OFFICE OF ENERGY INFRASTRUCTURE SAFETY

WILDFIRE SAFETY ADVISORY BOARD

RECOMMENDATIONS TO THE OFFICE OF ENERGY INFRASTRUCTURE SAFETY ON ADDITIONAL WILDFIRE MITIGATION PLAN REQUIREMENTS AND PERFORMANCE METRICS, AND SAFETY CULTURE ASSESSMENT

JUNE 2024

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BACKGROUND

Following catastrophic wildfires in California, Public Utilities Code (P.U.C.) §8386 sub-sections(b) through (d) established requirements that electrical corporations file Wildfire Mitigation Plans (WMPs) on an annual basis with the Office of Energy Infrastructure Safety (Energy Safety) beginning in 2020. P.U.C. §326.2 established the Wildfire Safety Advisory Board (WSAB or the Board), a seven-member body of wildfire and utility policy experts appointed by the Governor, Speaker of the Assembly, and Senate Committee on Rules. These statutes further established Energy Safety[1] as a department under the California Natural Resources Agency (CNRA). The legislation mandates that the WSAB develop and make recommendations to Energy Safety related to the electrical corporations' WMPs and safety culture assessments. Under P.U.C. §326.2, the WSAB provides independent analysis and expert guidance to Energy Safety on wildfire safety issues.

Each member of the Board brings a unique perspective and expertise to their review of WMP requirements and performance metrics. Additional information about the Board, its members, prior recommendations, advisory opinions, and meeting history can be found on its website: https://energysafety.ca.gov/what-we-do/wildfire-safety-advisory-board/.[2]

The current Board members are:

- Jessica Block, Chair
- Chris Porter, Vice Chair
- Diane Fellman
- Ralph Armstrong
- Timothy Haines
- John Mader
- Alexandra Syphard

2023 – 2024 Activities and Accomplishments

The Board, during 2023:

- Held five public Board meetings.

[1] Formerly known as the Wildfire Safety Division at the CPUC.

[2] The Board approves the recommendations and advisory opinions found here but individual recommendations may not reflect the views of individual Board members.

- Conducted field visits at Southern California Edison (SCE), Liberty, Pacific Gas and Electric (PG&E), Truckee-Donner, and Healdsburg facilities.
- Developed recommendations to Energy Safety, on 2023 Wildfire Mitigation Plan Additional Requirements and Performance Metrics, and Safety Culture Assessments.[3]
- Developed and adopted an Advisory Opinion providing recommendations to the State's publicly owned utilities and electric cooperatives (collectively POUs) on their 2023 Wildfire Mitigation Plans.[4]
- Engaged with stakeholders and experts to develop three policy papers on above-grade distribution systems policy, updating vegetation management regulations and industry practices, and updating utility regulations in light of climate change and wildfire risks.[5]
- Onboarded a new Board advisor.

Subsequently, in the first half of 2024, the Board:

- Held two public Board meetings:
    - February 7: Adopted the three policy papers listed above.
    - March 21: Held a strategic plan meeting.
    - Onboarded a graduate student assistant, an analyst, and a supervisor.
- Held six working group meetings with the POUs and their representative bodies to discuss improvements to reporting in the POU WMPs.

For the second half of 2024, the Board will develop and adopt recommendations to the State's POUs on their 2025 WMPs. Furthermore, it will adopt a strategic plan which will outline the Board's goals and priorities over the next few years, and develop a business plan identifying the specific actions and timeframes in which they will be carried out.

[3] California Wildfire Safety Advisory Board, "Recommendations to the Office of Energy Infrastructure Safety on Additional Wildfire Mitigation Plan Requirements and Performance Metrics and Safety Culture Assessment," June 13, 2023, energysafety.ca.gov/wp-content/uploads/2023/06//final-adopted-wsab-2023-annual-puc-section-8389-recommendations.pdf.

