targeted the assets most likely to have a condition that could cause an ignition, achieving higher hazard find rates, detecting emergency conditions earlier, and avoiding unnecessary inspections of low-risk infrastructure.

Thus, the purpose of RIDI was to reduce wildfire risk by concentrating enhanced inspection efforts that look for non-obvious hazards where catastrophic ignition risk is highest. This risk-informed approach, however, would not have been as feasible to accurately implement absent the volume of data and baseline of knowledge developed under the DIAR program.

Q. Why was the program necessary?

A. SDG&E's drone inspection programs are necessary to reduce wildfire and safety risk by identifying conditions on electric infrastructure that cannot be reliably detected through traditional ground patrols or other inspection methods. Drone inspections provide close-range, high-resolution imagery of pole tops, crossarms, and equipment in high-fire-threat and hard-to-access areas, allowing SDG&E to detect and remediate less obvious issues that may not even be visible through climbing, lift trucks, or helicopters, each of which also present greater safety, environmental, and operational constraints, in addition to being a more disruptive inspection method for customers on inspected properties. The program improves worker and public safety, enables inspections in rugged and remote terrain, supports faster emergency response and outage assessment, and enhances SDG&E's ability to prioritize repairs using a risk-informed approach. Drone inspections are designed to complement existing inspection programs and are a critical component of SDG&E's wildfire mitigation and asset management strategy.[11]

Upon implementation of the program in 2019, the effectiveness of drone inspections in identifying potential hazards and ignition sources versus traditional inspection programs became immediately apparent. The success of the DIAR and RIDI programs in identifying potential fire and safety hazards for remediation are shown in the tables below. These tables provide metrics on both the number of hazards identified and the severity of the hazards.

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[11] *See* SDG&E 2023-2025 Base WMP (October 23, 2023) at 44 (citing implementation of a risk informed drone inspection program and use of machine learning and damage detection models as a WMP strength); OEIS's Final Decision of SDG&E's Evaluation of 2022 WMP Update (July 2022) at 2 (citing SDG&E's continued successful use of drones "with a relatively high find rate" in distribution system inspections); *Id*. at 57 (citing implementation of machine learning to aid in damage detection as an improvement in SDG&E' WMP practices).

Table JK- 5: 2019-2023 Fire/Safety Hazard Find Rate Comparison

Year	Poles Inspected (Drones)	Drone Inspection % of Fire/Safety Issues per Poles Inspected (% of poles with 1 or more Fire/Safety Issues)[12]	Poles Inspected (CMP)	CMP Detailed Inspection % of Poles with 1 or more Fire/Safety Issues
2019	10,524	35% (11% of Poles Inspected)	16,239	3.1%
2020	26,787	30% (20% of Poles inspected)	17,935	3.3%
2021	23,081	38% (28% of Poles inspected)	23,354	2.5%
2022	25,976	35% (25% of poles inspected)	17,935	2.5%
2023	15,234	49% (28% of poles inspected)	11,755	3.1%

Table JK- 6: 2019-2023 Severity of Issues Identified by Drone Inspections

Issue Severity	Tier 3 (2019-2020)	Tier 2 & WUI (2021-2022)	RIDI (2023)	Total
Level 1 - Emergency	113 (1.4%)	226 (1.6%)	26 (0.006%)	365
Level 2 - Moderate	9,056	16,049	7,452	35,114

GO 95, Rule 18B defines a Level 1 or emergency issue as a condition that presents an immediate risk of high potential impact to safety or reliability and a Level 2 or moderate issue as any other risk of at least moderate potential impact to safety or reliability. Rule 18B further mandates that potential fire hazards in the Tier 2 and Tier 3 HFTD with moderate severity be remediated within 12 and 6 months, respectively. Therefore, issues identified through these inspection programs had the potential to result in a catastrophic ignition event had they not been identified and repaired in a timely manner, with a calculated average wildfire consequence cost of $829M per event.

12 The first number is the overall issue find rate, or number of issues found measured by the number of poles inspected. The second number (in parenthesis) is the number of poles with issues versus poles with no identified issues, illustrating that in many cases drone inspections discovered more than one issue on the pole.

Overall, DIAR and RIDI found 18% more poles with emergency or moderate potential fire hazards than traditional Detailed Inspections and were effective in identifying emergency damages approximately 29 months earlier.

Below are some examples of the types of damages SDG&E was able to identify during drone inspections performed from 2019-2022 that otherwise would not have been visible through traditional ground-based inspections.

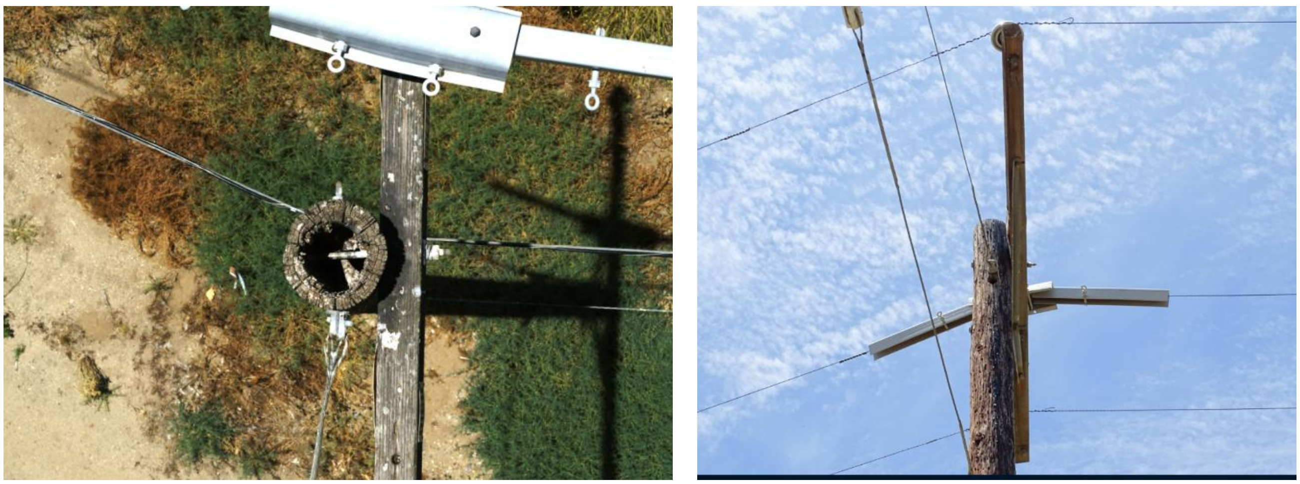


Figure JK- 1: P110290, 6/25/2020, Hollow Pole Top and view from below with no visible damage.

Figure JK- 2: P475444, 12/10/2021, Damaged Crossarm and view from below with no visible damage.

Figure JK- 3: P283191, 1/3/2022, Bolt coming out and view from below with no visible damage.

Figure JK- 5: P572459, 4/9/2020, Transformer lid missing.

Figure JK- 4: P46654, 5/8/2020, Loose tie wire on insulator.

As illustrated by these examples, an elevated perspective of electrical assets significantly improves the identification of potential fire hazards, such as damaged conductors, crossarms, arrestors, insulators, or deadends (hardware used to carry the full mechanical tension of conductors rather than merely supporting their weight) not otherwise visible through traditional asset inspections. This is particularly the case in areas with challenging terrain or dense vegetation where ground inspections are difficult or unsafe.

Similarly, the RIDI inspection prioritization model implemented in 2023—based on situational and asset awareness gained through the comprehensive inspections performed from 2019-2022—was able to identify and prioritize poles not otherwise due for a detailed inspection but that had additional potential risk identified through a drone inspection through DIAR. Below are photos showing the image collected during DIAR and the photo collected during the 2023 RIDI. These illustrate that enabling a risk-informed inspection strategy versus time-based was necessary to support SDG&E's wildfire mitigation strategy.

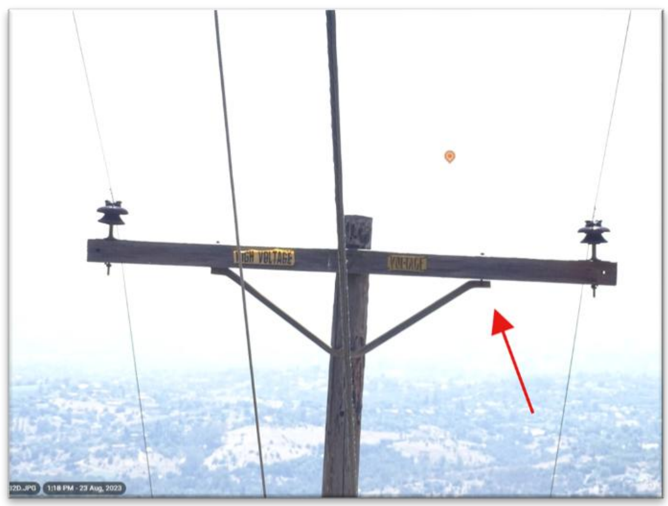
Figure JK- 6: Damaged Pole (P812049)

DIAR Tier 3 – 4/25/2022

RIDI - 8/14/2023

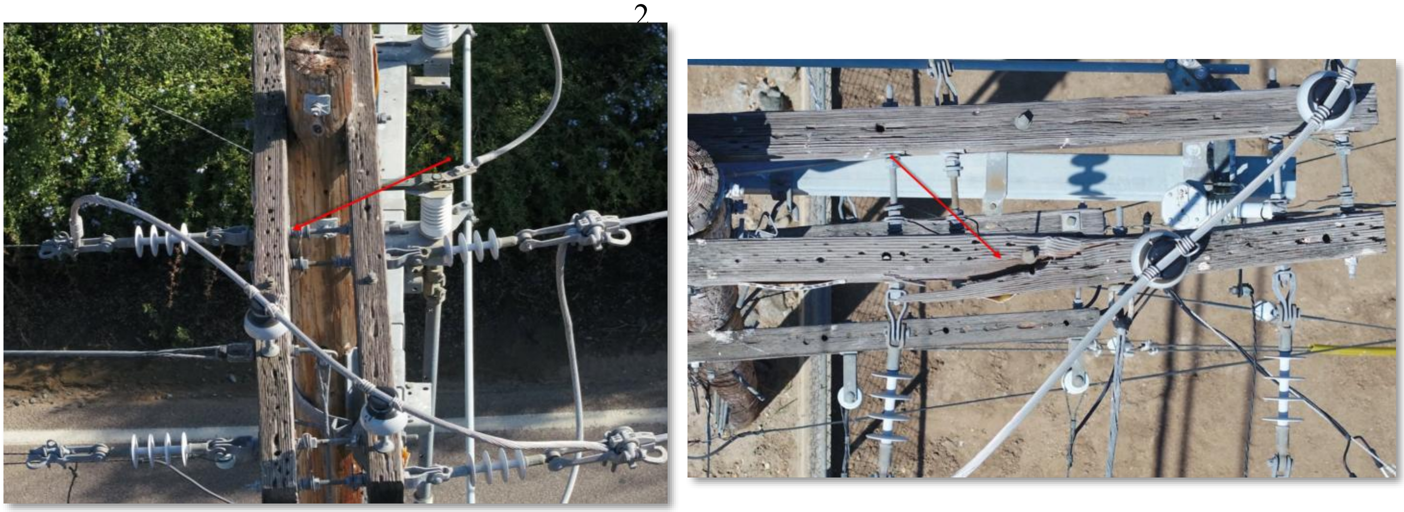
Figure JK- 7: Missing Hardware (P411485)

DIAR Tier 3 – 12/11/2019



RIDI - 8/23/2023

Figure JK- 8: Damaged Crossarm (P176389J)



DIAR Tier 3 – 11/25/2019

RIDI – 6/28/2023

Figure JK- 9: Damaged Pole (P200756)

DIAR Tier 3 – 6/10/2020

RIDI - 3/14/2023

Q. Describe the scope of technologies, including Artificial Intelligence and Machine Learning, in implementing the DIAR and RIDI programs.

A. The scope of technologies involved in the DIAR and RIDI programs fell into three general categories: Software, Data Management and AI/ML.

1. Software

When SDG&E started the DIAR program in 2019, we needed to find a way to perform flight planning and execution at scale. This included the ability to upload, store and visualize over 700,000 drone images anticipated to be collected for the approximately 40,000 distribution poles in the Tier 3 HFTD. SDG&E also needed a solution that allowed inspectors to review the images and identify potential fire and safety hazard issues, perform QA/QC of the inspection reports, and publish the findings for further corrective work management.

For flight planning and inspection, we examined software options already in use by SDG&E and met with several external vendors with inspection software solutions related to imagery and drones. Through the bidding process, SDG&E selected a software solution that required the payment of license fees, implementation of custom enhancements needed to support DIAR workflows, including QA/QC review processes, cloud data storage and integration with the other work management solutions discussed below. This software solution was used from 2019-2023 to support the over 100,000 flights and inspections performed and remains operational to support the RIDI program in current form.

2. Data Management

SDG&E also required a work management system to record and track flights, inspections, and management of findings through repair completion and reporting. SDG&E tracked both the flights completed by the pilots as well as flights delayed because of permitting or other authorizations, access issues, customer issues, and other constraints. Inspection tracking included identifying inspections that were complete and awaiting QA/QC and finalized reports. Finally, management of the findings required the ability to identify the type of issue, severity of issue for prioritization, location for grouping efficiency, level of effort needed for engineering or design, type of repair resulting from the engineering for reporting and cost forecasting (*e.g.*, pole replacement, crossarm replacement, other type of engineering repair), tracking of the status of engineering for construction readiness, environmental review, permitting needs, land rights issues, issuance to construction, construction status, redesign or additional information needed for construction, as-built receipt, true-up and QA/QC and close-out.

SDG&E examined options already in use at the company, but because no single enterprise system existed to manage all phases of work, it elected to retain the services of an external vendor to develop a custom tracking and reporting solution, including databases and Power BI dashboards specifically for DIAR that would support internal management of the repairs and reporting to Energy Safety. This work was necessary to track inspection targets, translate inspection findings into actionable, auditable work records and to support program close-out and data migration, as well as produce weekly, monthly, and ad-hoc reports to respond to data requests and provide regulatory support.

3. AI/Machine Learning

SDG&E's efforts in the development of artificial intelligence and Machine Learning began prior to the start of DIAR with the goal of promoting cost efficiency by enhancing and expediting review of images for various purposes. In late 2018, SDG&E initiated a bid solicitation event for services related to intelligent imagery with the goal of creating a centralized platform for imagery management and development of Machine Learning models that could potentially be utilized for project planning, improvements to asset data, enhancement of inspections, vegetation management and environmental services. Specifically, SDG&E investigated the ability to use Machine Learning models to identify assets, perform measurements and assess damage of overhead electric facilities, as well as recognize environmental issues, such as dense vegetation areas. At that time, there were no vendors with "off the shelf" Machine Learning capabilities. SDG&E ultimately received three vendor proposals through a competitive bidding process that involved the development of Machine Learning capabilities and required the collection of additional imagery that could be used to train and develop the Machine Learning models, which also required the time of subject matter experts such as QEWs and engineers.

In 2019, SDG&E's digital innovation group also completed a pilot project unrelated to WMP efforts with an external IT vendor exploring this same technology. The result of the pilot concluded that the technology existed to develop Machine Learning capabilities, but that effort would require larger image datasets and labeling of assets and different damage types to be successful.

Ultimately, developing Machine Learning model capabilities as part of the DIAR program offered cost efficiencies, along with potential to reduce ongoing labor costs from the DIAR program and expedite review of drone inspection images to identify high risk issues. From the outset, the drone program offered not only the opportunity to collect imagery for human review, but also to generate high-quality labeled datasets that could be used to develop Machine Learning models capable of automated asset identification and damage detection on overhead electric facilities. These models could ultimately be expanded beyond the drone program and into other aspects of SDG&E's business operations to further achieve cost efficiencies.

During the early phase of this process, drone imagery captured was reviewed by QEWs and the findings from these human inspections were used to train and validate early computer-vision models to identify assets and potential fire and safety hazards on overhead distribution infrastructure. To operationalize these capabilities once developed, SDG&E created the IIP platform. IIP is an enterprise, cloud-based system that applies AI and Machine Learning models to imagery collected from drones, fleet vehicles, and mobile devices. IIP's core function is to automatically detect electric assets, identify damage conditions, and integrate risk insights into SDG&E's compliance and operational workflows for qualified review and action.

IIP was explicitly developed as a "human + machine" partnership, in which Machine Learning models can rapidly triage large volumes of imagery while human inspectors retain responsibility for final assessment and repair decisions. This approach was intended to improve consistency, scalability, and timeliness of inspections without replacing qualified human judgment. By the end of 2020, SDG&E had developed over 30 Machine Learning models with basic asset and damage detection capabilities using the imagery collected from DIAR.

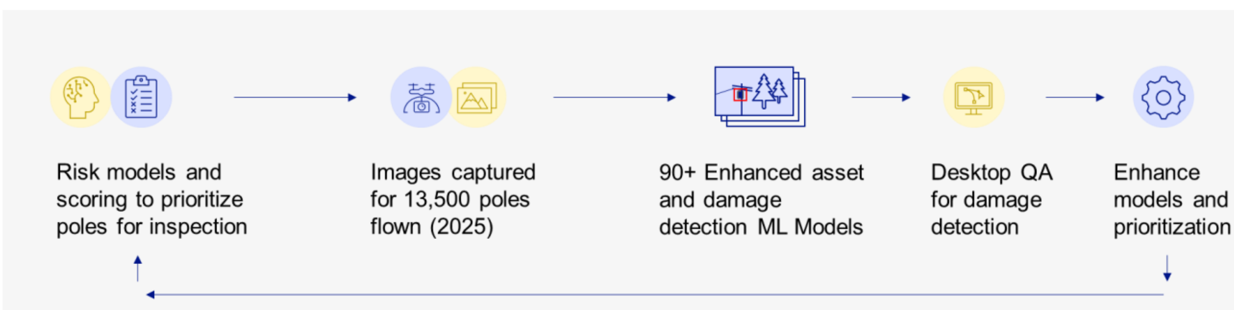
Starting in 2021, SDG&E harnessed these IIP digital capabilities to accelerate AI and Machine Learning to support wildfire mitigation and compliance activities.[13] SDG&E was the first utility to explore and operationalize IIP technology in this fashion. Among other things, Machine Learning model capabilities included:

- Automated asset identification on overhead electric structures used to better inform our asset management strategy and risk understanding;
- Damage and defect detection relevant to wildfire risk and system safety;
- Third-party attachment and equipment detection on poles for improved notification to responsible parties related to communication equipment hazards in conformance with GO 95 Rule 18 and better understanding of asset risk related to unauthorized attachments; and
- QA/QC of drone inspections to identify any potential damages missed by the inspector.

[13] *See* SDG&E 2023-2025 Base WMP (October 23, 2023) at 232-233.

SDG&E also continued to develop and refine additional models. At the end of 2022, SDG&E had collected over 1.9 million images from DIAR and developed 75+ asset identification and damage detection models that were used to QA/QC over 65,000 drone inspections performed by Qualified Inspectors.

The Machine Learning capabilities developed through DIAR were also integrated into SDG&E's RIDI framework at the end of 2022 to support the scope of RIDI inspections in 2023; this framework is still in use today with over 90 Machine Learning models in operation. To support RIDI, outputs from the Machine Learning models—such as asset condition indicators and detected anomalies—were combined with other risk inputs (*e.g.*, asset health and consequence-of-failure considerations) to inform inspection planning and prioritization in the HFTD and WUI areas. The illustration below provides a visual representation of the integration of AI and data analytics into RIDI informing both the scope of inspections and improving the quality of inspections.



Through early 2023, SDG&E had used IIP to assess over two million images to identify twenty different types of damage with an accuracy rate of over 85%. The accuracy and efficacity of the IIP tool was heavily reliant on the volume of data obtained during the 2019-2022 period; without the number of images obtained early in the program, IIP tool development and accuracy could have been compromised and the achieved efficiencies might not have been realized. IIP development was also a standalone initiative in SDG&E's 2023-2025 WMP (WMP.1342), generating compliance obligations under SDG&E's WMP.[14]

SDG&E has also leveraged lessons learned and technologies developed to share and support development of similar inspection programs across the country. Use of drones for inspections is increasingly recognized as a best practice in a comprehensive asset management regime. SDG&E actively shares information about its drone program, data, and AI capabilities developed through IIP with other investor-owned utilities (IOUs) and the broader utility industry[15] through formal collaboration groups, including the Utility Inspection & Geospatial Alliance, the Open Power AI Consortium (an EPRI venture), and the AWS Energy & Utilities Customer Advisory Council. SDG&E also regularly educates and exchanges lessons learned through industry conferences and forums, including recent presentations at DistribuTECH on the evolution of compliance using drones, data, and AI.[16] This collaboration helps advance industry best practices while ensuring SDG&E's investments deliver value beyond a single utility.

Q. Please provide an overview of the internal and external personnel that worked on this Program and contributed to the costs?

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[14] *See id.* at 137 (describing WMP three year objectives, including "[c]ontinue intelligent image processing, utilizing artificial intelligence and innovation to detect damage to high fire risk distribution assets and vegetation.").

[15] AmazonNews, *How machine learning and drones are helping prevent wildfires, Using AWS image recognition tools, San Diego Gas & Electric is reimagining the 140-year-old utility for today's demands, and tomorrow's climate* (May 17, 2022) available at https://www.aboutamazon.com/news/aws/how-machine-learning-and-drones-are-helping-prevent-wildfires.

[16] DTECH, 2026 Event Schedule, *Evolution of Compliance Risk Assessment* (February 5, 2026) available at https://www.distributech.com/2026-event-schedule/evolution-of-compliance-risk-assessment.

A. For DIAR, management and oversight of the program was performed by internal SDG&E employees with the support of an external Project Management Office (PMO) contractor to provide staffing resources necessary to manage the program. The inspection work was performed by external drone pilots and QEW inspectors. Support for inspections and construction repair work, including safety, security, environmental, aviation, access protocol, and customer relations was also provided by external contractors. Technology support for software, data management and AI/ML was performed by external contractors with SDG&E management direction and oversight. Engineering and support services related to repairs was also performed by external contractors with SDG&E management and oversight. SDG&E supply management follows established processes to address competitive contractor rates and cost efficiency, as further discussed below.

When RIDI was implemented in 2023, management and oversight was performed solely by internal SDG&E employees with no PMO support, in part due to knowledge gained over the course of the program as well as the reduction in the required number of inspections. The inspections were performed by external drone pilots and QEW inspectors. Support for inspections and construction repair work, including safety, security, environmental, aviation, access protocol, and customer relations was provided by external contractors. Technology support for software and AI and Machine Learning was performed by external contractors with SDG&E management direction and oversight; however, data management transitioned to the use of internal systems and was primarily performed by internal employees. Engineering, construction, and support services related to repairs were also primarily performed by internal resources.

Q. What was the procurement strategy for the external vendors and contractors that performed work on this Program?

A. In 2019, SDG&E utilized an existing master service agreement (MSA) for Program Management services that had negotiated rates and the requisite insurance requirements (including aviation liability insurance) to start the drone program. The drone vendors, engineering and other inspections and repair support contractors were subcontractors to the prime under this existing MSA. Existing agreements with SDG&E's Aviation Services group were also utilized to provide safety and security support to the drone pilot teams and ensure that drone inspections were performed safely and in compliance with all Federal Aviation Administration requirements. Multiple vendors were also engaged to identify a platform that would support flight planning, image capture/upload, and inspections. The procurement strategy allowed SDG&E to establish workflows and processes and develop a project execution plan that was then used to develop scopes of work for the next phase of inspections in Tier 2 that started in 2021.

In 2021, SDG&E utilized a new Project Management Organization (PMO) that was selected through a competitively bid request for proposal effort. The PMO provided support related to overall program management, flight/assessment planning and management, public outreach support, environmental and permitting support, technology and data management, project controls and reporting, issue repair tracking, management and support, engineering and construction coordination, and close-out.

SDG&E also competitively bid the image capture and inspection work and field aviation safety/security support this next phase of DIAR. The drone vendor and inspection contractor that was selected in 2021 as a result of the competitive request for proposal process and continued to be utilized for the 2023 inspection work. However, SDG&E negotiated with the vendor to reduce the per pole unit rate for inspections starting in 2023 because of improved pilot experience, improved customer coordination that facilitated improved inspection production, and other process improvements resulting from lessons learned over the 2019-2022 period.

Construction services performed by external contractors throughout 2019-2023 were subject to competitively bid MSAs with SDG&E's Construction Management department. Material procurement used for repairs also goes through the Supply Management department and is competitively bid on a regular basis and undergoes a robust quality assurance inspection process.

Finally, SDG&E used an MSA that was competitively bid in 2017 to perform the work related to IIP and developing the Machine Learning models.

With the transition to RIDI in 2023 and use of SDG&E's internal work management system, an outside PMO was no longer needed to support RIDI, however, the PMO remained to support ongoing DIAR repair work and reduce the instance of backlogs. External engineering groups and construction contractors were also used for the majority of DIAR repairs, as well as RIDI repairs where internal resources were not available or had limited capacity.

Q. Where do these inspections occur?

A. From 2019-2020, DIAR inspections occurred in the Tier 3 HFTD. In 2021-2022, after completion of all in scope overhead electric distribution infrastructure in Tier 3, SDG&E continued the DIAR program with inspections of the entire Tier 2 HFTD and higher wildfire risk areas within the WUI.

In 2023, upon the transition of DIAR to a risk informed cyclical inspection program, RIDI, SDG&E used an inspection prioritization model to conduct inspections of the highest risk assets across the Tier 2 and Tier 3 HFTD and higher risk WUI areas. Cyclical, risk informed drone inspections of infrastructure continue as a component of SDG&E's WMP.

Q. Is this program specifically limited to the HFTD? If not, are the costs recorded to SDG&E's WMPMA limited to costs to implement this program in the HFTD?

A. No, the program was not specifically limited to the HFTD. Costs of inspection and repair of poles within select and higher risk areas of the WUI were also recorded in SDG&E's WMPMA, consistent with SDG&E's 2023 WMP.[17]

Q. If the program scope and costs includes work outside the HFTD, why?

A. From 2021-2023, SDG&E performed approximately 6,200 drone inspections in the WUI through the DIAR and RIDI programs. The majority of these poles were located in coastal canyon areas, which pose a unique fire risk due to terrain and winds during Santa Ana conditions. SDG&E focused additional resources, such as drone inspections, in these coastal canyon areas in part due to the Coastal Fire in 2022, during which an ignition in such an area led to the destruction or damage of 32 structures and two firefighter injuries.[18]

In addition, some WUI areas, especially coastal canyons, present limitations in traditional inspection effectiveness due to steep slopes, dense vegetation, limited access roads and narrow rights of way with many environmental constraints. Ground inspections in these areas are slower and often inspectors have difficulty safely accessing pole tops and crossarms. This leads to potential misses in identifying damages that could result in an ignition event.

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[17] *See* SDG&E 2023-2025 Base WMP (October 23, 2023) at 40, 140.

[18] FEMA, California Coastal Fire, FM-5439-CA, available at https://www.fema.gov/disaster/5439#local-resources.

Drone inspections of this infrastructure were a reasonable means of identifying non-obvious issues on electrical infrastructure in the WUI given the comparatively lower cost of inspections and repairs versus SDG&E's hardening programs, and in light of the risk of catastrophic fire in the event of an ignition in the WUI. The WUI poses specific risk because it is where electric infrastructure, dense vegetation, and communities intersect, meaning that even minor equipment failures can escalate into catastrophic wildfires. Due to the proximity of larger populations, ignitions in or near the WUI pose the potential for catastrophic damage, as evidenced by the Eaton Fire, which burned into a WUI area.[19] In 1985, San Diego experienced the Normal Heights Fire, a destructor urban wildfire that—in part due to its proximity to larger population density—destroyed or damaged over 100 structures, left hundreds homeless, and caused widespread devastation across 300 acres.

Further, drone inspections of infrastructure advanced SDG&E's situational awareness capabilities, facilitating better PSPS decision-making for infrastructure in high-risk areas, which include the WUI depending on wind and other conditions. This is further discussed later in my testimony.

Q. What is the cycle and scope for inspections under this Program and how was this determined?

The Program was divided into three phases between 2019-2023: DIAR Tier 3, DIAR Tier 2/WUI and RIDI. All three phases had slightly different cycles and scope for inspections.

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[19] CALMatters.org, The LA County fires devastated homes in the wildland urban interface. Here's what that is (January 28, 2025) available at https://calmatters.org/environment/wildfires/2025/01/la-county-fires-wildland-urban-interface/.

1. DIAR Tier 3

From 2019-2020, SDG&E inspected all distribution overhead poles in the Tier 3 HFTD, our highest fire risk area. Approximately 2,000 poles were removed from the scope of inspections since they had been recently replaced through other programs.

2. DIAR Tier 2

In 2020, SDG&E formed a multidisciplinary leadership team formed to review the existing DIAR program and explore future options. Representatives on the team included personnel from ten different departments including project management, QA/QC, electric operations, aviation services, wildfire mitigation, construction services, asset management, supply management, engineering, and central business planning. The team reviewed the inspections already performed, the types of issues identified, and the number and severity of findings identified; compared drone inspections with traditional inspection results; discussed the efficacy of ground versus aerial inspections; reviewed program processes and procedures as well as lessons learned; and examined historical financials and future forecasts for multiple scenarios related to repair completion and inspection cycles, including discontinuing drone inspections after Tier 3 HFTD was complete. Ultimately the team concluded that drones were a valuable tool and should be used to support future inspections.

Based on this effort, SDG&E elected to continue DIAR in the Tier 2 HFTD to support development of a complete baseline of our distribution system in the HFTD, reduce overall wildfire risk, and allow time to incorporate drone inspections and lessons learned into SDG&E's CMP program. Scope and structure of the program expansion was approved by SDG&E senior leadership. DIAR Tier 2 included inspections and associated repairs of the entire Tier 2 HFTD and higher risk WUI areas. From 2021-2022, approximately 3,000 distribution poles were descoped from Tier 2 HFTD inspections due to recent replacement or scheduled replacement or removal through other programs.

Drone inspections performed from 2019-2022 allowed SDG&E to obtain a full system health baseline for SDG&E's HFTD and higher risk WUI areas and obtain data necessary to implement a more informed risk-based inspection program in later years.

3. RIDI

Based on completion of DIAR inspections, SDG&E evaluated program results and determined that continuing a blanket approach to drone inspections would likely yield diminishing wildfire risk-reduction benefits, given the interval inspection timelines. At the same time, DIAR imagery and repair outcomes enabled the development of advanced risk models and IIP tools capable of improved prediction of assets that posed the greatest risk of having a condition that could pose a fire or safety hazard. SDG&E used this information to explore development of a risk informed drone inspection program, targeting these assets to obtain longer-term program cost efficiencies on an ongoing basis.

Consistent with OEIS guidance emphasizing risk-informed mitigation, SDG&E discontinued DIAR and launched the RIDI program in 2023.[20] RIDI shifted the program scope from HFTD-wide coverage to targeted inspection of the highest-risk assets. At the same time, SDG&E discontinued the HFTD Tier 3 inspections, which targeted approximately 13,500 poles inspections solely in the Tier 3 HFTD annually, to further obtain efficiencies. Similar to the HFTD Tier 3 Inspection Program targets, SDG&E elected to plan drone inspections of

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[20] *See, e.g.* SDG&E 2023-2025 Base WMP (October 23, 2023) at 44 (discussing improvement in asset inspections through risk informed prioritization of drone inspections beginning in 2023).

approximately 13,500 poles annually, or approximately 15% of poles in the HFTD and higher risk WUI areas.

Under RIDI, the poles selected for inspection were not fixed or purely time-based like traditional inspection efforts. Instead, SDG&E developed a model that incorporated consequence of wildfire risk data, asset data (*e.g*., age, location, material, height, elevation, number of attachments), environmental considerations, such as higher wind areas and soil types, as well as damage predictions from ML models run on imagery from prior years. For example, drone imagery may have identified minor crossarm degradation that did not require repair at that time, but that information was used to inform the inspection prioritization model of the higher potential risk related to that facility as the passage of time could increase the extent of the damage. Once all of the poles received a risk score, the scope of inspections was reviewed to take into account navigation efficiency that would help decrease per pole inspection costs by selecting poles in similar areas.

Q. Did you make any changes to the Program between phases to reduce costs?

A. Yes. DIAR Tier 3 included a field-support model that included dedicated visual observers paired with drone pilots and increased aviation, safety and public relations field staffing. Based on experience gained during the DIAR Tier 3, DIAR Tier 2 reduced the number of field personnel by eliminating the visual observer and pairing the drone pilot with a QEW Inspector and reducing the ratio of aviation safety support to inspection crew. We also reduced the image capture requirements from three levels to two levels (eliminating shots required from below the conductor) and replacing those with a ground capture. This reduced the average number of images per pole from ~40 to ~20.

SDG&E also saw efficiencies from software improvements over time, including more integrated flight planning and navigation tools. Use of competitive bidding also reduced and fixed the inspection costs and improved contractor rates in multiple areas. Finally, elimination of the startup costs and increased experience of program personnel in all areas contributed to increased production and lower overall costs.

For RIDI, the reduction in the number of inspections, a negotiated decrease in the per pole inspection costs, elimination of the PMO and use of more SDG&E internal resources and enterprise workflows was all done to reduce program costs without compromising, quality, safety or compliance.

Q. Are there any compliance requirements associated with this program?

A. Yes. The program is a regulated wildfire mitigation activity approved by the CPUC and, subsequently Energy Safety through SDG&E's WMPs, which establish mandatory annual targets, scope, and funding levels that SDG&E is required to implement; failure to execute these approved programs would expose SDG&E to regulatory enforcement and potentially jeopardize its ability to obtain a safety certificate. The program is subject to oversight and verification by Energy Safety and independent evaluators, who, pursuant to statutory requirements, assess whether SDG&E funded and implemented approved WMP activities as committed, including drone inspections and resulting repairs.[21]

GO 95, Rule 31.2 also requires SDG&E to inspect lines "frequently and thoroughly for the purpose of ensuring that they are in good condition so as to conform with" GO 95. Drone

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[21] *See* Public Utilities Code Section 8386.3.

inspections are part of our inspection strategy to support the health of our overhead lines in the HFTD and WUI.

Q. What were SDG&E's program targets for the DIAR and RIDI programs in its WMP?

A. The table below provides the WMP targets for the subject years. However, while the WMP target represents inspection units only, the WMP cost targets include forecasted repair costs for the over 25,000 issues identified by DIAR and RIDI inspections from 2019-2023.

Table JK- 7: Drone Program WMP Targets ($000s)

Target	2019	2020	2021	2022	2023	Total
WMP Target Capital ($)	$-	$3,600	$13,595	$26,402	$80,740	**$124,337**
WMP Target O&M ($)	$-	$50,500	$35,358	$52,000	$53,171	**$191,029**
WMP Target (Inspection Units)	0	33,000	22,000	22,000	13,692	**90,692**

Q. Did SDG&E achieve its WMP targets?

A. SDG&E met or exceeded its inspection targets for 2019-2023. The table below provides the actual spend and inspections performed for the subject years. Please reference the Drone Investigation Assessment and Repair workpapers found in SDG&E-T3-WMPMA-07-E for additional information.

Table JK-8: Drone Program Actual Spend and Inspections ($000s)

Actual	2019	2020	2021	2022	2023	Total
Capital ($)	$274	$16,145	$12,890	$32,266	$60,666	**$122,241**
O&M ($)	$13,557	$45,964	$33,170	$44,755	$53,301	**$190,747**
Inspections	10,524	26,787	23,081	25,976	15,234	**101,602**

Q. Are drone inspections coordinated with any other programs?

A. Yes. As previously mentioned, from 2019-2022, in scoping drone inspections SDG&E excluded poles scheduled for replacement or recently replaced. Generally, however, DIAR inspections were not conducted in conjunction with any other programs. This practice was consistent with Energy Safety's findings and requirements that, "[w]hile drone inspections are useful to supplement routine inspections, SDG&E must demonstrate that its personnel are continuing to properly perform routine distribution inspections."[22]

Part of the reason for conducting drone inspections independently of traditional inspection programs was to provide an objective and statistically meaningful way to evaluate the advantages of drone inspections versus traditional alternatives by creating an independent verification dataset. Executing drone inspections separately—rather than integrated with ground patrols or detailed inspections— allowed SDG&E to assess whether existing programs consistently identified the same conditions, whether certain defect types were missed in specific inspection programs, and whether inspection frequencies, methods, or scopes were appropriately calibrated to actual field conditions. Maintaining independent inspection programs during this period reduced confirmation bias, prevented inspectors from being influenced by prior findings or prior work performed on the same assets, and enabled a clearer comparison of detection rates, condition severity, and corrective outcomes. As a result, drone inspections were used as a diagnostic tool to validate assumptions underlying traditional programs, identify systemic gaps or strengths, and support continuous improvement by informing adjustments to inspection methodologies, prioritization, and resource allocation—without undermining or duplicating the core compliance function of existing inspection requirements.

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[22] SDG&E 2023-2025 Base WMP (October 23, 2023) at 45.

Additionally, during this time, drone inspections were limited to only identifying potential fire and safety conditions, therefore drone inspections did not qualify to meet the compliance requirements of Detailed inspections.

In 2023, RIDI expanded the scope of inspection beyond just identifying potential fire and safety hazards, to include conditions required for identification during Detailed Inspections. With this change, SDG&E cancelled detailed inspections on poles within the scope of RIDI in 2023, and the RIDI inspection satisfied compliance requirements for Detailed Inspections. This resulted in approximately 2,000 Detailed Inspections being removed from scope, reducing redundancy of inspections and saving costs for Detailed Inspections. These efficiencies were gained as a product of the volume of data obtained over the 2019-2022 DIAR program, allowing for confidence in utilizing drone inspections to satisfy other inspection program requirements

Q. Did you make any changes to your traditional inspection programs as a result of lessons learned with the drone program?

A. Yes. SDG&E made targeted changes to its traditional inspection programs based on lessons learned from the drone inspection program. Specifically, we concluded that while drones are particularly effective at identifying certain high-risk asset conditions—especially damages not easily visible from the ground – there were other changes that could improve the quality of our traditional inspections.

First, we started a dedicated inspection team for overhead inspections and patrols where individuals received focused training related to identification of conditions associated with potential fire, safety, reliability or compliance risk, and were not necessarily involved in the construction of the facilities or corrective work performed. This training facilitated independence and reduced potential inconsistent priorities between the individuals performing inspections and those responsible for constructing and maintaining the facilities. It also generated cost savings by prioritizing resources to perform repairs.

Next, SDG&E developed enhanced training for all personnel to improve the quality of inspections. Specifically, we recognized the need to reinforce the importance of identifying customer hazards and hazards related to communications infrastructure during inspections. We also updated the inspection software and equipment used by inspectors to make it easier for inspectors to access facilities, complete the inspection and take photos of damages identified during inspections. Finally, we identified the need to update our condition codes and work management processes. All these changes are in various stages of implementation.

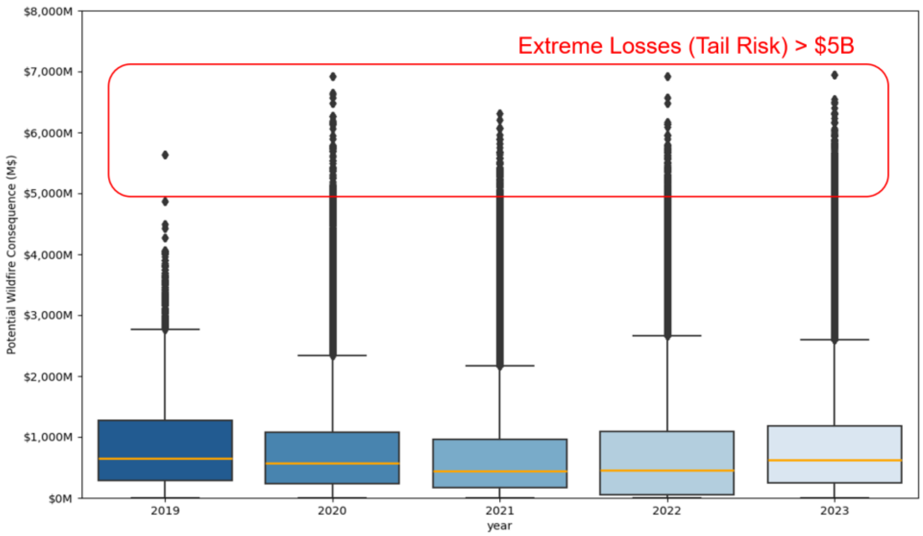
Q. Describe any studies on the effectiveness of this program

A. In 2022, SDG&E completed a third-party supported analysis evaluating the effectiveness of its drone inspection program. The study reviewed multiple years of drone and traditional ground inspection data and found that drone inspections materially improved the identification of high-risk asset conditions, including accelerating the detection of emergency-level damage compared to traditional inspection methods. These findings helped inform the evolution of SDG&E's drone inspection program from DIAR to the RIDI program that start in 2023, as well as its integration into our broader asset management and wildfire mitigation strategy. A copy of this study is attached as Appendix A to this testimony.