[4] California Wildfire Safety Advisory Board, "Advisory Opinion for the 2024 Wildfire Mitigation Plans of Electric Publicly Owned Utilities and Rural Electric Cooperatives" December 4, 2023, https://energysafety.ca.gov/wp-content/uploads/2023/12//wsab-2024-wmp-pou-advisory-opinion.pdf.

[5] The policy papers are titled "Policy Paper on Updating Vegetation Management Regulations and Industry Practices," "Policy Paper on Updating Utility Regulations in Light of Climate Change and Wildfire Risks," and "Above-Grade Distribution Systems Policy Paper," and the links to these documents are available through this link: https://efiling.energysafety.ca.gov/Search.aspx?docket=2024-WSAB-WMP-GPSCA.

Acknowledgements

We want to acknowledge the collaboration and engagement between the Board and Energy Safety and express excitement about its expanding depth and breadth, particularly as we turn towards emerging topics like how longer-term climate change may impact wildfire risk. We look forward to continued collaboration with the IOUs, the POUs, relevant government agencies, and interested stakeholders.

The Board acknowledges that our work would not be possible without the skill, creativity, and expertise of our advisors Jonathan Frost and Sang Soble, our graduate student assistant, Amanda Voropaeff, and our retired annuitant, Mary Ann Aguayo. All members of staff keep the Board on track to meet both statutory requirements and self-determined goals. Furthermore, they help translate Board members' wealth of knowledge into actionable policy recommendations and best practices for further reducing utility wildfire ignition risk and for the electrical corporations and POUs to adapt to rapidly changing climate, weather, and landscape.

INTRODUCTION

Pursuant to P.U.C. §326.2(b) and §8389(b) (1-3),[6] the Wildfire Safety Advisory Board provides these recommendations to the Office of Energy Infrastructure Safety (Energy Safety) as it updates its Wildfire Mitigation Plan (WMP) Base Guidelines applicable to the Investor-Owned Utilities (IOUs), Independent Transmission Owners (ITOs) and Small and Multi-Jurisdictional Utilities (SMJUs) (collectively "electrical corporations").[7]

The Board acknowledges and appreciates Energy Safety's review, consideration, and incorporation of many of the Board's recommendations in WMP Guidelines over the past several years. The Board also acknowledges Energy Safety's efforts to hone the electrical corporations' requirements since the Board first provided its recommendations in 2020. The Board adopts these recommendations to Energy Safety for its consideration and to transmit to the California Public Utilities Commission (CPUC).

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[6] Public Utilities Code § 8389(b) states that the Board shall make recommendations to Energy Safety on the following: "(1) Appropriate performance metrics and processes for determining an electrical corporation's compliance with its approved wildfire mitigation plan. (2) Appropriate requirements in addition to the requirements set forth in Section 8386 for the wildfire mitigation plan. (3) The appropriate scope and process for assessing the safety culture of an electrical corporation."

[7] The 2025 WMP Updates were broken into two groups with submission deadlines of April 2, 2024, and July 8, 2024. Considering these submission dates and the Board's statutory requirement to deliver its recommendations by June 30th, the WSAB did not have sufficient time prior to publication of this report to review the 2025 WMP Updates and comment on how well the updated information aligns with the WMP update guidelines. The Board will subsequently review the WMPs to inform its recommendations to Energy Safety in future reports.

RECOMMENDATIONS

1. Wildfire Mitigation Plan

Additional Requirements

Through its review of the WMPs, the Board aims to both provide meaningful recommendations on the WMPs by focusing in on topics where we can lend our unique expertise. Through Energy Safety's efforts, the WMPs have considerably evolved and improved since the first cycle in 2020. To continue this trajectory, the Board makes the following recommendations for Energy Safety's future WMP Guidelines. See the table below for the WSAB's recommendations for additional requirements for the WMPs.

Table 1. WSAB Recommendations on the WMPs

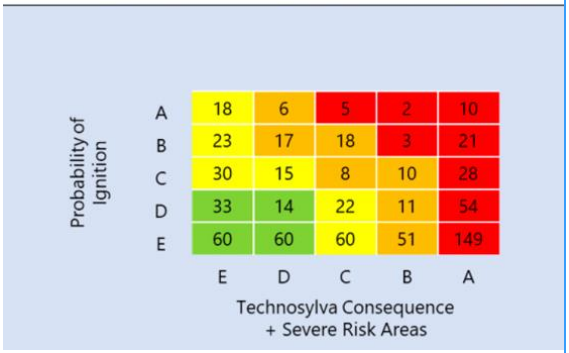
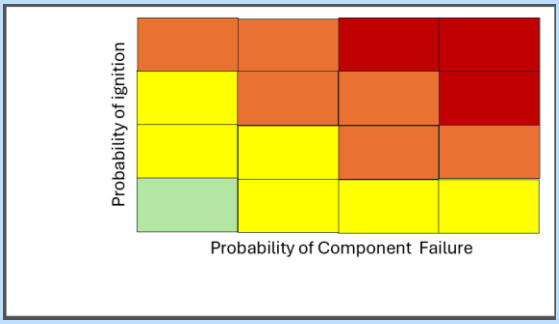
No	Recommendation	Justification
1	Cost benefit analysis (CBA) calculations should quantify the benefits of avoided PSPS events. Furthermore, Energy Safety should require the electrical corporations to describe how they calculate the benefits from avoided events and include these benefits as part of their CBA calculations.	Currently, the electrical corporations factor PSPS likelihood and PSPS consequence into their risk calculations, but it is unclear if and how they factor in avoided PSPS events specifically. By including the avoided PSPS events into the CBA calculation, the electrical corporation can paint a more complete picture of the benefits of certain investments. To achieve this, a retrospective analysis may be needed by the electrical corporations to factor in all the historical events where PSPS was avoided due to grid hardening investments.
1a	Energy Safety should require the electrical corporations to provide information on areas that have already been hardened that are still subject to PSPS events. This data should include relevant metrics on customer outage minutes in hardened areas due to PSPS events.	There have been several areas that have been hardened that may still be impacted by PSPS events if the circuits are not hardened all the way from the transmission substation. It is important for Energy Safety to understand this issue so they can better encourage the strategic siting of grid hardening

No	Recommendation	Justification
		projects that will reduce impacts to customers in grid hardened areas.
1b	Energy Safety should require the electrical corporations to collect data and report on how effective the grid hardening work is in terms of estimated outage and PSPS event reduction.	The data will inform the effectiveness of grid hardening measures in reducing outages and PSPS events.
2	Energy Safety should require the electrical corporations to report in WMPs their evaluation of the risk of legacy, pre-GO 95 equipment in the electrical corporation's service territories in the HFTD, including the methods that they used and assumptions they made in that evaluation, and their plans to mitigate those risks.	The WSAB previously recommended to Energy Safety that the 2023 WMP Guidelines should require reporting on utility protocols and practices applying to older legacy equipment installed prior to the current implementation of GO 95 standards. While Energy Safety agreed and intended to fully incorporate the recommendation, this has not yet occurred. The WSAB adds the recommendation to Energy Safety to require risk evaluations of pre-GO 95 equipment and plans to mitigate this risk as new components of the WSAB's recommendation relating to this equipment.
3	Energy Safety should issue guidance to the electrical corporations to prioritize undergrounding of circuits originating from transmission substations for areas where undergrounding is deemed to be the best-suited hardening measure. Energy Safety should require the electrical corporations to include information in the text or in the appendix of their WMPs regarding how individual undergrounding projects reduce both wildfire and PSPS risk. If the specific undergrounded segments are still at risk of PSPS events,	By prioritizing circuits that originate from transmission substations for undergrounding, the electrical corporation prevents the undesirable situation where a downstream segment is undergrounded, but the customers still face PSPS events due to upstream risk from unhardened facilities closer to the substation. Energy Safety should better understand how often this occurs and include PSPS risk reduction as a