Q. Describe any studies or estimates on the wildfire risk reduction from this program.

A. From 2019-2023, drone inspections identified, on average, 18% more potential fire hazards than traditional detailed overhead CMP inspections within the SDG&E inspection workflow. An evaluation of potential wildfire impacts during extreme fire weather, based on the locations of High-Priority Infractions identified through 2019–2023 drone inspections, estimates that an average potential wildfire resulting from these infractions could have resulted in costs of approximately $829 million. Additionally, this analysis reveals a significant wildfire tail risk in SDG&E's service territory, with certain high-consequence locations projecting potential damages exceeding $5 billion.[23]

Figure JK- 10: Distribution of Estimated Wildfire Consequences (Average ≈ $829M; Tail Risk > $5B)



Year	Average Potential Loss (M$)
2019	$866.17 ± 91%
2020	$855.97± 111%
2021	$763.24 ± 122%
2022	$761.78 ± 122%
2023	$865.79 ± 102%

The analysis underscores that if even one of the 86,162 inspections completed from 2019-2022 and the 15,234 inspections in 2023 identifying one of the 365 emergency or 35,114 other asset repairs or replacements were missed and subsequently resulted in an ignition under potential worst-case fire-weather conditions, the financial and safety consequences of that incident alone would far exceed the total $350[24] million cost of SDG&E’s drone programs, fully

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[23] Wildfire consequence values were calculated using Technosylva’s 2025 estimates for acres burned and structures destroyed under 24-hour unsuppressed fire simulation scenarios. These simulations were conducted for selected days between 2013 and 2025 when extreme fire weather conditions were present, ensuring that the estimates reflect high-risk scenarios consistent with historical patterns of severe wildfire behavior. Dollar conversion factors for structures destroyed and acres burned estimates are detailed in SDG&E 2026–2028 Base WMP (September 30, 2025), available at https://www.sdge.com/sites/default/files/regulatory/SDG%26E_2026-2028_Base-WMP_R2.pdf.

[24] Cost reflects fully loaded program costs.

justifying the costs from a cost-benefit perspective. These findings highlight the disproportionate financial and safety risks associated with missed high-priority repairs and reinforce the cost-effectiveness of proactive drone-based inspections and repairs as a critical wildfire mitigation strategy.

Q. Did SDG&E consider any alternatives to this program?

A. Yes. Drone inspections compared favorably to alternatives, principally because they identified issues that are less obvious during other inspections. Further, alternative inspection methods of these assets were sometimes impossible or not cost-effective, as many of the poles and wires in SDG&E's HFTD areas are in remote or sometimes inaccessible areas. The benefits of drone use for inspection has been the subject of various studies with the conclusion that "drones can decrease the time and cost of the inspection, while increasing the reliability, safety of the inspection, and data consistency."[25] Alternatives considered the use of helicopters, bucket trucks, and climbing and are further discussed below.

4. Helicopters

The use of a helicopter for inspections of distribution infrastructure requires low-altitude operations, creating significant noise and dust impacts. Further, it is difficult to observe all conditions from the vantage point of a helicopter, a fact similarly noted by PG&E in describing

[25] MDPI, Drone-Based Non-Destructive Inspection of Industrial Sites: A Review and Case Studies (2021) at 23, available at https://www.mdpi.com/2504-446X/5/4/106.

why it elected to end most helicopter inspections in lieu of drone alternatives.[26] PG&E also noted that helicopters failed to offer sufficient image quality. Another study also found that helicopter inspections can miss issues clearly identified by drones.[27]

5. Bucket Trucks

Bucket trucks require physical access to each pole, which is resource intensive, time-consuming, environmentally impactful, and operationally impractical. Roads do not exist to all SDG&E distribution assets, so the use of bucket trucks is improbable, if not impossible, in many locations.

6. Climbing

Climbing poles to observe and inspect for issues is not reasonable, practical, or safe, as climbing poles to observe electrical components from above requires outages and puts workers at a greater safety risk. Drones offered superior efficiency and precision while minimizing environmental disruption, making them an optimal solution for asset inspections.

Q. Did SDG&E's drone programs include repairs?

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[26] PG&E 2023-2025 WMP R8 (February 13, 2025) at 488, available at https://www.pge.com/assets/pge/docs/outages-and-safety/outage-preparedness-and-support/021325-2023-2025-wmp-r8.pdf. ("Drones will be the main vehicle of inspection…") (*See also* at 1075-1088, discussing various aerial and ground inspection methodologies and concluding "the drone only method is the most promising for aerial inspections in the near-term. The value proposition for aerial inspections lies in detecting conditions that are challenging to see, especially those that are so severe as to create an immediate ignition or public safety risk. … It was the methodology with the lowest unit cost and the ability to scale the most quickly since both image capture and desktop inspection can be done rapidly. Helicopter-only inspections produced lower quality pictures at a higher unit cost. Due to the challenges associated with helicopter-only inspections, PG&E believes that helicopter-only is better used to supplement other aerial methods as needed or considered as a longer-term opportunity.").

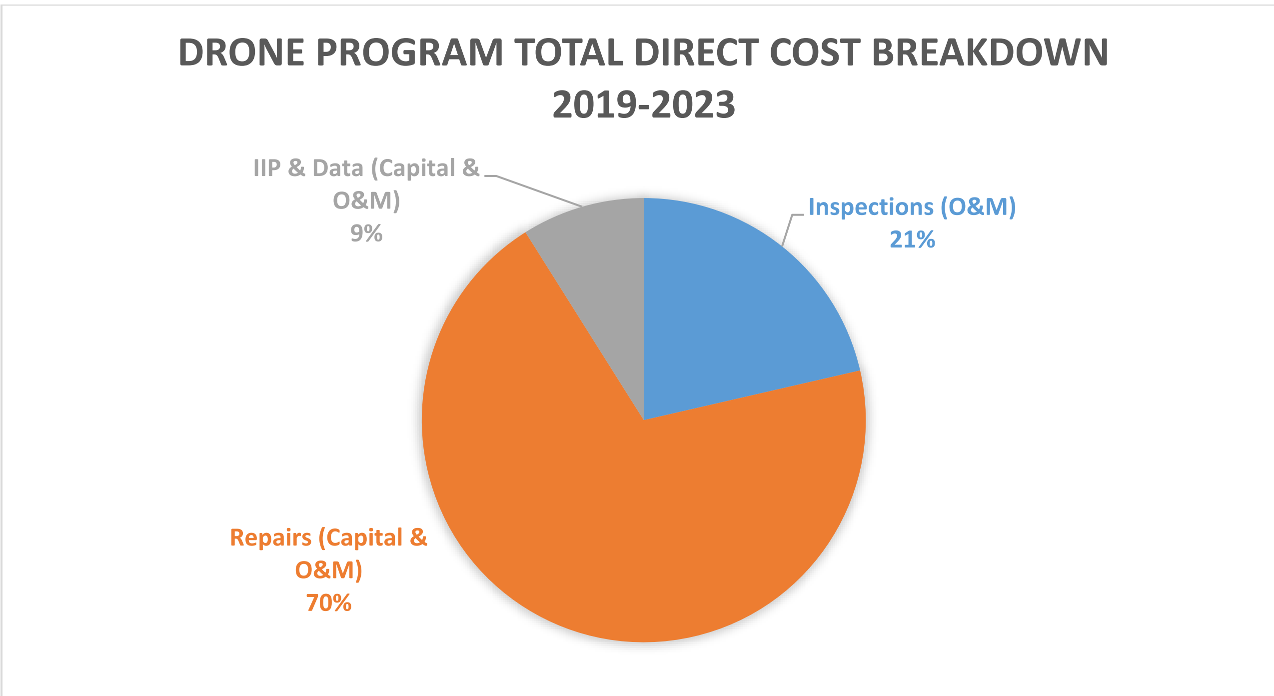
[27] AeroDeploy, Drone Inspection Cost vs Traditional Methods: Real Numbers from 10,000+ Inspections, available at https://aerodeployuav.com/drone-inspection-cost-vs-traditional/.

A. Yes. Costs of repairs arising from these programs were reported in SDG&E's WMPs as well as its Track 2 and Track 3 requests.

Q. What portion of the costs are attributable to repairs?

A. Approximately 70% of the capital and O&M costs are contributable to repairs as shown in the figure below.

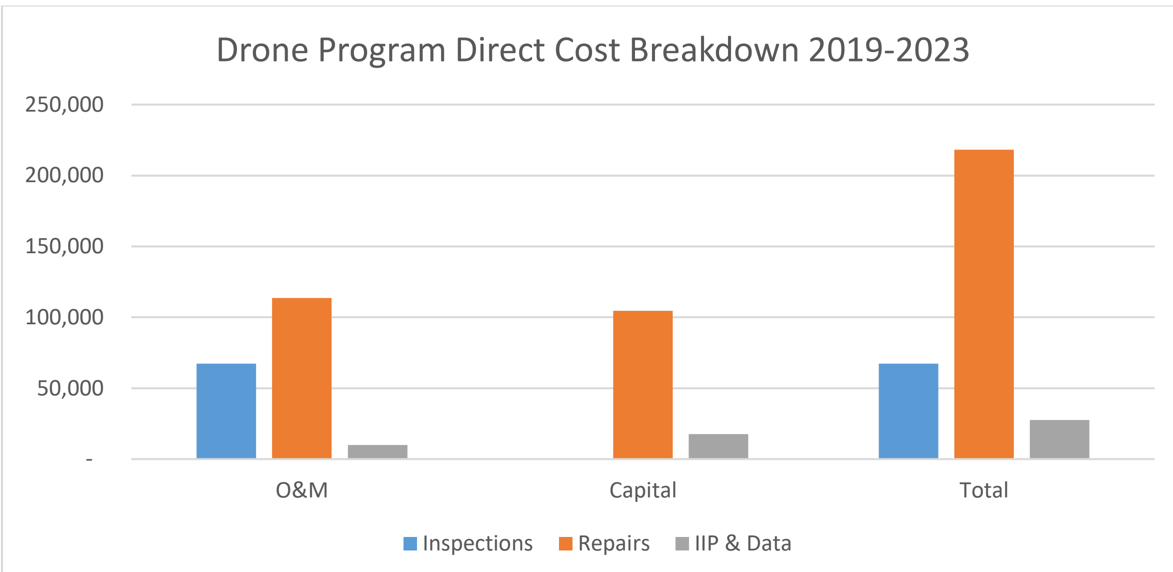
Figure JK- 11: Total Drone Program Cost Percentages



Q. Provide a breakdown of costs included in this program between inspections, repairs and Artificial Intelligence/Data.

A. This Program includes O&M costs to perform image capture and inspections, develop the technology and software needed to perform and manage the work and data and costs to perform the O&M repairs associated with infractions found during these inspections. The Program also includes capital costs to develop the technology and software needed to perform and manage the work, develop the Machine Learning models and perform the capital repair work associated with infractions found during these inspections. The development of Machine Learning models to perform asset identification and damage detection are part of our IIP work. Accordingly, I collectively refer to the technology components of the drone program below as "IIP & Data." The chart below provides a breakdown of the O&M and Capital costs between these three main categories: Inspections, Repairs and IIP & Data.

Figure JK- 12: Breakdown of Total Drone Program Costs



Additional cost details can be found in the Drone assessments workpapers found in Exhibit SDG&E-T3-WMPMA-07-E submitted with this testimony.

Q. Describe the repairs that have occurred as a result of these programs?

A. The chart below provides a high-level illustration of the different categories of repairs we tracked as part of the drone program. These categories represent the type of resolution for the condition identified rather than the condition itself. For example, emergency repairs included a variety of issue types, but all posed an imminent threat of impact to safety, including fire. Other engineering represented issues that required pole loading analysis and design work, but did not require a pole replacement, such as installation of a new guy or anchor or transformer replacement. O&M repairs were generally minor repairs that did not require a pole loading analysis such as replacing chipped or damaged insulators, loose or missing hardware, or slack guy wires. CIP or Communication Infrastructure Provider repairs were related to issues with third party communications attachments that required notification to the attaching company and coordination on resolution of the repair. Similarly, customer repairs were related to customer owned equipment that required some type of remediation, such as a bent riser, missing insulation on the customer's service connection, or damaged electrical panel. Customer repairs also required notification and coordination with the customer to resolve, which was also included in the repair costs program. Finally, overlap repairs were those that affected poles in scope with another program. As discussed earlier, we coordinated with those other project teams to reduce duplication and redundancy of work as described in more detail below.

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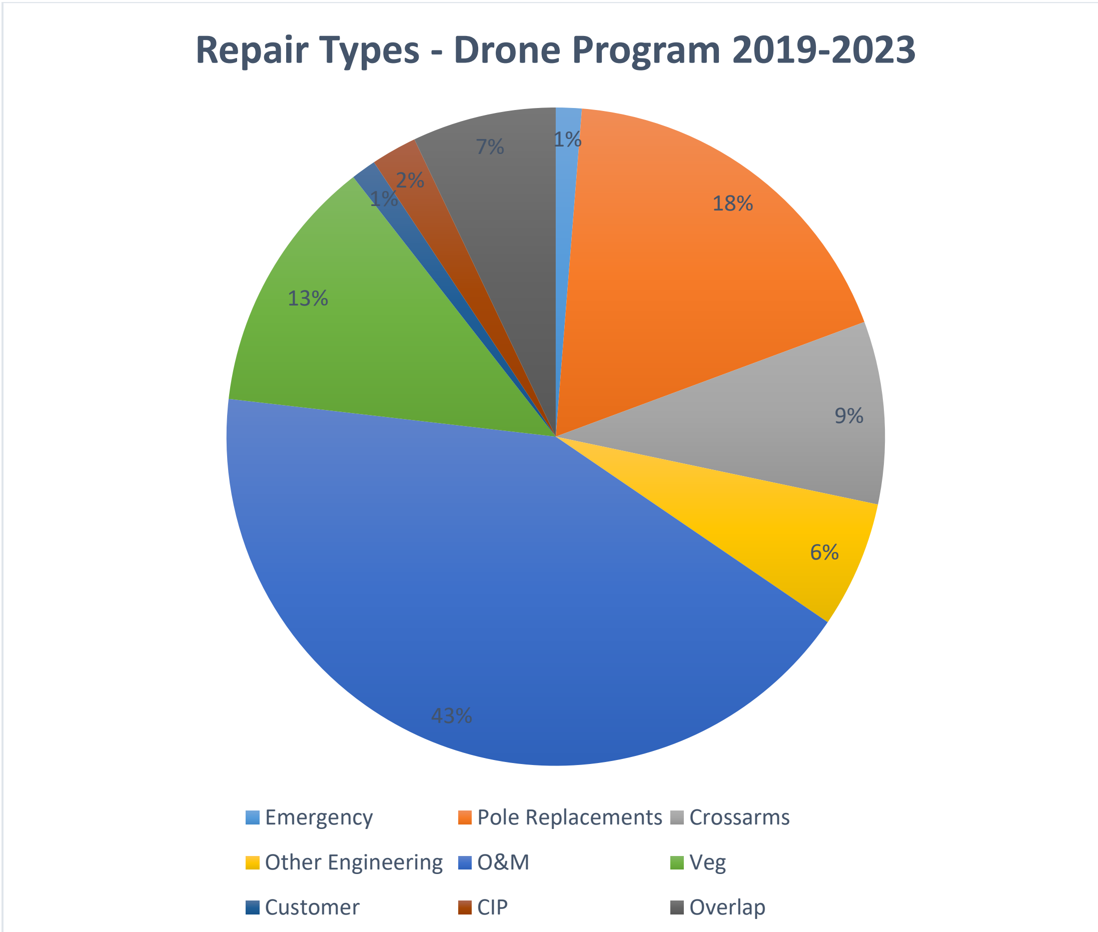
Figure JK-13: Drone Program Repair Types



Overall the top 10 issue categories (not in order of volume) were:

1. Damaged arrestor, insulator, armor rod or other pole top work
2. Damaged pole
3. Damaged crossarm
4. Damaged conductor or equipment grounding
5. Vegetation clearance issue
6. Exposed connection
7. Loose communications attachment
8. Loose or missing hardware
9. Damaged, missing or loose guy or anchor
10. Improper splice

Q. Are repairs consolidated with this or any other construction/maintenance program?

A. Yes, we reviewed all DIAR and RIDI repair work for overlap with traditional inspection findings and other construction and maintenance projects and programs, such as traditional corrective maintenance repairs, Strategic Undergrounding, Covered Conductor, expulsion fuse replacements, hot line clamp replacements, and other projects/programs. That is also represented in the figure above under "Overlap." Repairs and replacements were coordinated with other project teams to identify repair efforts on poles either led through the DIAR project or performed through the scope of the other project. If the latter was selected, the other Project would take the lead to complete the repair or scope of DIAR, or each program would be required to continue with their own scope. For example, if DIAR identified the need to replace a broken insulator, but SDG&E also intended to replace the pole and infrastructure through planned covered conductor installation, the covered conductor project would incorporate and satisfy the scope of the DIAR work.

Overall DIAR identified approximately 2,200 overlapping poles with other programs and coordinated the repair to either be handled by DIAR or the other program, achieving cost efficiencies with drone repairs and other project and program costs.

Q. Are there requirements that SDG&E perform these repairs?

A. Yes. "To ensure safe operations and the reduction of wildfire risk, Energy Safety expects that Electrical Corporations maintain electrical lines and equipment through: (1) thorough inspection of those lines and equipment to identify conditions that increase wildfire risk, and (2) expedient remediation of conditions identified during inspections to reduce known wildfire risks. Unresolved conditions leave known wildfire risk on the system."[28] Further, in 2020, Energy Safety noted the requirements that SDG&E repair Level 1 conditions immediately, and found that, overall, "SDG&E took action to resolve and remedy actions in a timely manner."[29]

Further, SDG&E was required to repair facilities identified as having potential violations of General Orders and other requirements. While SDG&E's drone program was in addition to its auditable maintenance program as described in GO 95, Rule 18B; Rule 18A states that electric utilities are responsible for taking appropriate corrective action to remedy potential violations of GO 95 and safety hazards posed by their facilities.

Q. Please provide the average costs for capital and O&M repairs for the Drone program versus other CMP repairs.

A. Below is a comparison of the total cost and cost per unit for repairs performed as part of DIAR versus repair costs resulting from other inspection program findings. But as explained in more detail below, the direct cost comparison between repairs arising from SDG&E's drone inspection programs and repairs arising from other AM&I programs is not "apples to apples," because the costs related to CMP repairs do not include costs related to engineering, design, permitting, and environmental reviews, which are pooled and separately recorded to SDG&E's authorized overhead pools accounts. These activities can be significant cost drivers depending on the nature of a project. Engineering, design, permitting and environmental costs incurred to make

[28] OEIS's Annual Report on Compliance of SDG&E's 2020 WMP (January 2023) at 54-55, available at https://energysafety.ca.gov/news/2023/01/10/energy-safety-issues-final-annual-report-on-compliance-for-san-diego-gas-electrics-approved-2020-wildfire-mitigation-plan/.

[29] *Id.* at 67.

repairs arising from drone inspections were directly charged to the program and are included in the table below.

Table JK- 89: Capital Repair Cost Comparison

	2019	2020	2021	2022	2023	Total
Total Drone Capital Repair Costs ($000s)	274	12,962	8,550	25,589	57,157	**104,532**
Cost/Unit	$34,204	$39,398	$25,221	$57,119	$32,003	**$35,921**
Total CMP Capital Repair Costs ($000s)	12,727	12,431	16,835	15,621	10,837	**68,451**
Cost/Unit	$16,857	$18,254	$23,061	$24,757	$23,058	**$20,952**

Table JK- 910: O&M Repair Cost Comparison

	2019	2020	2021	2022	2023	Total
Total Drone O&M Repair Costs	77	27,756	10,564	30,677	44,584	113,658
Cost/Unit	$1,185	$6,651	$3,961	$7,710	$6,160	$6,271
Total CMP O&M Repair Costs	0	22	744	381	454	1,601
Cost/Unit	N/A	$4,473	$7,666	$3,003	$5,535	**$5,148**

Q. Why are the capital unit costs higher for drone repairs than repairs identified from other inspection efforts?

A. There are multiple factors that contributed to the higher capital unit costs for DIAR than other corrective maintenance repairs.

First, many of these costs were subject to significant inflationary pressures due to the economic conditions and supply chain limitations present during the COVID-19 pandemic and a period of record inflation from 2020-2023.

Additionally, DIAR engineering costs were charged directly to the program. Costs recorded to other corrective maintenance repair programs are recorded to SDG&E's authorized engineering overhead pools. As a result, the engineering costs associated specifically with DIAR serve to inflate the unit costs for comparison purposes, because they are considered a direct cost while the other programs' engineering costs are included within the indirect costs and thus not included in the per unit calculation.

Further, while both the DIAR program and other CMP inspections performed pole replacements in the HFTD, the repair processes differed materially during the 2019–2022 period due to the maturity of the programs, the volume of the findings, and how the work was managed and executed. When the DIAR program started, inspections were planned, scheduled and performed outside of SDG&E's scheduling and inspection enterprise systems, and the findings were not integrated into SDG&E work management systems. While SDG&E did explore a manual process to create notifications or work orders resulting from the drone inspections, the volume of findings were much greater than internal resources could manage at the time, both from a design, engineering and construction perspective.

Accordingly, to avoid delays in addressing or repairing findings (which could result in an ignition or safety event), reduce the risk of non-compliance with other General Order and applicable requirements, and promote safe and reliable operations through reduced PSPS impacts, SDG&E elected to manage the repair work outside of existing work management systems and assign external resources to manage the work and engineer and design the repairs and execute the construction work needed to complete the repair/pole replacement. So, where smaller O&M repairs were able to maintain a similar unit cost to our traditional CMP repair work, the more complex capital repairs, primarily pole replacements, resulted in approximately 42% higher costs from 2019-2023 due to the reasons stated above and the need to develop new work processes, engage external resources, and provide necessary additional oversight and management. For repairs resulting from the RIDI program beginning in 2023, we integrated the repairs into traditional work management systems and were able to realize a decrease in unit costs between DIAR and RIDI by managing the repairs with other CMP inspection findings and performing more of the RIDI repair work in house (both engineering and construction).

Finally, due to the volume of repair work, there can be a delay between when repair work begins and when it is completed, which can result in fluctuations in when costs are incurred. For example, between 2022 and 2023, much of the preparation costs for pole replacements completed in 2023 were incurred in 2022.

Q. Were these costs forecasted or authorized in SDG&E's prior GRC?

A. No. SDG&E's DIAR and RIDI programs were developed after SDG&E submitted its Test Year 2019 GRC testimony and no associated costs were authorized in D.19-09-051.

Q. Are there any particular cost drivers that resulted in increases over authorized?

A. The drone program was added to SDG&E's AM&I programs to address wildfire risk after the enactment of SB 901 and AB 1054 and supplemented SDG&E's existing inspection programs. Accordingly, the drone inspection and repair costs were not included in SDG&E's prior GRC and were therefore not included in the authorized funds. As stated earlier in my testimony, 70% of the drone program costs from 2019-2023 are related to repairing potential fire and safety hazards identified during drone inspections. The number and severity of conditions identified, and repairs needed were not contemplated and far exceeded any costs associated with other overhead electric distribution repair programs.

Q. Please describe any relevant feedback on this program from the Office of Energy Infrastructure Safety.

A. Energy Safety has consistently praised SDG&E's use of drones to inspect infrastructure and implement technologies such as Machine Learning to improve inspection methodologies.[30] In fact, Energy Safety has challenged other utilities, such as PG&E, to further expand the use of drone technology to aid inspections, taking action to require PG&E to provide additional reporting on drone inspection pilots because it was "using drones in a limited capacity."[31]

OEIS approved SDG&E's 2021 WMP Update and within "areas of significant progress," OEIS explicitly recognized SDG&E's use of drones to augment existing inspection programs as part of its maturation and innovation in wildfire mitigation.[32] Additionally, in the Final Decision on SDG&E's 2022 Wildfire Mitigation Plan Update, OEIS noted SDG&E's progress in inspection technologies, including drones, and cited strong find rates and improved visibility of pole-top and equipment conditions as part of SDG&E's wildfire-risk reduction strategy.[33]

Additionally, the Independent Evaluator (IE) for SDG&E's 2021 WMP found drone imagery effective in significantly the volume of initiatives that could be verified, including grid hardening, weather stations, and fuels management.[34] The IE positively noted the robustness of SDG&E's program and the quality of images, as well as the breadth of possible uses for the

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30 *See* n.11, *supra.*

31 PG&E 2023-2025 WMP R8 (February 13, 2025) at 1075, ACI PG&E-22-20.

32 OEIS's Evaluation of SDG&E's 2021 Wildfire Mitigation Plan Update (Final Action Statement, July 2021) available at https://energysafety.ca.gov/wp-content/uploads/tn10257_20210720t164339_revised_final_action_statement_on_san_diego_gas__electr.pdf.

33 OEIS's Final Decision of SDG&E's 2022 WMP Update (July 2022) at 18 ("SDG&E's Drone Investigation, Assessment and Repair (DIAR) Program was effective at detecting issues. This led to a 62 percent reduction in issues found in subsequent Corrective Maintenance Program inspections in 2021 in the Tier 3 HFTD, even with a 20 percent increase in distribution pole inspections.").

34 Final Independent Evaluator Report on Compliance for SDG&E's 2022 WMP (June 30, 2022), available at https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=52688&shareable=true

imagery,[35] concluding "[t]he applications of these models are many. From advance warning concerning any assets at risk due to topological changes (earthquakes/ settling; mudslides; subsidence) to routine flights that monitor vegetation clearances around any of these assets. By continuing to build its imagery library, *SDG&E is investing in an asset that can pay dividends in operational and safety efficiencies for years to come*."[36] The IE further noted that it was "encouraged by the innovative approach SDG&E is undertaking in partnership with other private entities and academia in the realm of Artificial Intelligence and Machine Learning."[37]

Formal critical feedback on drone inspection scope or targets only occurred in 2024 and 2025, when OEIS scrutinized SDG&E's proposal to reduce the number of drone inspections performed annually. Noting the effectiveness of drone inspections at reducing wildfire risk, in 2025, OEIS expressly denied SDG&E's request to reduce the number of WMP.552 Drone Assessments[38] from 13,500 to 6,500, stating that SDG&E did not show good cause and emphasizing that SDG&E's find rate for drone inspections was considerably greater than its find rate for detailed inspections, so the proposed reduction would likely leave risk unidentified.[39]

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[35] *Id.* at 88. The robustness and consequent usefulness of the tools described below is dependent upon the depth of imagery available. With sufficient imagery and following "orthorectification" (a process by which images are converted into data usable for mapping), the resulting models can enable the capture, storage, and reference of additional details useful for multiple purposes.

[36] *Id.* at 90 (emphasis added).

[37] *Id.*

[38] OEIS's Decision for SDG&E's 2025 Petition to Amend to its 2023–2025 Base WMP (July 11, 2025) at 7, available at https://efiling.energysafety.ca.gov/EFiling%5CGetPublicDocument.aspx?documentId=58911.

[39] *Id.*

OEIS specifically stated that "SDG&E should *increase* the targets to avoid level 2 conditions remaining unidentified and uncorrected in the HFTD by other inspection types."[40]

Q. Has SDG&E reviewed any information on similar programs at peer utilities?

A. Yes. Through early and sustained benchmarking and collaboration, SDG&E worked to share lessons learned and align its drone programs with peer utilities. When SDG&E started the DIAR program, it was the only California IOU to utilize drones for inspections on distribution facilities; our distribution drone inspection program materially advanced the development of similar programs at PG&E and SCE, reducing their need to independently design, test, and refine inspection methodologies for electric distribution facilities.

In August 2019, SDG&E reached out to SCE and PG&E when initiating our distribution drone inspections. As part of those communications, PG&E and SCE shared data capture requirements, inspection process and safety measures. PG&E and SCE shared this information for transmission drone inspections, as my understanding is that they did not have distribution drone inspection programs at the time. All three companies also began participating in Unmanned Aerial Vehicle (UAV) monthly operations check-ins to discuss any incidents and lessons learned. We also reached out to several drone vendors that also provided services to PG&E and SCE to learn more about implementing a drone program, including the type of aircraft and cameras used, to flight planning, lessons learned, flight safety considerations, etc.

Periodic benchmarking and touch points continued in 2020 and 2021, sometimes focusing on permitting issues, such as obtaining approvals to perform drone flights on state park

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[40] OEIS's Rejection and Order to Resubmit for SDGE 2026-28 Base WMP (June 24, 2025) at 6 (emphasis added), available at https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=58774&shareable=true.

lands or reviewing program status. In 2021, SDG&E and SCE participated in a multi-day collaboration meeting that included field visits to demonstrate drone operations performed with a QEW and office meetings to review all aspects of the execution of our drone program. By sharing practical lessons learned on data capture standards, safety protocols, flight planning, permitting, and field execution, SDG&E helped peer utilities avoid duplicative trial-and-error and accelerate their program deployment. SDG&E's field demonstrations and end-to-end program walkthroughs directly informed changes to SCE's inspection approach, including adoption of a combined ground-inspector-and-pilot "360 inspection" model.

In 2022, while SDG&E was completing drone inspections of all of its electric distribution assets in the HFTD and higher risk WUI areas, SDG&E participated in additional benchmarking meetings with PG&E as they prepared to start distribution drone inspections. In addition, more focused discussions with SCE and PG&E related to implementing a risk-informed inspection approach began.

Since 2022, SDG&E continues to benchmark practices with PG&E and SCE on a quarterly basis and has expanded collaboration efforts to include other utilities across the United States, including Hawaii, and internationally with Australia as they face similar challenges with wildfire.

SDG&E has also leveraged information developed during the drone inspection process to inform regulatory developments. For instance, SDG&E participated in Office of Energy Infrastructure Safety workshops held in 2023 to discuss changes to GO 165 inspection requirements to potentially require the use of drones for inspections or adopt a more risk-informed strategy versus time-based approach. These recommendations were intended to be brought to the CPUC through the Climate Adaptation OIR (R.18-04-019).

Finally, SDG&E initiated a joint Machine Learning model study with SCE and PG&E, which included sharing of images of distribution poles to test models and provide damage and asset predictions for analysis by SCE and PG&E. The intent of this study was to determine whether SDG&E's developed Machine Learning models would be effective on imagery acquired by the other utilities and on their assets, and to evaluate whether model sharing would be valuable to the other utilities. SDG&E's experience with risk-informed inspections and machine-learning-enabled image analysis supported shortened development timelines, improved inspection effectiveness, and reduce overall implementation costs.

By pioneering large-scale drone inspections and associated AI capabilities for electric distribution facilities, SDG&E effectively blazed a trail that peer utilities were able to follow, improving their programs while saving time, resources, and development expense that would otherwise have been borne by their ratepayers.

Q. Please provide any cost comparisons between SDG&E, PG&E and SCE's drone inspections from 2019-2022.

A. Cost comparisons for electric distribution drone inspections from 2019-2023 are challenging because of significant variations in the scope of the programs implemented by each utility and the timing of when each utility implemented distribution drone inspection programs. SCE did not begin distribution drone inspections until 2021, and PG&E only implemented a pilot program for distribution inspections using drones in 2022. Given these variations, it is not reasonable to compare costs on a per-structure basis for a given year.

Q. Please provide any cost comparisons between SDG&E, PG&E and SCE's repair work 2019-2022.

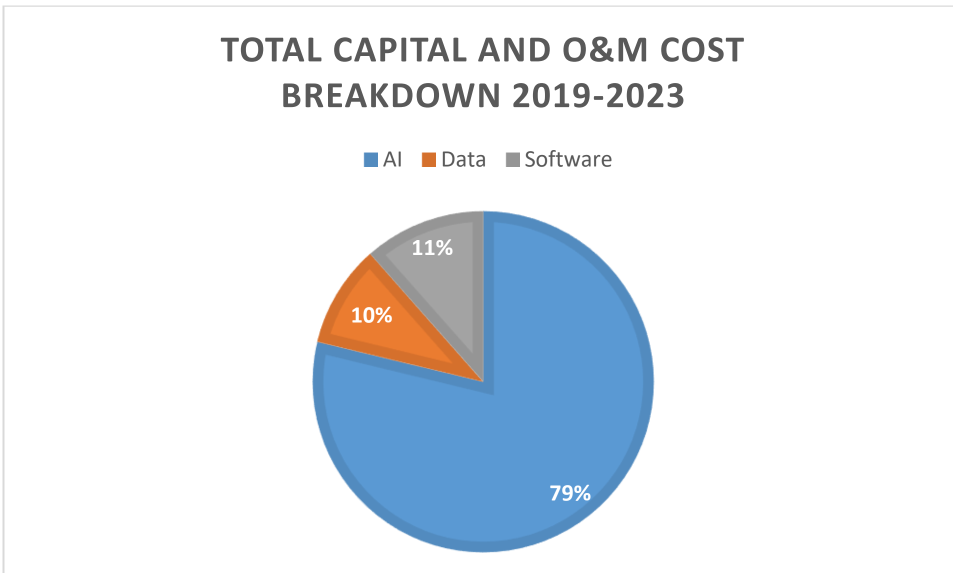
A. There is no publicly available information to make an informed comparison of repair costs resulting from drone inspections, in part due to the program variances in scope and timing discussed above.

Q. Provide a breakdown of SDG&E's costs on IIP and Data between O&M and Capital and on data management versus AI for 2019-2023.

A. Below is a breakdown of SDG&E's costs for work from 2019-2023 related to Machine Learning model development, software and data management. Please note that data management costs are embedded in some of the inspection and repair costs, since personnel involved in those work streams also were responsible for data accuracy and reporting.

Table JK- 1011: Breakdown of Technology Costs for DIAR and RIDI from 2019-2023 ($000)

	Capital ($000s)	O&M ($000s)	Total($000s)
IIP/ML (AI)	$15,326	$6,390	$21,716
Data	$1,479	$1,201	$2,681
Software	$903	$2,268	$3,172
Total	$17,709	$9,859	$27,568



Note that the costs to develop the Machine Learning models from 2019-2023 will provide sustained value because they are reusable enterprise assets that continue to be applied across new inspection cycles and programs. As new imagery is collected, the same models are reused and improved, increasing accuracy and expanding coverage over time rather than requiring redevelopment. This allows SDG&E to realize compounding safety, operational, and cost-efficiency benefits well beyond the initial investment.

Q. Besides the identification and repair of damages identified through drone inspections, what other benefits were realized because of the drone program?

A. While identifying and repairing damage was the primary objective of DIAR and now with RIDI, the programs delivered multiple additional operational, analytical, and strategic benefits that extended well beyond individual inspection and repair outcomes.

First, DIAR significantly improved SDG&E's system-wide situational awareness in the HFTD by providing a baseline visibility of all distribution overhead facilities, particularly pole-top components that are difficult to assess from the ground. This enhanced visibility allowed SDG&E to better understand where wildfire risk was concentrated and to refine its wildfire-mitigation strategy accordingly.

Next, DIAR provided SDG&E with a benchmark against its traditional ground-based inspection program (CMP), which helped to identify gaps in what ground inspections were identifying, and asset conditions that warranted changes to inspection practices or prioritization.

DIAR also generated a large, structured dataset of labeled imagery and inspection results that had not previously existed at SDG&E. That dataset created a historical record of asset condition in Tier 3 and Tier 2 HFTD areas and supported analysis of asset degradation and repair effectiveness. With the availability of high-resolution imagery, this dataset is trusted and remains valuable even after the inspections themselves were completed.

One of the most significant secondary benefits of DIAR and RIDI was that it provided the data needed to develop IIP. DIAR imagery reviewed by QEWs was used to train and validate machine-learning models, test whether automated asset and damage detection was feasible, and establish a human-in-the-loop inspection framework. DIAR is the origin point for SDG&E's AI-enabled inspection capabilities that will continue to benefit SDG&E and its customers well into the future. While financial benefits of ML capabilities have already been realized, the ML development costs are upfront, while benefits recur and grow as models are reused and improved.

Imagery from DIAR and RIDI created the ability to not only identify damages, but also catalog assets that help SDG&E mitigate wildfire risk. For example, imagery from these programs helped us identify approximately 800 non-CALFIRE approved fuses for replacement. CALFIRE's Power Line Fire Prevention Field Guide[41] evaluates equipment based on whether it can produce heat, sparks, molten material, or flaming debris during normal operation or fault clearing. A non-CALFIRE fuse, such as an expulsion fuse, ejects burning fuse elements that can drop to the ground during normal operation. Under dry or windy conditions, that fuse material can cause a catastrophic ignition event. Equipment that does not meet those ignition-prevention criteria is considered non-exempt and presents a high-risk in fire-threat areas; presence of this equipment on infrastructure also triggers additional compliance requirements regarding vegetation management and other programs.

SDG&E's 2023 WMP discussed how installation of CALFIRE approved fuses are considered highly effective at risk reduction, and expulsion fuse replacement was a component of SDG&E's approved WMPs.[42] Therefore, identifying where these fuses are and replacing them with alternative CALFIRE fuses helps mitigate wildfire risk. Leveraging DIAR and RIDI inspections to aid in identifying the location of non-CALFIRE fuses promoted efficiencies and resulted in savings versus manual field visits to create an inventory of non-CALFIRE fuses on infrastructure.

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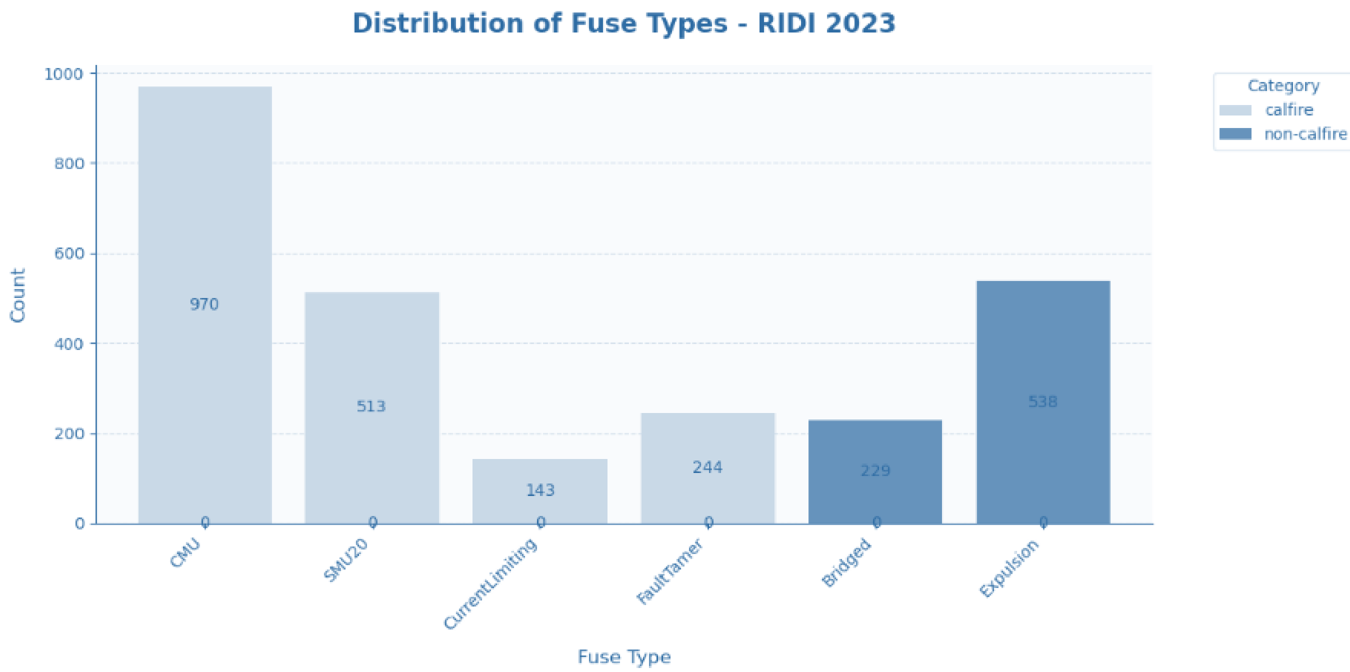
[41] *See* California Powerline Equipment Identification Pocket Guide.

[42] SDG&E's 2023-2025 Base WMP (October 23, 2023) at 222-223.