No	Recommendation	Justification
	then this needs to be clearly stated and the electrical corporation needs to clearly explain how it intends to virtually eliminate that PSPS risk within 5-10 years.	criterion to be met for any targeted undergrounding projects.
4	Asset and vegetation management inspection and maintenance: In addition to annual targets, Energy Safety should require electrical corporations to include the total number of assets and total circuit miles that need to be inspected system-wide and the cadence of the inspections over the three-year reporting cycle of the WMP.	Electrical corporations currently set various inspection targets annually in the WMP submission. However, it is not always clear what the overall inspection and maintenance targets are for the service territories and what percentage of the work is completed each year. By providing the total number of assets and circuit miles that need to be inspected and the cadence of inspections during the three-year WMP reporting period, together with the annual targets, the electrical corporations can help put all their inspection and maintenance targets into context and describe how the work is spaced out during the reporting period.
5	Energy Safety should require the electrical corporations to detail plans that remedy issues of improperly rated equipment accounting for both current and fault duty.	Electrical corporations must ensure that properly rated equipment is used on circuits to prevent arcing or damaged equipment. Improperly rated equipment installed on a circuit, such as a 400-amp switch on a 600-amp circuit, can cause fire hazards. This needs to be better understood and reported and the electrical corporations need to explain how they plan to mitigate these risks.
6	Energy Safety should require the electrical corporations to include in the WMPs an evaluation of the risk from the remaining non-exempt equipment from Public	By evaluating and reporting on the risk of PRC Section 4292 non-exempt equipment, the WMPs could provide a clearer picture of the declining and remaining equipment-related risk in the

No	Recommendation	Justification
	Resources Code (PRC) Section 4292 in the HFTD.	electrical corporations' service territories.
7	Energy Safety should require the small and multi-jurisdictional utilities (SMJUs) to include a brief narrative in their WMPs about how wildfire mitigation efforts fit within the broader context of the electrical corporation's enterprise risk management (ERM) as part of its risk informed framework.	By requiring this information for the WMPs, Energy Safety and stakeholders can better understand how the electrical corporation's WMP efforts interact with the broader companies' ERM, including any interactions and/or overlap with key decision-makers for both the ERM and wildfire mitigation efforts, explaining how decision-making is similar or different across both these efforts and if there are potential opportunities for closer coordination between those responsible for these efforts or other improvements. The large electrical corporations already provide this information in their WMPs and provide useful examples for the SMJUs to consider.
8	Energy Safety should require the electrical corporations to clearly articulate a strategy in their WMPs for mitigating PSPS vulnerability and enhancing the resiliency of areas of high societal and economic importance, such as central business districts and downtown areas, that are otherwise not required by law to have backup generation. This should include an overview of all of the areas that are currently at risk (i.e. listing all of the areas still at risk), the estimated economic impacts of PSPS events to those areas (if known), and a description of how the electrical corporation will use any combination of grid hardening from the transmission substation to the area, deployment of mobile generation, or	The WMPs are unclear about how the electrical corporations intend to ease the burden of PSPS events and enhance the resiliency of places such as downtown areas or central business districts specifically. When these areas lose power, the economic and societal costs can be high. A clear strategy to reduce these impacts can help prioritize efforts to ensure that communities can remain safe and continue to function even under conditions with elevated or high wildfire risk. The WSAB acknowledges that the electrical corporations have implemented numerous projects that have achieved this level of community resiliency, but it is unclear how systematic these efforts