Figure JK- 134: RIDI 2023 Fuse Types



Other examples of realized value added related to the Machine Learning models developed through DIAR and RIDI include:

- Poles without Avian Protection (HFTD): IIP produced pole-level detections identifying poles lacking Avian Protection devices in the HFTD and provided these lists to electric engineering to support WMP compliance and asset replacement scoping. Avian protection devices are important in wildfire mitigation to help prevent bird contact with electrical lines and equipment that become an ignition source.
- Porcelain arresters: IIP deployed porcelain-specific arrester detection models and identified approximately 2,500 porcelain arresters in Tier 3 that allowed engineering to expedite arrester replacements and reduce costs associated with fielding similar to the non-CalFire fuses described in detail above. Porcelain arrestors also present a potential ignition source since they can produce heat, sparks or molten material during failure.
- Third-party attachment recovery: IIP models have identified unauthorized attachments, supporting recovery of unpaid recurring attachment fee revenue.

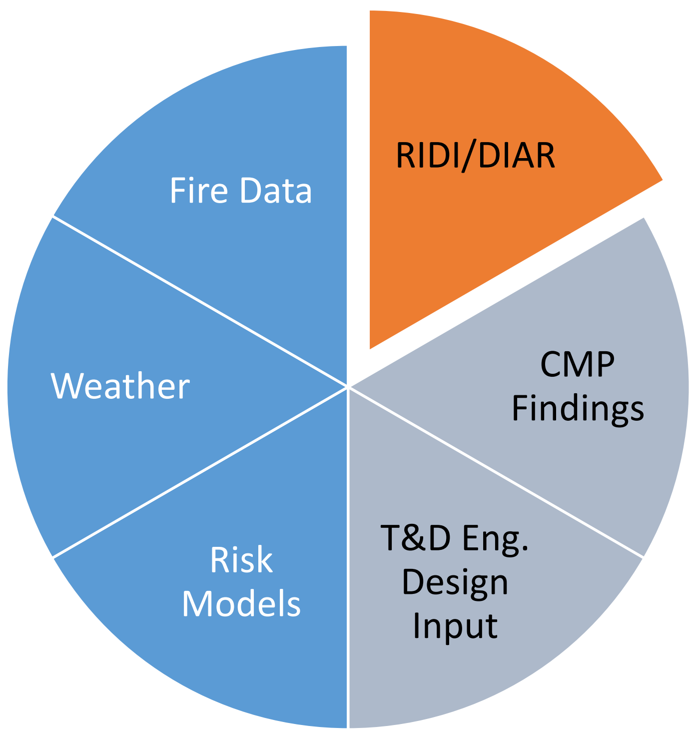
The scale of DIAR also functioned as a reasonable sample to test existing processes, which exposed and allowed us to remedy bottlenecks and inefficiencies across inspection, engineering, permitting, and construction. By addressing system issues, pinch points in contractor coordination and repair execution, and simplification of workflow design, improved resource allocation, and data handoffs, we were able to realize cost reductions benefiting our customers not just related to DIAR and RIDI over the 2019-2023 period, but associated with other SDG&E projects and programs.

DIAR also helped SDG&E improve customer interactions and worker safety by improving access protocol data (*e.g.*, gate codes and contact information) for customers across the HFTD. This data supports more efficient, safer and customer-focused operations across the Company.

Finally, the experience SDG&E gained on DIAR helped normalize and operationalize drone usage across the organization; this work has enabled the company to use drones for situational awareness during extreme fire weather and PSPS events, rapid visual confirmation of conditions following outages or incidents, support for asset management and compliance activities outside routine inspection cycles, obtaining beyond visual line of sight authorizations from the FAA, and perform stringing operations with drones rather than manpower, which promotes employee safety and can accelerate and re-energization timelines.

SDG&E's PSPS decision making is based on key information such as weather conditions, fire conditions, vegetation and fuels, and asset conditions. Asset health information obtained through the DIAR and RIDI programs is routinely used to determine the Alert Speeds or thresholds of wind speeds for when SDG&E shuts power off to a circuit segment. As part of SDG&E's WiNGS-Ops model—which supports PSPS decision making—SDG&E developed an interactive dashboard to easily identify assets with open work orders that require lower de-energization wind gust thresholds. By addressing poles with open work orders, this approach could prevent the de-energization of hundreds of customers, enhancing the reliability and resilience of assets during extreme fire weather conditions.[43]

Figure JK- 5: PSPS Decision-Making Data Inputs



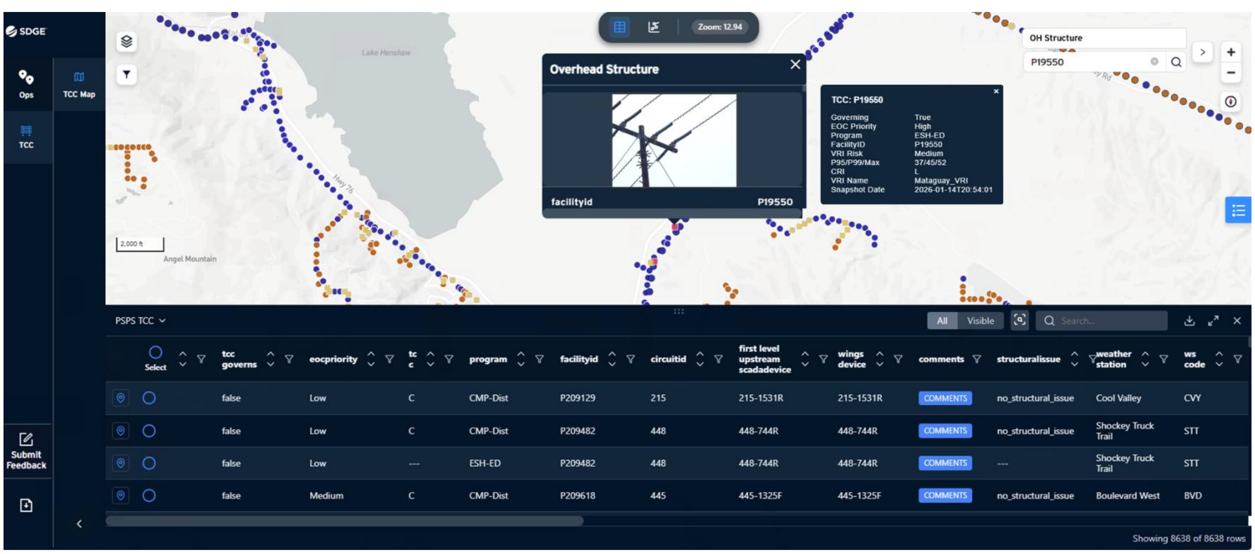
Over time, SDG&E's drone program reached a level of maturity that delivered substantial operational value, particularly in enhancing situational awareness during periods of extreme fire weather when proactive de-energization through PSPS may have been required. Drone imagery played a critical role in identifying Temporary Construction and Compliance

[43] *See* SDG&E 2026-2028 WMP (September 30, 2025) at Appendix D-8.

(TCC) poles.[44] TCC poles represent structures with temporary configurations due to ongoing construction, or compliance issues awaiting permanent repairs. Automated visibility of these assets enabled SDG&E to prioritize repair and replacement activities throughout the year and, critically, in the days leading up to potential de-energization events. In addition, this intelligence supported dynamic adjustments to base alert wind speed thresholds for specific circuit segments during PSPS events. This targeted, surgical approach provides a more precise and data-driven understanding of asset conditions, empowering operational decisions that minimize customer impacts while maintaining system safety and reliability.

The figure below shows how drone imagery is visually integrated into a unified WiNGS-OPs platform, providing situational awareness and supporting informed PSPS de-energization decisions.

Figure JK- 16: WiNGS-Ops TCC Viewer Screenshot



[44] *See* SDG&E 2026-2028 WMP (September 30, 2025) at 151-152.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

APPENDIX A

DISTRIBUTION INSPECTION ANALYSIS REPORT

Appendix A

Distribution Inspection Analysis Report

Sempra Energy®

SDG&E | & WILDFIRE SAFETY

Distribution Asset Inspection Report

Purpose:
This document reviews recent asset inspections on SDG&E distribution systems, with a focus on the effectiveness of enhanced inspections on wildfire mitigation and risk management efforts.

Version 1.0
August 2022

Table of Contents

1. Introduction

1.1 Overview

This Distribution Asset Inspection Report was prepared by the San Diego Gas and Electric (SDG&E) Wildfire Mitigation Program (WMP) Team, with the support of a third-party evaluation team, to measure the impact and effectiveness of enhanced inspections on SDG&E power distribution systems. In particular, this study evaluates how well drone inspections capture asset-related issues deemed to be potential direct causes of wildfire ignitions. For this study, the third-party evaluation team (hereafter referred to as the "Project Team") was provided with inspection results on SDG&E distribution systems—roughly three years of data, dating back to 2019, for drone inspections (conducted under the Drone Investigation, Assessment and Repair program, or DIAR), as well as roughly five years of data, dating back to 2017, on land inspections (conducted under the Corrective Maintenance Program, or CMP). This study was undertaken from May and August 2022.

1.2 Objective

This analysis will demonstrate the data-driven and risk-based approach that SDG&E employs when planning its inspections on distribution system assets (primarily for poles), and specifically its decision to increase the use of these enhanced drone inspections over the past three years. The primary goal of this analysis will be to show the effectiveness of drone inspections in identifying findings most directly associated with wildfire ignitions (e.g., issues that can create heat or sparks). This demonstrated effectiveness, relative to other types of inspections, will therefore show that the decision to increase drone inspections is justified since the drone program helps WMP address wildfire-associated findings in order to reduce risk.

The next sections of this report will cover the Project Team's overall methodology and the scope and sources of study data, before explaining analytical and modeling steps, summarizing results and findings, and wrapping up with a conclusion and recommendations for next steps.

2. Data and Modeling Preparation

2.1 Tools

For this study, the Project Team did its development work in Python, using Jupyter notebooks and commonly used Python data science packages like pandas, seaborn, and scikit-learn. Development notebooks were saved to an SDG&E repository at the conclusion of the study for future reference (notebooks may be requested by reaching out to the Points of Contact listed in the Appendix).

2.2 Data Collection

The Project Team worked closely with data subject matter experts (SMEs) identified by the WMP team. These SMEs helped the Project Team gather and understand data, while also helping validate data sources and analytical methodology.

The master dataset of distribution system inspection results, prepared by the SDG&E Asset Management team with the help of SDG&E business data analysts, encompassed inspections from both CMP and DIAR. Example fields included Pole ID Number, the date of the inspection, a computed indicator variable to represent whether the inspection yielded a finding, and if so, a description of the type of finding observed (e.g., “damaged crossarm”). The dataset also contained geographic and environmental data, leveraging the SDG&E Geographic Information System (GIS) among other tools to supplement the core inspection data with information on physical attributes for and surrounding each pole, including max wind gust speeds, vegetation metrics, pole material and treatment, and pole elevation.

To this master dataset, the Project Team merged additional datasets (provided by SDG&E data analysts) for specific analyses. Most important among these were datasets covering ignitions, outages, and SDG&E’s proprietary Fire Potential Index (FPI) metric.

2.3 Data Processing

2.3.1 Data Cleaning

The Project Team performed several basic actions to help clean and prepare the data for modeling and analysis. More detailed notes are available in the notes for each Jupyter notebook, but the overall process is summarized here.

Multiple data sources were used to construct the master dataset for this study. These included SDG&E data on CMP detailed inspections and findings, outage and ignition events, and daily FPI/weather data, as well as drone inspection and findings data from Sharper Shape assessments, and pole data from the SDG&E GIS team (see Fig. 1).

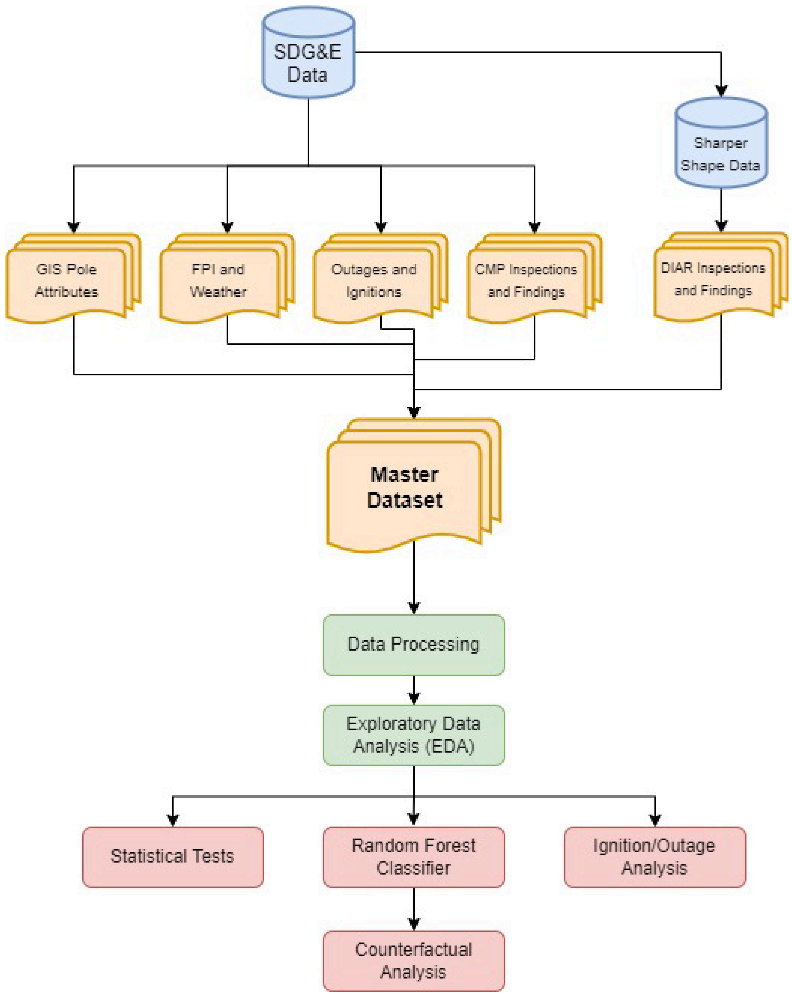


Fig. 1: Overview of project data sources and analytical methodology

From this raw aggregate, certain fields were converted into different data types for manipulation. Data gaps were identified, with missing values imputed based on the nature of the field (e.g., categorical vs. numeric) and advice from SDG&E SMEs; features that were deemed too sparsely populated for imputation (e.g., over 85% null) were dropped.

A list containing some of the fields initially provided by SDG&E in the version of the master dataset used for the majority of this study is shown in Table 1. This does not include additional computed fields later added by the Project Team for various purposes (e.g., data validation, analysis, comparison, etc.).

ID/Geographic Location	Pole Attributes	Weather Attributes	Other Environmental Attributes	Inspection and Findings
PoleNumber	CurrentMaterial	WG50FGustFrom	VegRiskIndex	Description
DistrictName	Species	WG50FGustTo	SoilsCategory	DaysSinceLastInspection
CircuitID	Treatment	TCZZone	ForestArea	Source
	Height	TCZDegF	Elevation	Program
	PoleAgeInYears	ClimateZone	Percent_1gc	LastInspectedSource
	ConductorSize		Percent_2gc	InspectionMonth
	Manufacturer		Percent_3gc	
	Class		Percent_4gc	
	PreviousMaterial		Total_Overlap	
	PoleType			
	PrimaryPole			

Table 1: Selected Distribution Dataset Features

2.3.2 Data Preparation

After cleaning the data and validating the result with SDG&E data SMEs, the Project Team conducted further data manipulation to help prepare specific analyses. A few new features were computed, including a binary feature to indicate whether an inspection yielded a wildfire-associated finding. Wildfire-associated findings were identified by SMEs in the Asset Management team and determined based on inspection condition codes from the SDG&E "OHVI and QC Condition Code Inspection Reference" (dated 5/17/19).

The Project Team faced two main challenges when working with the master dataset. The first was the prevalence of categorical (qualitative) data, which needs to be converted to numeric data for many analyses. The standard approach is to use "one-hot encoding," which converts a single categorical feature into multiple numeric (binary) features, with a new column for every observed or possible value for the original feature. Each row is then assigned a "1" under the field corresponding to its original categorical value, and a "0" for the others. In the master dataset, however, many categorical features each had many possible values (referred to as having "high cardinality"). One-hot encoding all categorical features would mean a dataset with several hundred columns—yielding too many predictor variables, lowering accuracy, and becoming unwieldy to manipulate. Moreover, the type of random forest model used later in this study can be biased towards categorical features with high cardinality. As a result, during modeling (see Analysis Overview), a variation known as "target encoding" was used to help mitigate these problems. With target encoding, a type of average value is computed that converts the categorical feature into a single numerical feature. Since target encoding can subsequently lead to its own problems, like overfitting, the random forest model needed to be recalibrated to help mitigate any undesired behavior (see Random Forest Classifier).

The second challenge with the master dataset was the heavy skew seen in many of the features. Most of the analytical methods used in this study assume a roughly normal distribution ("bell curve") for each feature. To adjust for skew, the Project Team leveraged the SMOTE method (synthetic minority over-sampling technique) from the Python imbalanced-learn package. This was used to help scale the data and set up the random forest classifier (again, see Analysis Overview).

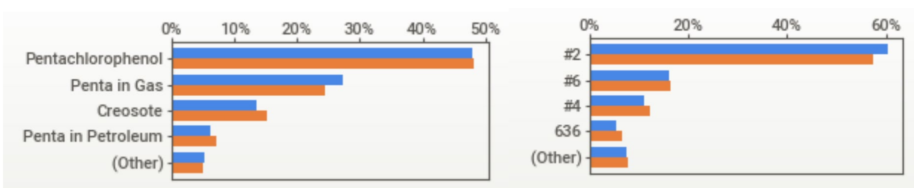


Fig. 2: Examples of skewed categorical features ("Treatment" and "ConductorSize")

2.4 Analysis Overview

2.4.1 Exploratory Data Analysis

The goal of this study is to establish the effectiveness of enhanced inspections in identifying wildfire-associated findings on distribution system assets. The Project Team began by conducting a round of exploratory data analysis (EDA) to confirm data quality, identify interesting data patterns or trends, and highlight areas for potential further study. Most of these EDA efforts involved examining the distribution for each feature, as well as the percentage of missing values and basic descriptive statistics (e.g., mean, median).

2.4.2 Statistical Tests

After completing EDA and confirming data quality, the Project Team then set up and conducted a series of statistical tests on the data. One of these was a chi-squared test on finding rates for the CMP and DIAR programs. The finding rate was defined as the proportion of inspections which yielded findings (in this case, specifically wildfire-associated findings). The chi-squared test helps establish that there is a statistically significant discrepancy in inspection finding rate across programs. Altogether, the statistical tests helped explore important proportions and comparisons within the dataset, as well as the effects of specific features on inspection findings.

2.4.3 Machine Learning Model

The primary portion of the study involved setting up a machine learning (ML) model to help determine the relative effectiveness of drone inspections in identifying wildfire-associated findings. Using a binary classifier, the ML model computed the likelihood that a drone inspection would identify such a finding, based on features selected during EDA.

This probability measure was then validated using a series of evaluation metrics, including f-score, precision, and false negative rate.

For this study, a random forest classifier was set up with the inspection result (whether the inspection uncovered a wildfire-associated finding) as the binary target variable. Both target encoding and SMOTE (see Data Preparation) were applied to set up the data and avoid potential biases with the methods used. Estimates from the model were then compared against actual inspection results to measure model performance.

As a classification model, the random forest can easily provide a measure of feature importance. Feature importance quantifies how useful each feature is in helping predict the target variable. The random forest ranks the importance of each feature in the dataset, using a quantified measure of the predictive quality of each feature. This can help validate methodology as well as provide insight for potential areas for further study.

2.4.4 Counterfactual Analysis

Another binary classifier was then set up to perform a type of counterfactual analysis on distribution assets which have not yet been inspected by DIAR (at the time of writing). This counterfactual analysis, evaluated at varying thresholds, helps provide a measure of the marginal impact of running additional enhanced inspections in terms of additional findings captured. This information can be leveraged by SDG&E to determine how to allocate resources to drone inspections in future years, based on staff and resource availability and overall funding.

2.4.5 Outages and Ignitions Analysis

Finally, a special analysis was conducted on distribution poles which experienced outages and ignitions. Using datasets for these events, as well as FPI, the Project Team explored the relationships between inspections, weather conditions, and the occurrence of outages and ignitions. Specifically, the Project Team sought to identify whether more recent inspections helped mitigate the incidence of outages or ignitions, and whether the inspection program (DIAR vs. CMP) had any impact.