No	Recommendation	Justification
	installation of a microgrid and over what time frame.	are and what the overall objectives are when considering all the affected areas. Prioritization could be based on the population size, if the location is a county seat, third-party analysis of economic impacts, repeated and/or prolonged PSPS impacts and wildfire ignition and consequence risk. The WSAB does not intend to prescribe any specific resilience measures for this effort or funding mechanisms and defers to the expertise of Energy Safety, the electrical corporations, and the CPUC.
9	Energy Safety should require the electrical corporations to report their risk analyses by ecological regions (or pyromes) in addition to their service territory as a whole. Once overall service territory analyses are made, these existing risk assessments should be refined by ecoregions as well.	There should be a section in the WMPs that characterizes relative risk by ecological region (as defined by the electrical corporation) and its related vegetation/topography/weather. As many of these variables are part of the risk analyses that go into the risk methodology, it is important to represent how the environmental variables are weighting the relative risks across a service territory.
10	Energy Safety should require the electrical corporations include risk matrices in their WMPs to depict the relative risks of the issues that they are addressing that relate to the areas of capital upgrades, and operations and maintenance expenditures including, but not limited to, their grid hardening, inspections, and vegetation work.	Risk matrices can help visually add perspective as to the relative risk of different hazards that the electrical corporations face. This includes both external factors such as the weather or environment and factors specific to the grid. The electrical corporations may use risk matrices such as the one below that SCE provided in its 2023-2025 WMP for measuring the risk of trees in different areas for its distribution grids in the High Fire Threat District (HFTD).

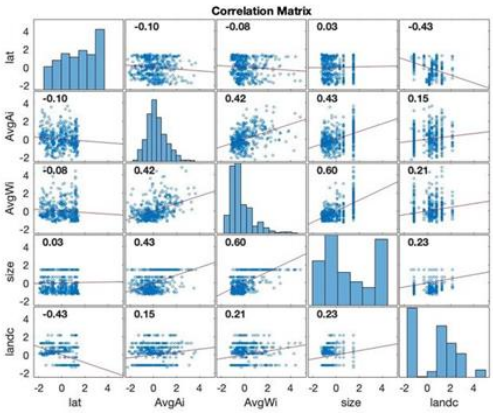
No	Recommendation	Justification
		Figure SCE 8-39 - Tree Risk Index (TRI) – Distribution Grids (HFRA) 
11	Energy Safety should require electrical corporations to report infrastructure component risks of failure against risk of ignition. A risk matrix should be included to illuminate the volume of a particular asset type (component) in the service territory. These should include (but not be limited to) different assets such as expulsion fuses, lightning arrestors, and conductors.	A risk matrix can help describe the relative risk of various assets of failure and ignition. Each component that has a risk of failure that can cause wildfire should be included in the risk matrix. The electrical corporations may use a template such as the one included below. 
12	Energy Safety should require electrical corporations to reorganize the required Table 6-1: Summary of Risk Models to show the relationship between models in a hierarchical way to reduce confusion and better illuminate the relationships between models.	Currently the table is a bit confusing in terms of how the models are ordered and a revision to use a hierarchical nesting structure to the table would help better clarify how the models relate to each other.
13	Energy Safety should require electrical corporations that deployed Machine	The use of ML and artificial intelligence (AI) tools are dramatically increasing in

No	Recommendation	Justification
	Learning (ML) risk mitigation of wildfire to report the following: 1. Data collection methods: a. Describe what data is collected, used to train the model, and methods for collection. Is it global or local data? b. Outline any data transformations performed during preprocessing. c. Explain how data was partitioned. (A model will give overly optimistic results if the using same sample data set for validation as for testing or validation and training.) d. Provide a correlation plot (Matlab: corr) - which describes the correlation between all the variables in the model. These plots are a sanity check for the relationship between the datasets. (See example below)	wildfire research and management.[8] Although tools and techniques of ML are well documented and used across various scientific and technical fields, it has yet to be well understood by those in policy and regulation. AI is an umbrella term that covers many facets that can be simplified to making machines process autonomously. ML is a facet of AI, where a model is trained on previous data then asked to predict or interpret future data; however, it is not fully autonomous. Using machine learning techniques to model the complications of fire behavior has posed a challenge,[9] however it has increased the understanding of controls on fire behavior. The power behind machine learning is that with a given set of input parameters the models can infer different solutions to answer different research questions. However, studies have highlighted the power and inherent uncertainty of machine learning. [10] To account for this uncertainty, policy makers have stepped in to advocate for transparency and accountability from all who use AI for the benefit of the general public. A Presidential Executive Order

[8] Jain, P. et al., (2020). *A review of machine learning applications in wildfire science and management.* Environmental Reviews, 28 (4): 478–505. https://doi.org/10.1139/er-2020-0019.