3. Detailed Methodology and Findings

3.1 Exploratory Data Analysis (EDA)

For each field in the master dataset, the Project Team computed basic summary statistics to get a better understanding of the dataset and its key features. Data gaps were also identified, with sparse features (defined as missing 85% or more of values) dropped from the dataset and missing values for other features imputed using SME recommendations (for example, using a SME estimate or a computed measure, like median or mean). For this study, DIAR and CMP detailed inspections from all of calendar years 2020 and 2021 were used, along with partial data from the end of 2019 (since the drone program began late in the year) and year-to-date data for 2022 (since the study concluded in August 2022). Additional inspection data for 2017-2019 were also used in certain analyses.

For CMP, this data focuses specifically on detailed inspections (five-year cycle), since these are most comparable to DIAR inspections in that they are scheduled routine inspections, rather than ones ordered in response to any suspected issue (which could inflate the probability that an inspection will yield a finding). Notably, the CMP data omits patrol inspections, since their targeted and narrower scope also makes them less comparable to the drone inspections in terms of findings captured (which usually means a lower finding rate).

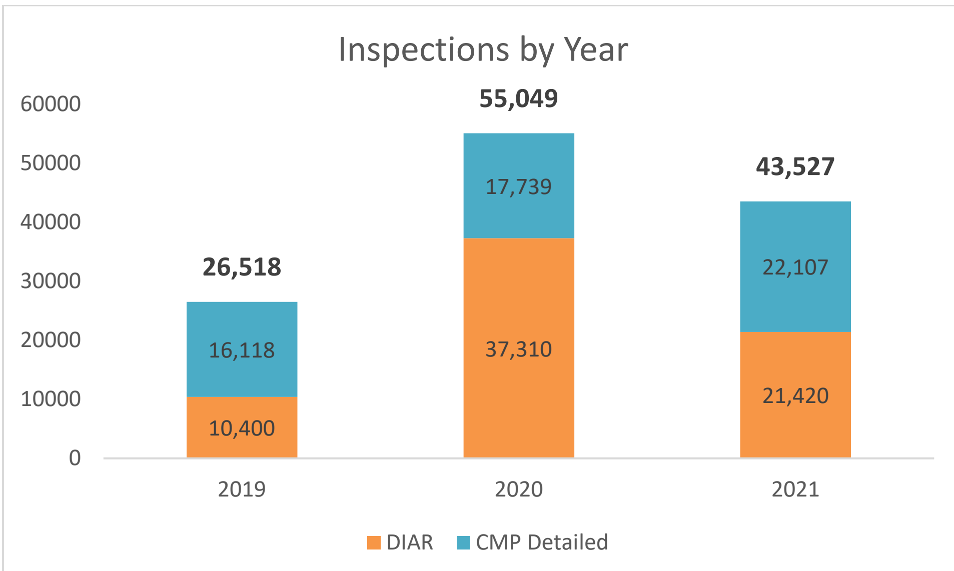


Fig. 3: Total inspections for distribution by program, for end of 2019 through 2021

The full EDA effort for this study can be reviewed in the annotated Jupyter notebook for distribution systems analysis. A few key findings are highlighted in this section of the report.

As a starting point, the team evaluated the number of wildfire-associated findings for each inspection program (DIAR and CMP detailed). For end of 2019 through 2021, the master dataset included 125,094 inspections, of which 69,130 were from DIAR and 55,964 were from CMP detailed. The Project Team determined the total number of inspections by counting the number of rows in the inspection data files for inspections with no findings (one inspection per line) and by using a count of unique values of a composite computed field in the findings dataset (inspection date plus Pole ID) to determine the number of unique inspections, each with one or more findings. This assumes that all findings on a pole on a given day count as part of the same inspection.

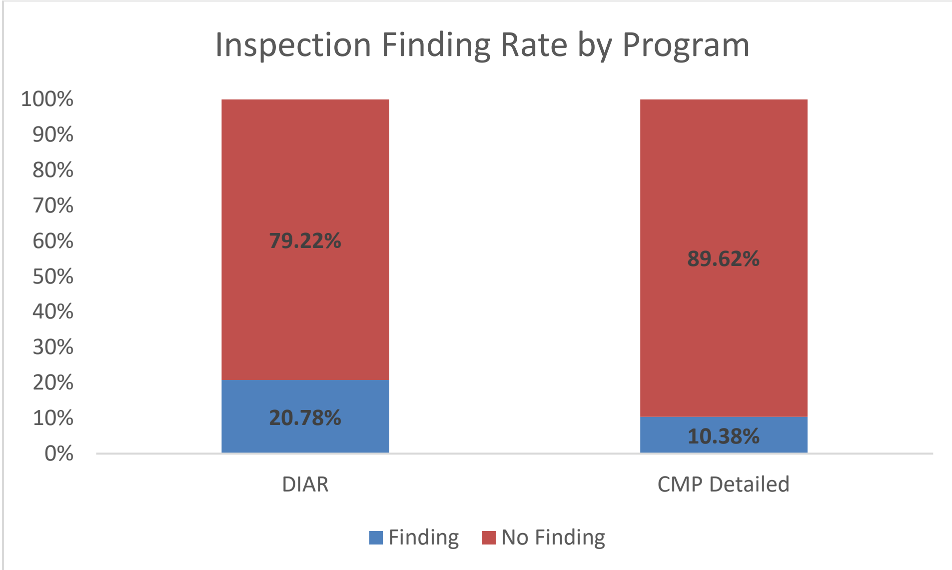


Fig. 4: Inspection finding rate by program

The Project Team then computed "wildfire-associated inspection finding rate," which was defined as the percentage of inspections yielding wildfire-associated findings, for both DIAR and CMP detailed. By examining percentages, the Project Team sought to normalize for the discrepancy in total count for either inspections or findings across program. For DIAR, 20.78% of inspections yielded findings, compared to 10.38% of CMP detailed inspections (see Fig. 4). This analysis suggests that DIAR distribution inspections are twice as likely to uncover wildfire-associated findings as CMP detailed inspections. This finding reflects available data, and this report makes no attributions to underlying reasons for any discrepancy since differences in funding, resource availability, and personnel were not part of the scope of this study. The mathematical validity of this ratio will be measured in the following analysis.

3.2 Statistical Tests (Chi-Squared Test)

The Project Team conducted a series of statistical tests to confirm certain relationships uncovered in EDA. Again, the full analysis can be reviewed in the annotated Jupyter notebooks, but certain highlights are covered here.

First, the team extended its analysis of wildfire-associated inspection finding rates across the DIAR and CMP detailed programs by demonstrating that the difference observed in the EDA was a statistically significant one, and not due to random chance. A chi-squared test was performed to demonstrate this statistical significance.

The chi-squared test is a classic example of a hypothesis test, in which the respective wildfire-associated finding rates for DIAR and CMP detailed inspections can be compared. The experiment can demonstrate that a meaningful discrepancy in finding rates exists by disproving a "null hypothesis," which for this example states that there is no meaningful difference in finding rates across the two programs. According to logical rules, disproving the null hypothesis would therefore imply the validity of the "alternative hypothesis," that the difference in finding rates is statistically significant. The chi-squared test computes the probability that, from the given dataset, any deviations from the null hypothesis can be fully explained through random variance in the data rather than the relationship proposed in the alternate hypothesis. A low probability therefore implies that the null hypothesis is not valid.

For this step, the chi-squared test was set up by separating DIAR and CMP detailed inspection findings. The Project Team used a chi-squared test from the scipy.stats library, which calculated that there was less than a 0.1% chance that the observed discrepancy in wildfire-associated inspection finding rates could be attributed solely to random variance. Since the standard threshold to prove statistical significance is anything under 5% ($\alpha = 0.05$), the Project Team rejected the null hypothesis and concluded that the 2x difference in finding rates across programs is a statistically significant one.

Other statistical tests explored specific relationships between sets of variables from the dataset (for example, that there was no strong relationship between issue descriptions—"damaged crossarm," "veg around base"—and the severity of an issue). Altogether, the conclusions covered in these last two sections provided the Project Team with enough verification to set up a machine learning model to investigate the effectiveness of drone inspections on their own merits (rather than in comparison with CMP detailed).

3.3 Machine Learning Model

From EDA and a chi-squared test, the Project Team observed that DIAR inspections were roughly twice as likely to find wildfire-associated issues (when compared to CMP detailed inspections), a relationship proven to be statistically significant. Next, the Project Team developed a predictive model, leveraging machine learning, which would help quantify the likelihood that a drone will capture a wildfire-associated finding during an inspection. The general approach centered on a binary classifier, trained on the master dataset, which would generate predictions (for a binary model, either a 1 or a 0) on a target variable. In this case, predicting a value of 1 for the target variable implies that, given all the other features in the model dataset (e.g., soil conditions, weather, pole age, time elapsed since last inspection, etc.), the model estimates that the drone inspection will uncover a wildfire-associated issue for the given pole; conversely, a 0 would represent an estimate that the drone inspection would not find such an issue. These predictions are then evaluated using commonly used metrics to gauge performance. A summary of this methodology is shown in Fig. 5.

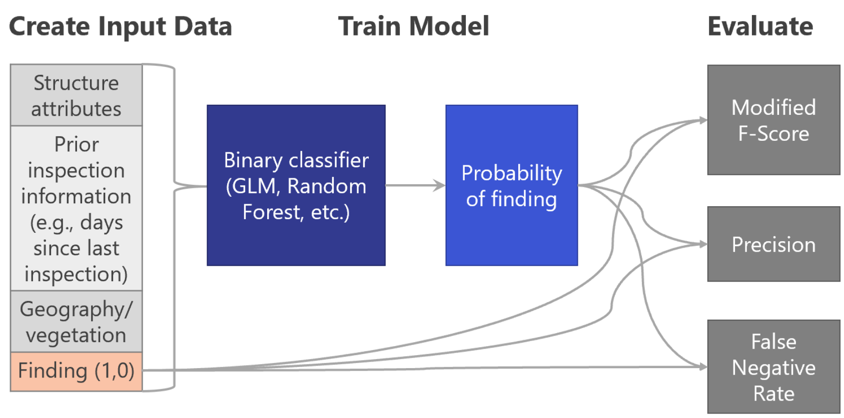


Fig. 5: Overview of modeling methodology

3.3.1 Random Forest Classifier

The binary classifier model used here was a random forest, a type of ensemble learning model comprised of many decision trees (so named because there are many trees in a forest), that learns which features in the model dataset best estimate the target variable. Each individual tree generates an estimate of the target, based on a series of decision nodes drawn from some subset of features from the model dataset. The large number of trees ensures that many different combinations and sequences of features are accounted for.

Since this is historical data, where the actual result of the inspection is already known, the decision trees can be evaluated based on how accurately they estimate the target variable over the entire set of test data. For this model, the random forest was built using the scikit-learn library, which scores each feature based on a metric known as “Gini importance.” A higher score indicates that, across decision trees, the feature was measured to be more important for target prediction.

Most decisions around feature selection were made based on inputs from interviews with SDG&E data SMEs, who recommended that fields be included or omitted based on both practical criteria (e.g., sparseness of data, or known concerns about data quality) as well as subject-based criteria (e.g., relevance to other WMP analytics and models). After dropping fields from the merged dataset (see Appendix), the remaining fields were verified using a correlation matrix from a visualization package called sweetviz.

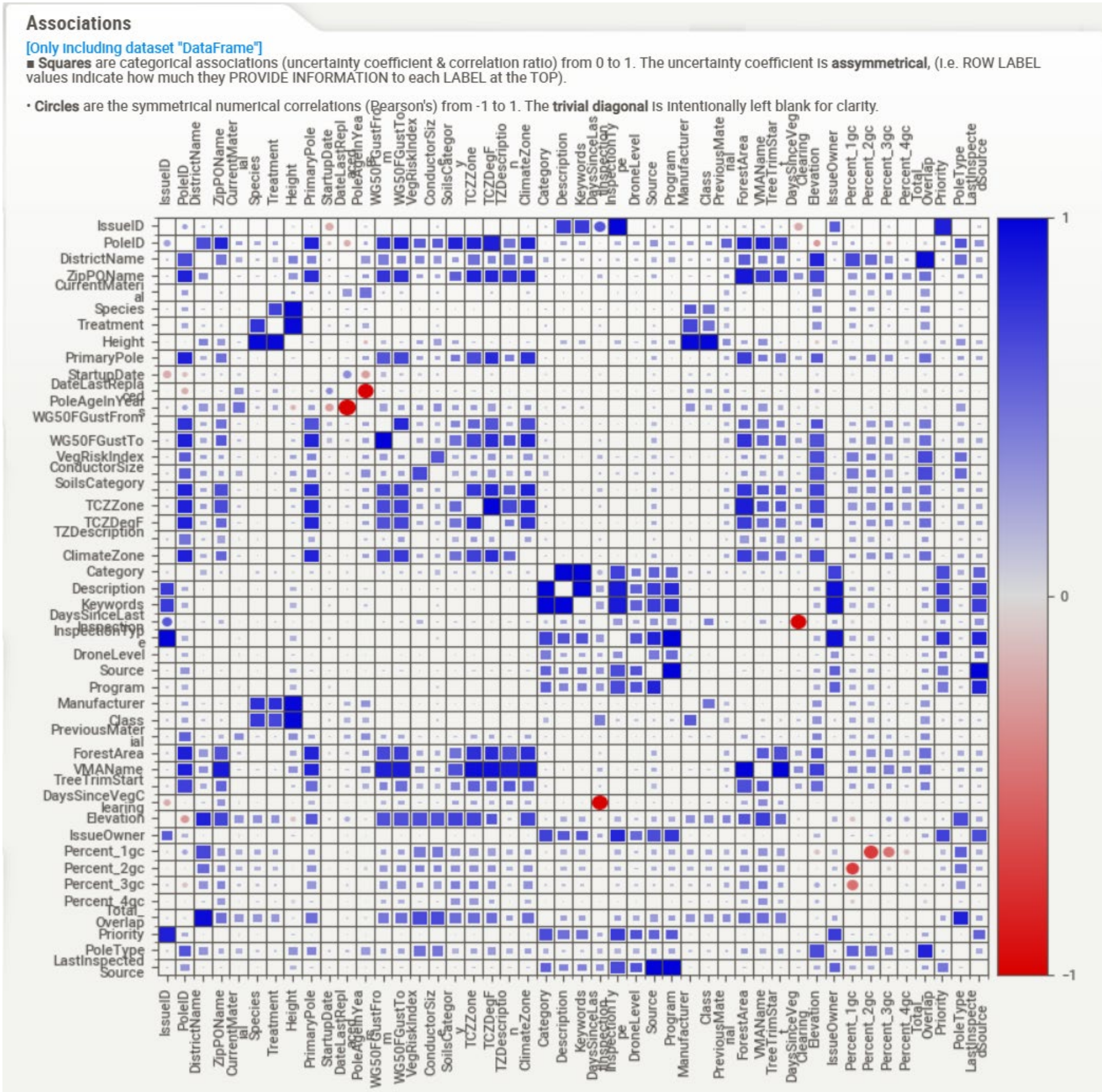


Fig. 6: Correlation matrix on initial dataset

The correlation matrix was examined to ensure that the features identified by the data SMEs would be suitable for modeling, avoiding sets of highly correlated variables which might impede model performance. Some correlations were obvious; in the correlation matrix above, “DateLastReplaced” and “PoleAgeInYears” are highly correlated since an earlier pole replacement date will mean the current pole must be older; thus “DateLastReplaced” was dropped from the dataset.

Correlated quantitative and qualitative features were handled slightly differently; with quantitative features, features were consolidated where possible. With qualitative features, models were run with different subsets of fields to examine the impact of removing certain fields from the analysis. Ultimately, the resulting dataset contained features deemed suitable for further modeling.

As detailed in [Data Preparation](), the Project Team adjusted the dataset and methodology throughout the modeling and analysis process to account for heavily skewed features and high cardinality in several categorical variables. SMOTE was applied to the dataset to reduce imbalance. In addition to reasons previously mentioned, target encoding also helped mitigate one of the potential pitfalls of using Gini importance, which is that the model has an inherent bias towards features that are either quantitative, or qualitative with high cardinality, both of which appear frequently in the master dataset. Target encoding thus reduces the tendency of the random forest to prefer these fields over others.

Finally, the random forest model itself would need to be recalibrated using cross-validation, essentially an iterative process of repeating the training and testing process on different subdivisions of the model dataset to improve prediction and reduce model biases from overfitting. This was necessary since the random forest model used in this study does not take class weights into account, thereby over-penalizing minority values. The cross-validated model generates predictions which more accurately reflect actual probability values for the predicted target variable, making them easier to interpret and evaluate in the context of a real-world problem (like inspection findings).

The project methodology used 70-30 splits to generate training and testing data. First, the Project Team created a training and test set and fitted a model called RandomForestClassifier (from sklearn.ensemble) to the training data. RandomForestClassifier was then recalibrated using cross-validation, using CalibratedClassifierCV (also from sklearn.ensemble). The recalibrated model was refitted to new training data and used to generate the actual predictions on a new test dataset. Finally, the Project Team used sklearn.metrics to build a confusion matrix to evaluate model performance.

3.3.2 Model Evaluation

The output of the calibrated random forest classifier are predictions of the target variable, generated for each row of the test data set. By comparing these predictions to the actual inspection results, the Project Team can quantify the accuracy of the ML model.

The standard approach to evaluating model performance is to start with a confusion matrix. This is a standard output of many modeling packages and helps compare the proportions of accurate predictions with erroneous ones.

For a binary classifier, there can be four outcomes when comparing a prediction to an actual result. Values can be either positive (1) or negative (0). The confusion matrix maps actual positives and negatives against predicted positives and negatives (see Fig. 7). For this confusion matrix, total counts are then given for each of the four possible outcomes (the total across the entire matrix represents the number of rows in the test set, which is a subset of the entire dataset).

Each row in the test dataset that was both predicted positive and actually positive was considered a “true positive” (TP). Rows that were predicted positive but actually negative were considered “false positives” (FP). Conversely, rows predicted negative and actually negative were “true negatives” (TN), while rows predicted negative and actually positive re “false negatives” (FN). Accurate models will naturally have high numbers of TP and TN and low numbers of FP and FN. False positives are also known as “Type I” errors, while false negatives are also known as “Type II” errors.

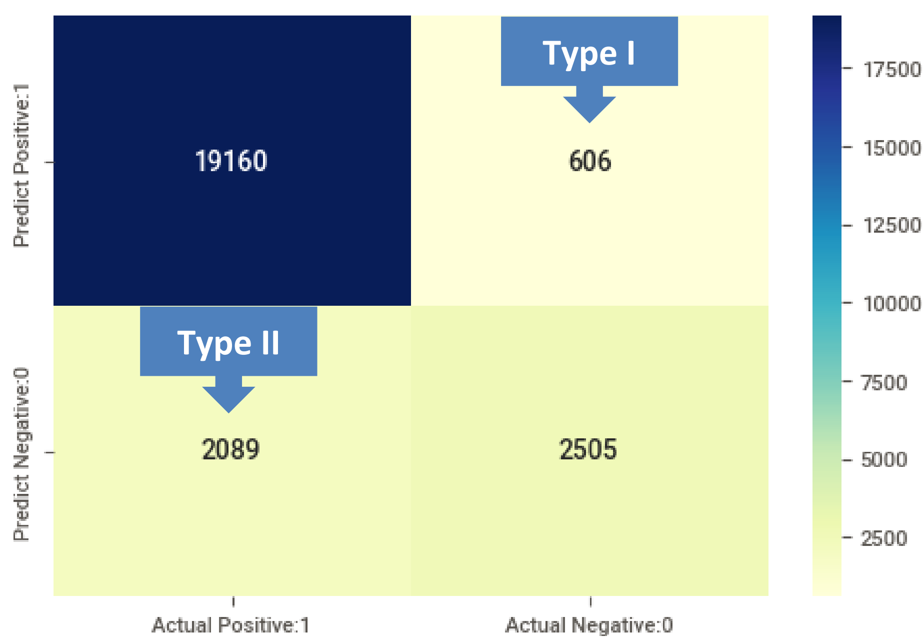


Fig. 7: Confusion matrix for random forest classifier, showing accuracy of predictions

The Project Team first computed the accuracy of the model. For a classifier, accuracy is traditionally defined as:

$$Accuracy = \frac{TN + TP}{TN + FP + TP + FN}$$

Based on the values in Fig. 7, the accuracy of this model is 89%. From the formula, we can see that this means that the model makes correct predictions (TP or TN) 89% of the time, which is quite good. Accuracy serves as a decent check that there are no obvious problems with model performance, but due to the skew still present in the underlying dataset, best practice dictates that additional metrics should be evaluated as well.