[9] Bisquert, M. et al., (2012). Application of artificial neural networks and logistic regression to the prediction of forest fire danger in Galicia using MODIS data. *International Journal of Wildland Fire*, 21, 1025-1029. http://dx.doi.org/10.1071/WF1105

[10] Kondylatos (Wildfire Danger Prediction and Understanding With Deep Learning. *Geophysical Research Letters*, 49(17). https://doi.org/10.1029/2022GL099368)used machine learning, specifically Extreme Gradient Boosting (XGBoost) and Random Forest to predict the potential for the point of ignition using a temporal split for training blocks, validation and predicting. Shmuel. & Heifetz. (A Machine-Learning Approach to Predicting Daily Wildfire Expansion Rate. Fire, 6(8). https://doi.org/10.3390/fire6080319) predicted the growth rate of fires using XGBoost and Random Forest with a 5-fold cross validation. Both papers used similar model methods, however the outputs were different; which speaks to the power and uncertainty of machine learning.

No	Recommendation	Justification
	 2. Data Preparation and Cleaning Methods: a. Describe how the electrical corporation cleaned its data. 3. Machine Learning Model: a. Describe how the electrical corporation chose Machine Learning. (WSAB recommends that each electrical corporation use more than one model to prove which is better for its data and explain its selection in its WMP. This ensures they are properly evaluating versus using the easiest or most convenient model.) 4. Model Evaluation a. Describe the training data. Specify the percentage of data used for training, validation, and testing (e.g., 70% training, 15% validation, 15% testing). b. Document validation methods comprehensively. c. Describe how features are extracted.	dated October 30, 2023 was published on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence.[11] This executive order aims protect the American public against the dangers of unregulated artificial intelligence. In summary, the order is aimed at requiring users of AI (including ML) to understand their tools well enough to describe and understand their outputs. Currently, large electrical corporations report using machine learning (ML) for risk modeling related to the probability of ignition. However, there are no clear guidelines on reporting methods for transparency. Additionally, currently, validation methods are either not mentioned or not described in detail in WMPs and should be included. This recommendation aims to establish an initial basic framework for how electrical corporations should describe its ML and/or AI methods throughout its reported work processes. As adoption of these tools grows, they will play a crucial role in informing risk mitigation practices. Early documentation of the tools currently in use is necessary to fully comprehend the model development changes that will impact future management decisions.

[11] https://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/

No	Recommendation	Justification
	d. Describe how classification occurs. e. Report relative feature importance in the model's results. f. Describe when and how revised learning occurs. Specify when new data is collected and how model training is updated.	

Performance Metrics

Per Public Utilities Code §8389(b)(1), in addition to continuing with existing performance metrics and processes, the Board has the following recommendation on performance metrics to enhance the current metrics in the Wildfire Mitigation Plans.

Table 2. WSAB Recommendations on Performance Metrics

No.	Recommendation	Justification
1	Energy Safety should require the electrical corporations to provide updated metrics for outages and wires down events to indicate the number of these events that occur during the fire seasons in the electrical corporations' service territories. These can be written as: • Number of all events with probability of ignition, including wires down, contacts with objects, line slap, events with evidence of heat generation, and other events that cause sparking or have the potential to cause ignition in the HFTD during fire season; • Number of wires down events in the HFTD during fire season;	Currently, the electrical corporations provide in their WMPs and Quarterly Data Reports (QDRs) information about the number of wires down events and outages in the HFTD, but it is unclear what the relative risk of these events are since there is no context as to season or weather conditions in which they occur. By specifying that these incidents occurred during the electrical corporations' fire seasons (as defined by the utility and for the relevant ecological regions in their service territories) both at a service territory level and ecological region level, then the reported information specifically reflects incidents that could pose an ignition risk, rather than irrelevant events such as winter storm outages.

No.	Recommendation	Justification
	• Number of outage events not caused by contact with vegetation in the HFTD during fire season; • Number of outage events caused by contact with vegetation in the HFTD during fire season; and • Number of outage events on circuits with adjusted settings for protective devices enabled in the HFTD during fire season. In addition, Energy Safety should also require the electrical corporations to provide these metrics broken down by ecological regions if feasible. Energy Safety should further require them to define the ecological region boundaries and fire seasons in the table notes or in a supportive narrative.	

2. Safety Culture Assessment

The electrical corporations have made considerable efforts over the years to incorporate values, attitudes and behaviors that can facilitate the success of their safety management efforts. Currently, the Safety Culture Assessment (SCA) process evaluates whether the electrical corporations are building and improving a wildfire safety culture focusing both on foundational components of safety culture and components specific to wildfire risk. We recognize that this is the narrow intent of the existing statutory requirement, and that the task of changing the culture at any organization is a long process that takes years. This effort goes beyond simply lowering accidents and developing new safety procedures and will take much effort both within and beyond the context of the SCA process for which Energy Safety is responsible.

The Board continues to evaluate the electrical corporations' safety cultures and seek out the perspectives of safety culture experts. Per P.U.C. §8389(b)(1), the Board has the following recommendations on the safety culture assessment process.

Table 3. WSAB Recommendations on Safety Culture Assessment Process

No.	Recommendation	Justification
1	Energy Safety should include a question about management integrity and ethics in the Workforce Survey.	Management integrity and ethics are integral components of an electrical corporation's overall culture, including its safety culture. These principles guide management's actions and significantly impact employee morale.
2	Energy Safety should include a question in the Workforce Survey about employee comfort level in reporting safety concerns or safety misconducts that have not been fully addressed.	Safety concerns and misconduct observed by employees that have not been fully addressed pose serious risks. Including a question or statement in Workforce Survey about employee comfort level in reporting safety concerns/safety misconducts that have not been fully addressed will help Energy Safety to better understand and access the electrical corporation's safety culture.
3	Energy Safety should include a question in the Workforce Survey about how frequently the electrical corporation performs workplace hazard assessments.	Regular evaluation of workplace hazards is important not only for reducing workforce accidents but also for improving transparency of the risks that the wildfire mitigation workforce faces.
4	Energy Safety should request that each electrical corporation develop or submit details of behavior-based safety programs that are currently driving its safety culture.	Prioritization of safe behaviors that ensure the necessary awareness to act in a prudent, efficient, and beneficial manner concerning safety for the employees and the public.
5	Energy Safety should require each electrical corporation to create a required, trackable curriculum of safety culture trainings for their management teams which would include topics such as safety	Creating a trackable curriculum and training requirement for managers at the electrical corporations will help leadership prioritize an adaptable safety culture that is suitable for the challenging environment that each electrical corporation faces in its ongoing

No.	Recommendation	Justification
	behaviors, regulations, policies, and laws with refresher intervals.	obligation to electrification, reliability, affordability, and wildfire mitigation.

APPROVAL

The California Wildfire Safety Advisory Board's recommendations to the Office of Energy Infrastructure Safety on additional wildfire mitigation plan requirements and performance metrics, and safety culture assessment were approved on June 5, 2024, and are hereby executed.

Jessica Block, Chair

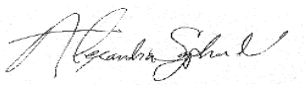
Christopher Porter, Vice Chair

Ralph M. Armstrong Jr., Board Member

Diane Fellman, Board Member

Timothy Haines, Board Member

John Mader, Board Member



Alexandra Syphard, Board Member

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