With an imbalanced dataset, another important metric is precision. Precision is generally defined as:

$$Precision = \frac{TP}{TP + FP}$$

As implied by the formula, precision reflects the proportion of positive predictions which are correct. In this example, the Project Team used a weighted precision score using sklearn.metrics. The weighted score specifically helps account for an imbalanced dataset. The weighted precision score was 88.35%, which means that 88% of the time, model-predicted positives were correct.

A similar metric is recall, which is the proportion of actual positives correctly identified by the model. Recall is computed as:

$$Recall = \frac{TP}{TP + FN}$$

Again, the Project Team used a weighted recall to account for imbalance; this value was 88.94%, meaning that the model correctly predicted positive outcomes (wildfire-associated findings) from model parameters 89% of the time.

Precision and recall are usually summarized using an aggregate metric called an F1-score, generally defined as:

$$F1\ Score = 2 * \frac{Precision * Recall}{Precision + Recall}$$

Again, the Project Team used a weighted version for the imbalanced dataset. For this model, the weighted F1-score was 88.07%.

Finally, the false negative rate examines the proportion of false negatives to all actual positives. The calculation is:

$$\mathrm{FNR} = \frac{\mathrm{FN}}{\mathrm{P}} = \frac{\mathrm{FN}}{\mathrm{FN} + \mathrm{TP}} = 1 - \mathrm{TPR}$$

Here TPR represents true positive rate (the inverse). For this example, the FNR is 9.83%.

These metrics were computed for different iterations of the model, and adjustments were made to the feature set to explore ways of improving model performance. Since all the final metrics presented here (accuracy, weighted precision, weighted recall, weighted F1-score, and FNR) have good results, the Project Team concludes that the model has been trained well on the dataset and can do a good job in predicting drone findings of wildfire-associated issues.

3.3.3 Feature Importance

Field	Feature Importance
DaysSinceLastInspection	0.190619
PoleAgeInYears	0.105335
Elevation	0.091697
Total_Overlap	0.050251

Fig. 8, left: Top features from random forest
Table 2, right: Top feature importance values from random forest

Because a random forest is trained using a score like Gini importance, it can also readily provide a quantitative measure of how important each feature is in predicting the target variable. For this model, the best predictive features were quantitative, and the two most important both relate to time (see Fig. 8 and Table 2). "DaysSinceLastInspection" had a feature importance score nearly twice as high as the next variable, "PoleAgeInYears." This implies that in the master dataset, the feature most closely associated with drone inspections identifying wildfire-associated findings was the total amount of time elapsed since the pole was last inspected. Since these variables are positively correlated (see EDA results in notebook), the Project Team can therefore demonstrate that poles that have gone uninspected for longer periods of time are more likely to develop issues directly associated with increased wildfire risk. This conclusion will be used as an assumption in the outages and ignitions analysis.

3.4 Counterfactual Analysis

After completing the machine learning model and verifying its performance, the Project Team used the calibrated random forest to perform a counterfactual analysis as a way to quantify the marginal benefits of increasing enhanced inspections, in measurable terms (e.g., the rate at which additional wildfire-associated findings are identified compared to how many additional poles need to be inspected).

The idea behind the counterfactual analysis is to have the trained ML model perform predictions on poles which have not yet been inspected by DIAR. The model is run at different threshold levels, which simulate an increase in the number of poles inspected. The resulting changes in other parameters (e.g., predicted inspection findings) allow analysts to then interpret what the marginal benefit in increasing drone inspections would be, compared to a program that only includes CMP detailed inspections (since the counterfactual represents what the finding totals would be without DIAR).

This counterfactual analysis uses poles that have only received CMP detailed inspections as a starting point for a theoretical inspection schedule with no drone inspections. This serves as a baseline for comparison against the other threshold values.

Threshold	Number of Structures	Percent of All Structures	Estimated Issues Found (TP)	Estimated Findings Missed (FN)	Estimated Finding Rate
0.1	22116	29.7%	4005	2699	82%
0.2	4427	5.9%	1456	5248	67%
0.3	1554	2.1%	800	5904	49%
0.4	1019	1.4%	614	6090	40%
0.5	659	0.9%	454	6250	31%
0.6	462	0.6%	346	6358	25%
0.7	292	0.4%	236	6468	19%
0.8	153	0.2%	132	6572	14%
0.9	25	0.0%	23	6681	7%

Table 3: Results of counterfactual analysis

The counterfactual analysis results are shown above. They can be thought of as a DIAR inspection plan for next year, prioritizing poles that have not yet received an enhanced inspection. At the bottom of the table is a scenario in which only 25 “new” poles are scheduled for inspection, yielding roughly 23 findings. The false negative count and estimated finding rate are also computed (respectively, 6,681 and 7.2%) in this scenario. As the number of inspections increases, the number of issues captured by the drone program also increases, the false negative count decreases, and the finding rate improves. In the scenario where 153 (or 128 additional) poles are inspected, the number of findings captured increases nearly triples, to 780, and the finding rate doubles to roughly 14%. Similarly, in the third scenario, inspecting 292 poles (an additional 139) results in nearly twice as many findings (236). Although the financial and logistical concerns around drone inspections were not within the scope of this study, this counterfactual result can be used as the benefit portion of a return-on-investment (ROI) type of calculation to determine the marginal benefit of every additional dollar spent on drone inspections.

By plotting the marginal findings for each threshold in the counterfactual analysis and fitting a trendline (a second-order polynomial function, written as $y = ax^2 + bx + c$, selected due to how well it fit the data), we can visually represent the marginal benefit in terms of additional wildfire-associated findings identified for every additional distribution pole inspected. In discussions with SDG&E SMEs, the Project Team also learned that future cycles of drone inspections will likely yield fewer inspections than this first cycle, due to the fact that many of the pre-existing issues that were more easily identified by DIAR than CMP detailed were identified and addressed during this initial cycle, and SDG&E does not expect as many issues to be present during the next enhanced inspection cycle.

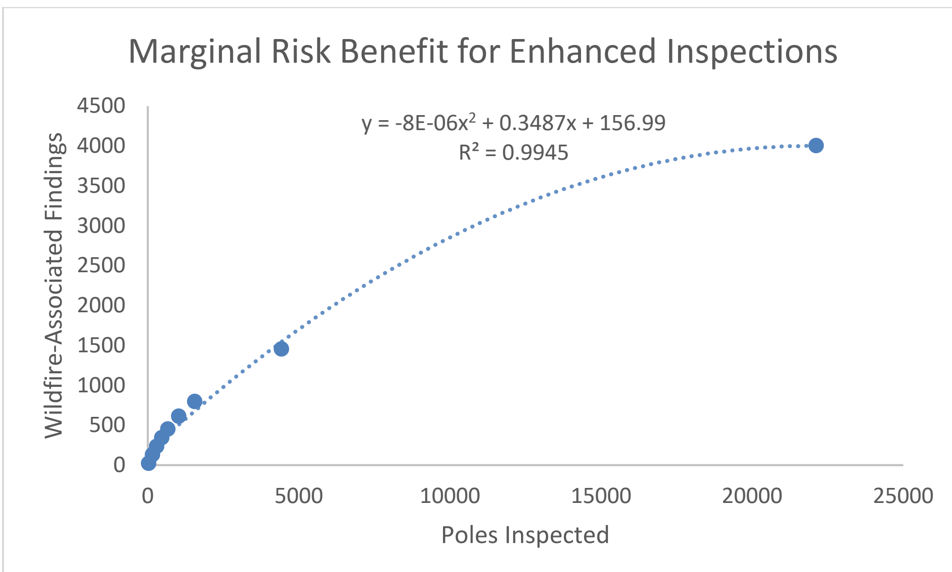


Fig. 9: Additional findings per pole inspected for drone program

The polynomial function ($y = -0.000008x^2 + 0.3487x + 156.99$, where x is the number of poles inspected and y the number of resulting wildfire-associated findings) generates a trendline which fits the data very well. The R^2-value is over 0.99, indicating that over 99% of the marginal increase in finding count at each threshold can be explained by the corresponding change in number of poles inspected. Using this trendline, in conjunction with some type of financial analysis (outside the scope of this study), WMP would be able to compute the ROI of each additional drone inspection in terms of additional findings captured by having the drone program. This could potentially be a very useful component of a risk mitigation benefit computation in a risk spend efficiency (RSE) calculation for WMP filings.

3.5 Outages and Ignitions Analysis

3.5.1 Overview and “CycleElapsed”

For outages and ignitions, the Project Team focused on analyzing the relationship between the recency of an inspection versus the incidence of an outage or ignition. In order to do this, the Project Team needed to compute a normalized feature that determines how far along in its respective inspection cycle (three-year DIAR or five-year CMP detailed) a pole was in before it experienced an outage. Represented as a proportion between 0 and 1, the Project Team referred to this feature as “CycleElapsed.” For this feature, 0 meant the pole was inspected on that day, 0.5

meant that the pole was halfway between scheduled inspections (for that inspection type), and 0.999 meant it was due for a new inspection in the next few days. The methodology is roughly approximate but makes a few assumptions, like rounding to 365 days a year, which was deemed acceptable given the presence of leap days and variations from a perfect three- or five-year cycle due to days falling on weekends and holidays or moved around for practical or logistical reasons.

The overall methodology for computing this feature is as follows:

- For each outage (or ignition), determine the pole affected and the date on which the outage (or ignition) occurred
- For the affected pole, find the most recent inspection performed on that pole, as well as the program responsible for that inspection
- Compute the time elapsed, in days, from most recent inspection date to outage (or ignition) date
- Compute the proportion of a full inspection lifecycle (for the respective program) that elapsed, based on the length of the inspection cycle
    - For poles most recently inspected by DIAR, the cycle is three years long (3*365 days)
    - For poles most recently inspected by CMP detailed, the cycle is five years long (5*365 days)

All else equal, this analysis normalizes for the length of the inspection cycle since this is ostensibly the amount of time which the inspection process allows to pass (for respective inspection programs) before a pole is due for another scheduled inspection.

Additional historical data (going back to 2017) was provided for CMP detailed inspections to help identify the most recent inspection, prior to outage or ignition. Keep in mind that official DIAR data is not available before late 2019, since that was the first recorded inspection for the program (Sept. 20, 2019). In the event where the most recent inspection was still not in the expanded dataset, the first inspection after the outage (or ignition) was identified, and then the date for that inspection were used to impute the date of the most recent CMP detailed inspection prior to the outage (or ignition) by subtracting the length of the inspection cycle—five years.

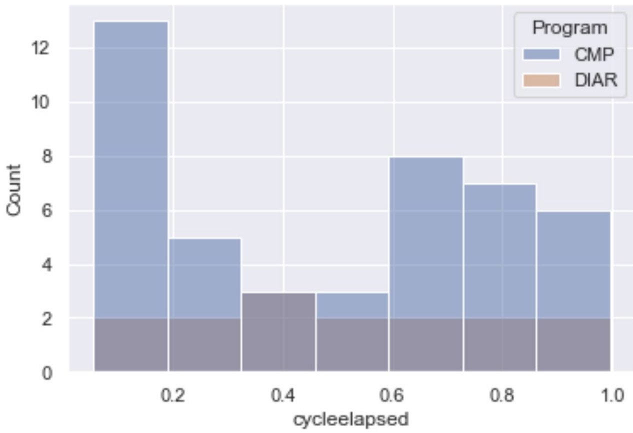
As a hypothesis, the Project Team expected that as “CycleElapsed” increases, the incidence of outages (or ignitions) would also increase. This is based on observations from EDA and model feature importance which suggest that *time elapsed since previous inspection* and *presence of findings* are positively correlated, and that the presence of asset-related issues are in turn hypothesized to be associated with additional outages and ignitions. The Project Team expected to see few outages or ignitions for low values of “CycleElapsed,” since recent inspections should have caught and addressed asset issues that might trigger these events.

3.5.2 Outages Analysis

Outages data was provided by SDG&E business data analysts and merged based on Pole IDs with the master dataset. Because the master dataset contained poles, outages due to individual components were mapped to the pole the components are installed on where applicable. Outages dating back to the start of the DIAR program (late 2019) were included in this study to align with the scope of the DIAR analysis.

With the outages dataset, all outages caused by issues relating to incidental foreign object contact, weather conditions, environmental hazards, and deliberate or accidental human intervention were dropped from the dataset. The Project Team removed these occurrences because they could not determine whether these causes would be sufficiently disruptive to cause an outage on a pole that was otherwise correctly inspected; subsequently, outages of these types could not be used to directly judge the effectiveness of an inspection program. (In order to capture additional outages, additional granularity would be recommended for the “Cause Description” field.) After applying this filter, the Project Team also filtered the outages dataset to affected poles in HFTD areas only. The resulting 60 outages were believed to be directly attributable to asset failures caused by issues identifiable in asset inspections, occurring in HFTD after September 20, 2019.

After filtering the outages dataset, the Project Team compared these asset failure-related outages on poles most recently inspected by either program (DIAR and CMP detailed) and plotted the findings. An overlaid comparison of poles attributed to each respective program is shown below.



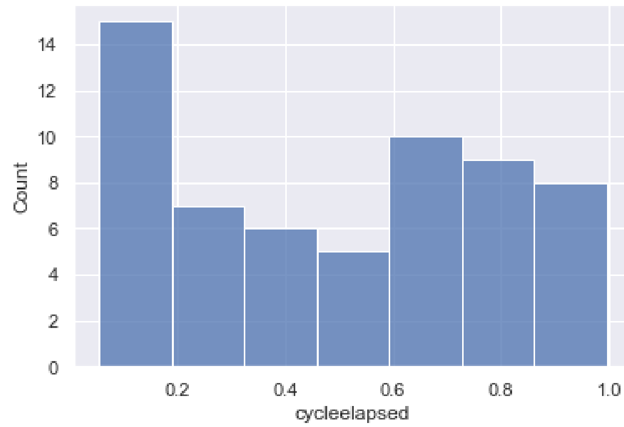


Fig. 10 (left): Asset-related HFTD outages (since 09/2019) based on program and proportion of inspection cycle elapsed
Fig. 11 (right): Total asset-related HFTD outages (since 09/2019) based on proportion of inspection cycle elapsed (sum of Fig. 10)

Firstly, the overall shape of the distribution does not align with the hypothesized linear increase in outage count as "CycleElapsed" increases from 0 to 1. Inspected by program, on the DIAR side we see relatively few outages (15 out of 60 total) which is not enough data points for generalizations about long-term behavior, but which are in a uniform trend across the inspection lifecycle. There are potential biases in this dataset since there are no DIAR inspections before late 2019, meaning that there have been fewer opportunities overall for outages to occur on poles most recently inspected by DIAR. As the enhanced inspection program continues, more poles will enter the upper half of the spectrum for "CycleElapsed," making it possible that future analyses could still identify an increasing trend.

The more interesting behavior occurs on the CMP detailed side, where among the 45 total outages there are relatively few between 0.2 and 0.6 (11 occurring 1-3 years after inspection) and relatively more from 0.6-1.0 (21 from 3-5 years after inspection). However, there is a large peak from 0.0-0.2, with 13 outages occurring from 0-1 years after inspection. This implies that nearly a quarter of all outages directly attributed to asset issues (13 out of 60 in HFTD from late 2019 to 2021) occurred on poles inspected by CMP detailed within the past year. One potential reason may be that visual inspections are less equipped to capture certain types of issues which lead to equipment failure (for instance, internal failures within equipment). The larger overall number of CMP poles is likely attributable to the fact that few poles were most recently inspected by DIAR in the early portion of the study time period (e.g., late 2019), and therefore nearly all outages during this period were attributed to CMP. Nevertheless, the time period chosen here provides the most data points for analysis, which was helpful for identifying potential seasonal behavior (see Fig. 13).

A set of boxplots aggregating summary statistics across inspection programs is shown in Fig. 12:

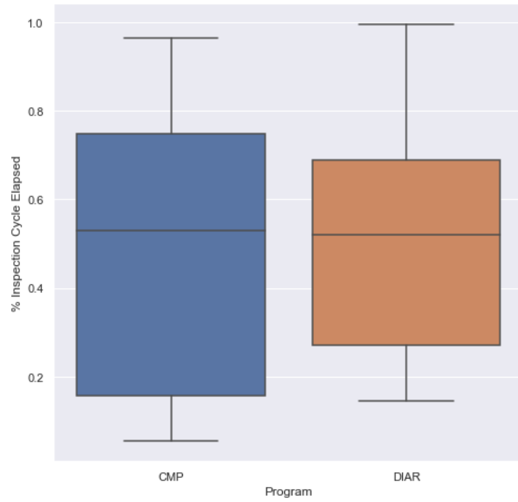


Fig. 12: Boxplot of proportion of inspection cycle elapsed versus program for asset-related HFTD outages since 09/2019

For DIAR, the average proportion of "CycleElapsed" was 0.51, with a standard deviation of 0.27 and a minimum of 0.15 (which for a 3-year cycle is a bit more than 5 months). For CMP detailed, the average proportion of "CycleElapsed" was 0.49, with a standard deviation of 0.32 and a minimum of only 0.06, or a little over 3 months after the most recent inspection for a 5-year cycle. The boxplot clearly demonstrates the effect enhanced inspections have on pushing out outage incidence for the minimum and first quartile (25%) later into the inspection cycle.

Of the CMP detailed poles, over half of the ones experiencing an asset-related outage within a year after inspection were in Northeast district. Moreover, they tended to be primarily issues relating to disconnect failure, cutout failure, and arrester failure. The Project Team therefore recommends that poles in Northeast district be eligible for enhanced inspections even if they have been recently inspected by CMP detailed, and that special attention be paid to pole attributes that could lead to failures with disconnect, cutout, or arresters.

A follow-up analysis on outages was designed to investigate the potential seasonality of outages, especially during wildfire season (roughly September to January). A count of outages by month is given in Fig. 13:

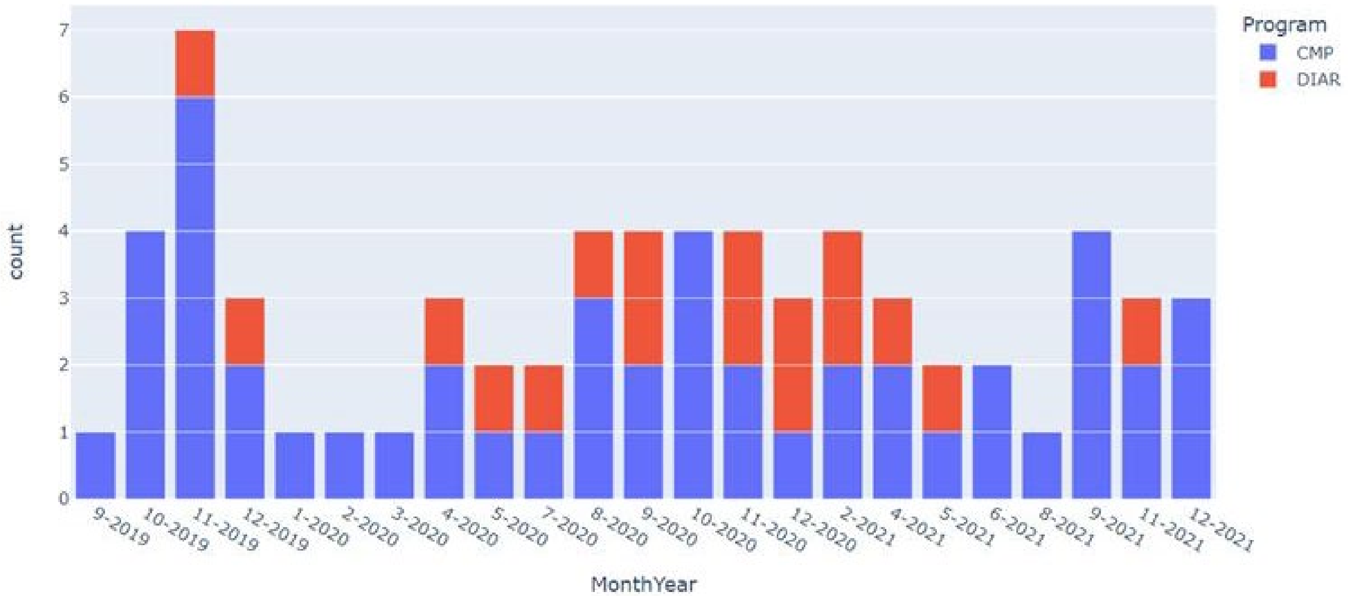


Fig. 13: Asset-related HFTD outages by month and program

There is a very large spike in outages in late 2019, with the seven in November representing nearly twice as many outages as any other month in the time period (note that the axis is slightly compressed since months with no outages were omitted). There was a sustained period of regular outages from August 2020 to February 2021, with over three outages per month during that wildfire season. Outages also rose again, starting in September 2021 and continuing to the last reported outages in the provided dataset (end of 2021).

With this in mind, the Project Team concludes that, all else equal, there has been an increase in the baseline probability of outages starting in September for each of the past three years and lasting anywhere from December to February of the following winter. In the leadup to this increased outage season, the Project Team recommends additional enhanced inspections to help maintain risk levels.

3.5.3 Ignitions Analysis

For ignitions, the Project Team followed a similar general approach to data processing and analysis used for the outages analysis. First, a dataset was provided by SDG&E business data analysts and merged based on Pole IDs with the master dataset. Some parts of this analysis used ignitions data dating back to 2015, while other parts focused on data dating back to the start of the DIAR program (late 2019) to align with the scope of the DIAR analysis.

With the ignitions dataset, all ignitions caused by issues relating to incidental foreign object contact and deliberate or accidental human intervention were dropped from the dataset. The Project Team removed these occurrences because they could not determine whether these causes would be sufficiently disruptive to cause an ignition on a pole that was otherwise correctly inspected; subsequently, ignitions of these types could not be used to directly judge the effectiveness of an inspection program. Only ignitions caused by “Equipment Facility Failure,” “Wire-Wire Contact,” or vegetation contact were considered for this analysis as these are all issues that an asset inspection can be reasonably expected to help mitigate. After applying this filter, the Project Team also filtered the ignition dataset to affected poles in HFTD only. The resulting 15 ignitions were believed to be directly attributable to asset failures caused by issues identifiable in asset inspections, occurring in HFTD (there may be a few more for ones with no cause listed in the data).

After filtering the ignitions dataset, the Project Team compared these asset failure-related ignitions on poles most recently inspected by either program (DIAR and CMP detailed) and plotted the findings. An overlaid comparison of poles attributed to each respective program is shown below.

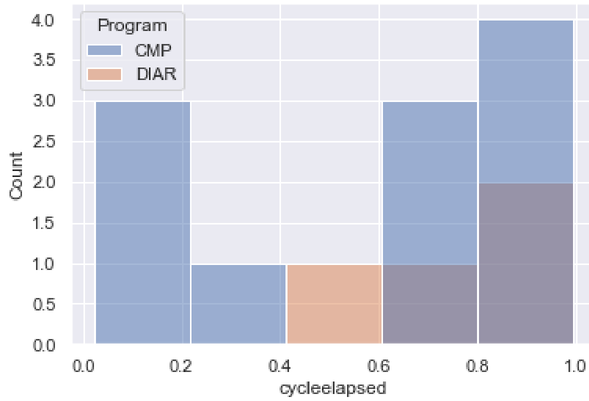


Fig. 14: Asset-related HFTD ignitions (since 09/2019) based on program and proportion of inspection cycle elapsed

There were very few data points for ignitions directly attributable to asset issues, making it difficult to generalize the results of this analysis. On the DIAR side, we see an implied increasing trend that fits nicely with expectations, with one ignition from 0.4-0.6, one from 0.6-0.8, and 2 from 0.8-1.0.

On the CMP side, there is an increasing trend with one ignition from 0.2-0.4, 3 from 0.6-0.8, and 4 from 0.8-1.0. However, there are also 3 ignitions from 0.0-1.0, meaning that three poles experienced ignitions within a year of receiving a CMP detailed inspection. For these three ignitions, one was caused by a conductor failure in Ramona district in April (Tier 2, also an outage), one was caused by a splice/clamp connector failure in Northeast district in September (Tier 3), and one was caused by a splice/clamp connector failure in Eastern district in August (Tier 3). All resulting fires covered less than 0.25 acres.

For DIAR, the average proportion of "CycleElapsed" was 0.73, with a standard deviation of 0.26 and a minimum of 0.42 (which is a bit more than 15 months for a 3-year cycle). For CMP detailed, the average proportion of "CycleElapsed" was 0.49, with a standard deviation of 0.31 and a minimum of only 0.06, or a little over 3 months after the most recent inspection on the 5-year cycle.

With so few data points, some of the analyses employed for outages were not very informative (see annotated notebook for additional details). However, the relatively large number of ignitions on poles within a year after a CMP detailed inspection does imply that SDG&E can still conduct enhanced inspections on poles recently inspected by CMP detailed if there are reasons to suspect possible ignition, since enhanced inspections may capture equipment issues that are not easily detected in a visual CMP inspection. Also, there were no asset-related ignitions observed in HFTD for at minimum 15 months after a DIAR inspection, compared to only 3 months for CMP detailed, suggesting that the enhanced inspection program has already made an impact in mitigating ignitions on distribution assets.

Finally, the team examined FPI level with regards to ignitions. This portion of the analysis remained focused on asset-related ignitions across the entire SDG&E power network (including assets outside distribution) and included data from as far back as 2015. The overall distribution of ignitions increased positively with FPI level, with the most occurring in elevated FPI (FPI between 12 and 14, inclusive). Interestingly, there was only one confirmed asset-related ignition in extreme FPI (FPI 15 and above), which is most likely due to two factors. One is that extreme FPI days are much more infrequent, and therefore on absolute terms fewer ignitions would be expected; the other is that other extreme FPI outages do occur in the original dataset, but are attributed to causes that the Project Team could not directly tie to asset failures identifiable in an inspection. The number of ignitions in Tier 2 HFTD does not change substantially for FPI 9 through 14 (see Fig. 15):

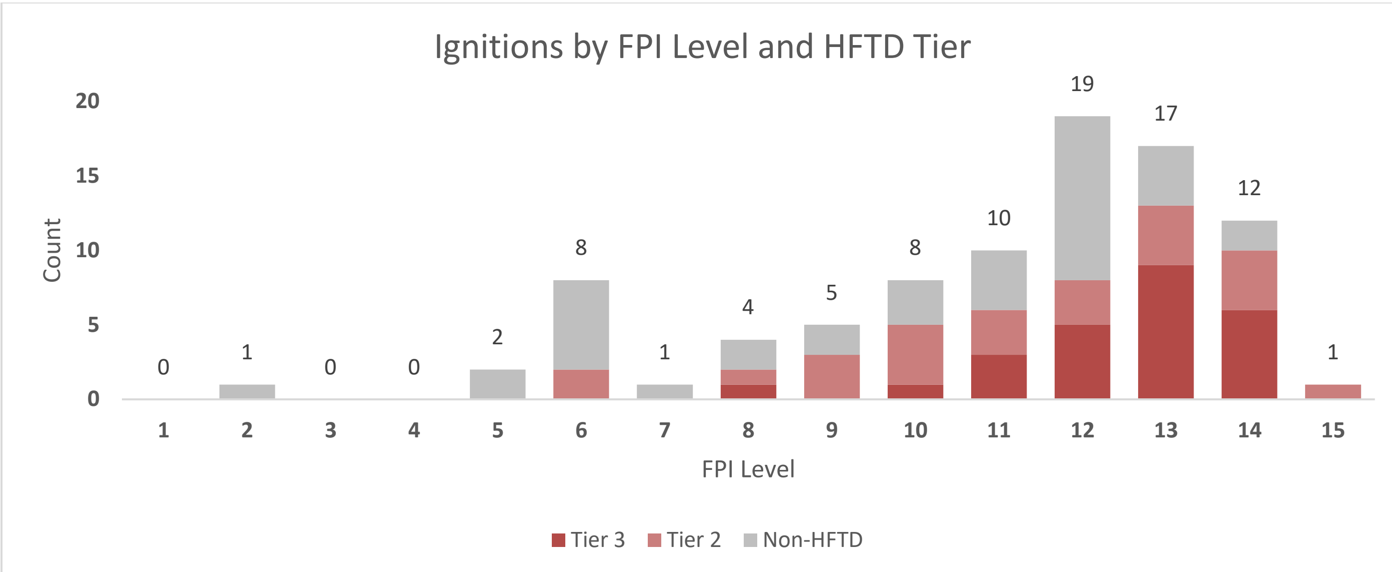


Fig. 15: Asset-related ignitions from 2015-2021, by FPI and HFTD Tier

There are a large number of ignitions in non-HFTD at elevated FPI, particularly for FPI 12 (11 ignitions), but also in normal FPI (6 at FPI 6). For Tier 3, there is a general increase in ignitions from FPI 10-14 and 80% of all Tier 3 ignitions occurring during elevated FPI. Based on this, the Project Team recommends enhanced inspections on Tier 3 HFTDs in the leadup to elevated FPI days to help mitigate increased ignition risk.

The Project Team also filtered the FPI data by structure type (distribution, transmission, and secondary assets; see Fig. 16). The overall shape of the distribution is, of course, identical to the previous chart. Transmission ignitions are rare across the board. Most ignitions occur on distribution assets, with a general increase from FPI 7 to FPI 14, and a peak at FPI 12-13. This increased risk of ignition at elevated FPI due to asset failures is a strong reason for SDG&E to increase enhanced inspections on its distribution assets in the leadup to elevated FPI periods. Interestingly, there is also a general increase in secondary ignitions from FPI 8 to 14. Though not strictly in the scope of this distribution analysis, the Project Team suggests that the enhanced inspection program might be expanded to secondary systems where feasible to help account for increased ignition risk for elevated FPI here as well.

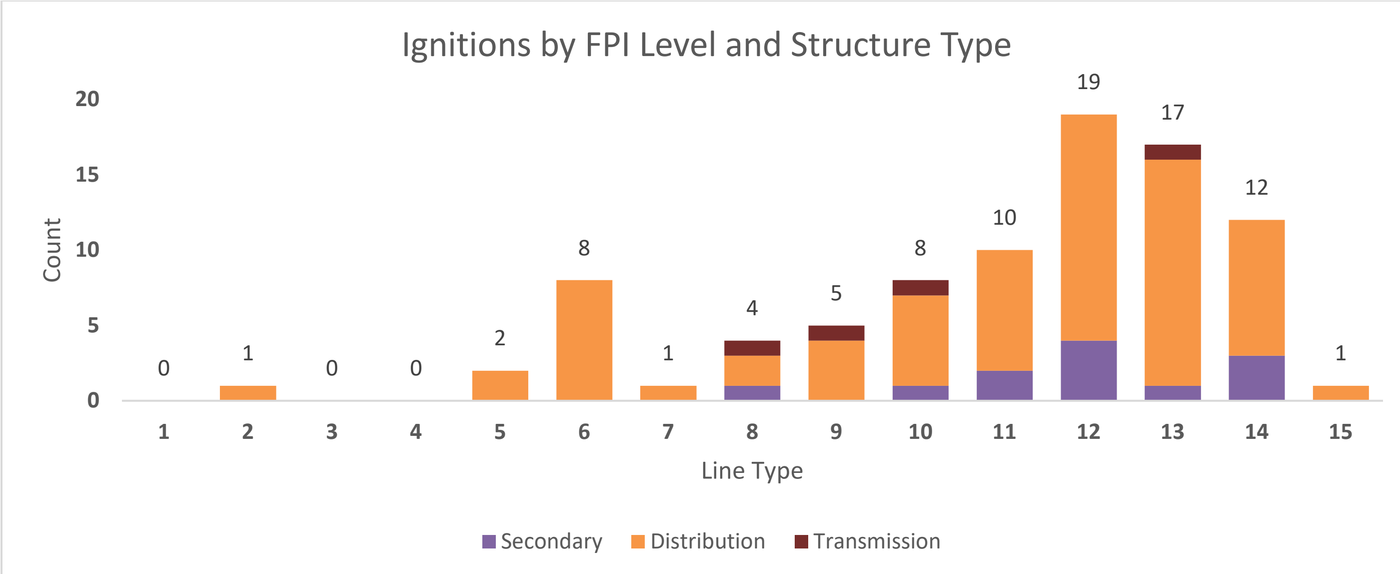


Fig. 16: Asset-related ignitions from 2015-2021, by FPI and structure type

The finding about secondary assets is borne out when specifically comparing ignitions to structure types, as seen in Fig. 17. Ignitions attributable to asset failure or vegetation encroachment (both issues identifiable in asset inspections) account for roughly half of all distribution ignitions, but a very small portion of transmission ignitions. Asset inspections on transmission assets are therefore less likely to substantially reduce ignition incidence. However, for secondary ignitions we see the opposite behavior, with most secondary ignitions attributed to issues identifiable in asset inspections.

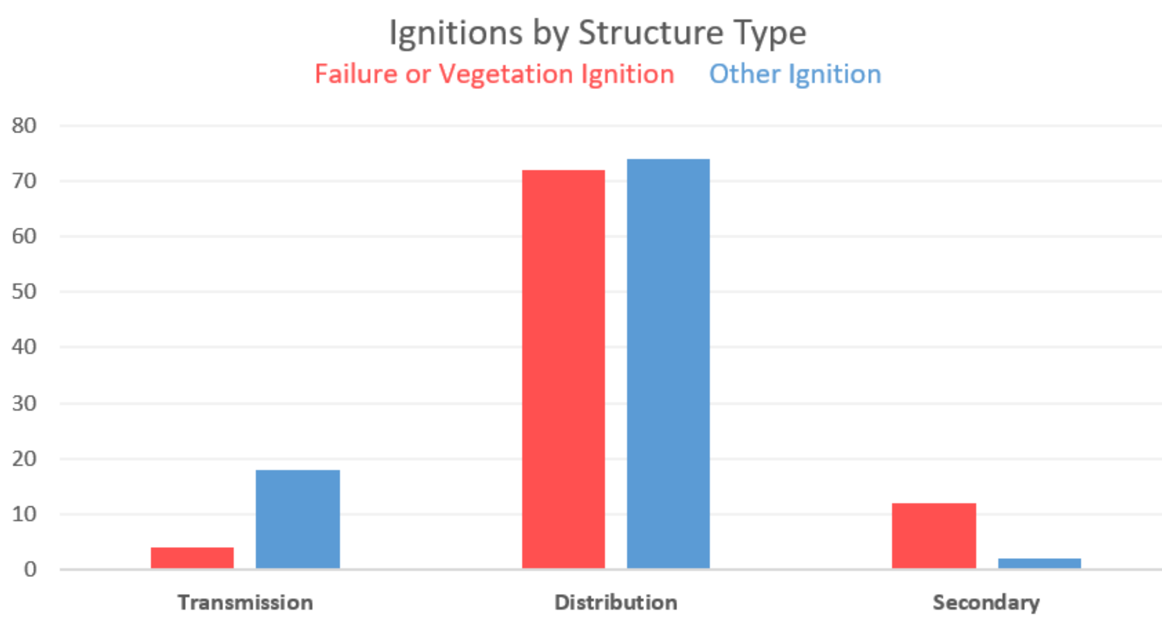


Fig. 17: Asset-related ignitions from 2015-2021, by structure type

4. Conclusion

4.1 Summary

The overall goal of this study was to demonstrate that SDG&E's distribution inspection program is data-driven and risk-based. From a wildfire risk mitigation perspective, one of the biggest process changes over the past few years has been the establishment of the enhanced inspection program. The analyses and models in this report sought to demonstrate that drone inspections are the best choice for WMP to identify wildfire-associated inspection findings.

Exploratory data analysis showed that DIAR inspections had a wildfire-associated finding rate twice as high as that of CMP detailed inspections over the same period. The statistical significance of this discrepancy was demonstrated using a chi-squared test, concluding that this was due to systematic differences in inspection results and not just random fluctuations in the data.

A random forest classifier was trained and calibrated on the inspection data, yielding a machine learning model that can capably predict (88% weighted F1-score) whether a drone inspection will yield a wildfire-associated finding. This ML model was then used to design a counterfactual analysis, which shows the marginal benefits of increasing the total number of drone inspections. The polynomial function $y = -0.000008x^2 + 0.3487x + 156.99$ is a good approximation of the predictive behavior of the counterfactual model, up to roughly 22,000 inspections.

4.2 Recommendations

Based on the findings in this report, the Project Team has three general areas for recommendations for further study and process enhancement for WMP and DIAR.

First, WMP can explore opportunities to build a more risk-optimized inspection schedule for DIAR by extending the ML model trained for this study. Although the poles and areas inspected by CMP each year are prescribed based on policies in California Public Utilities Commission General Orders (GOs), any risk-based adjustments to the schedule within those constraints can be explored and verified by feeding the ML model with asset data for the poles in question to predict which poles are most likely to have wildfire-associated issues. By prioritizing these poles with enhanced inspections, or scheduling additional enhanced inspections before wildfire season, SDG&E can further mitigate risk and correct issues before ignitions occur (see Outages and Ignitions Analysis for detailed recommendations). The statistical models in this study can also be extended using time series analysis to see if there are additional ways to design a more risk-optimized inspection schedule for DIAR, or to better track changes in inspection performance over time. These process enhancements would improve SDG&E's understanding of the timing impact of drone inspections, providing justification for any changes in schedule or quantifying any needs for additional staffing or budget.

Another enhancement can come from building a more generalized machine learning model, trained on even more asset data, or on data for different types of assets. A more generalized model can uncover additional predictive risk indicators, which can then be tracked to monitor additional sources of risk. Appropriate mitigation or correction plans can also be designed to address each, thereby enabling more proactive risk management for WMP.

Finally, the Project Team recommends that WMP continue to leverage the data aggregation methodology developed for this study. Compiling and synthesizing data from across the organization can yield additional insights and be used to power near-real time executive dashboards to help SDG&E leadership monitor wildfire risk and inspection results on distribution systems. Critical findings can be escalated to the appropriate parties, while key performance indicators (KPIs) for wildfire management and asset integrity metrics can be readily reviewed by management. Altogether, integrated data can power a number of innovations that enable more informed and risk-based decision making at SDG&E.

5. Appendix

Additional information relevant to the study and background.

5.1 Points of Contact

For questions about this study, please contact the SDG&E Wildfire Mitigation Program team:

- Jonathan Woldemariam (SDG&E Wildfire Mitigation Program Director), jwoldemariam@sdge.com
- Ashley Llacuna (SDG&E Wildfire Mitigation Strategy Manager), allacuna@sdge.com

5.2 Assumptions

Master dataset data processing:

- **Dropped** 'IssueID', 'PoleID', 'ZipPOName', 'CRIPoleAge', 'DateLastReplaced', 'StartupDate', 'CalcHealthIndex', 'CRI', 'WeatherStationName', 'GoogleElevationFt', 'TZDescription', 'Keywords', 'IssueDescriptions', 'CleanedDescription', 'VMAName', 'TreeTrimStart', 'DaysSinceVegClearing'
- **Filled blank values for** 'DistrictName', 'CircuitID', 'CurrentMaterial', 'Species', 'Treatment', 'Height', 'PrimaryPole', 'WG50FGustFrom', 'WG50FGustTo', 'VegRiskIndex', 'ConductorSize', 'SoilsCategory', 'TCZZone', 'TCZDegF', 'ClimateZone', 'DroneLevel', 'Manufacturer', 'Class', 'ForestArea', 'Elevation'
- **Created fields for** 'DIAR', 'CMP', 'DiarIssues'

Summary of issues identified as wildfire-associated:

```
#map issue types selected based on severity assessed by Fire Hazard or ignitions
dmap = {'Damaged Pole': 1, 'Damaged Arrestor/ Insulator/ Pole Top Work/ Armor Rod': 1, 'Damaged Crossarm': 1,
         'Veg around Base': 0, 'Damaged Conductor/ Grounding': 1, 'Guy Issues': 1, 'Exposed Connection': 0,
        'Loose Hardware': 1,'Leaning Pole/ Overload': 1, 'Damaged Transformer': 1, 'Veg on Secondary': 1,
        'Insufficient Clearance': 1, 'CIP Wire Loose': 1, 'Missing/Loose Cotterkey': 0, 'Improper Splice': 1,
        'Damaged/ Unsecure Conduit': 0, 'CIP Not Transferred': 1, 'Veg on Service': 1, 'Foreign Object': 1,
        'Damaged Avian Protection': 1, 'Damaged Switch': 1, 'Veg Proximity to Primary': 1, 'CIP Wire Issue': 1,
        'Loose Tie Wire': 0, 'Issue on Secondary': 1, 'CIP Connection Issue': 1, 'CIP Clearance Issue': 1}
```

Sample graphics showing FPI and ignitions