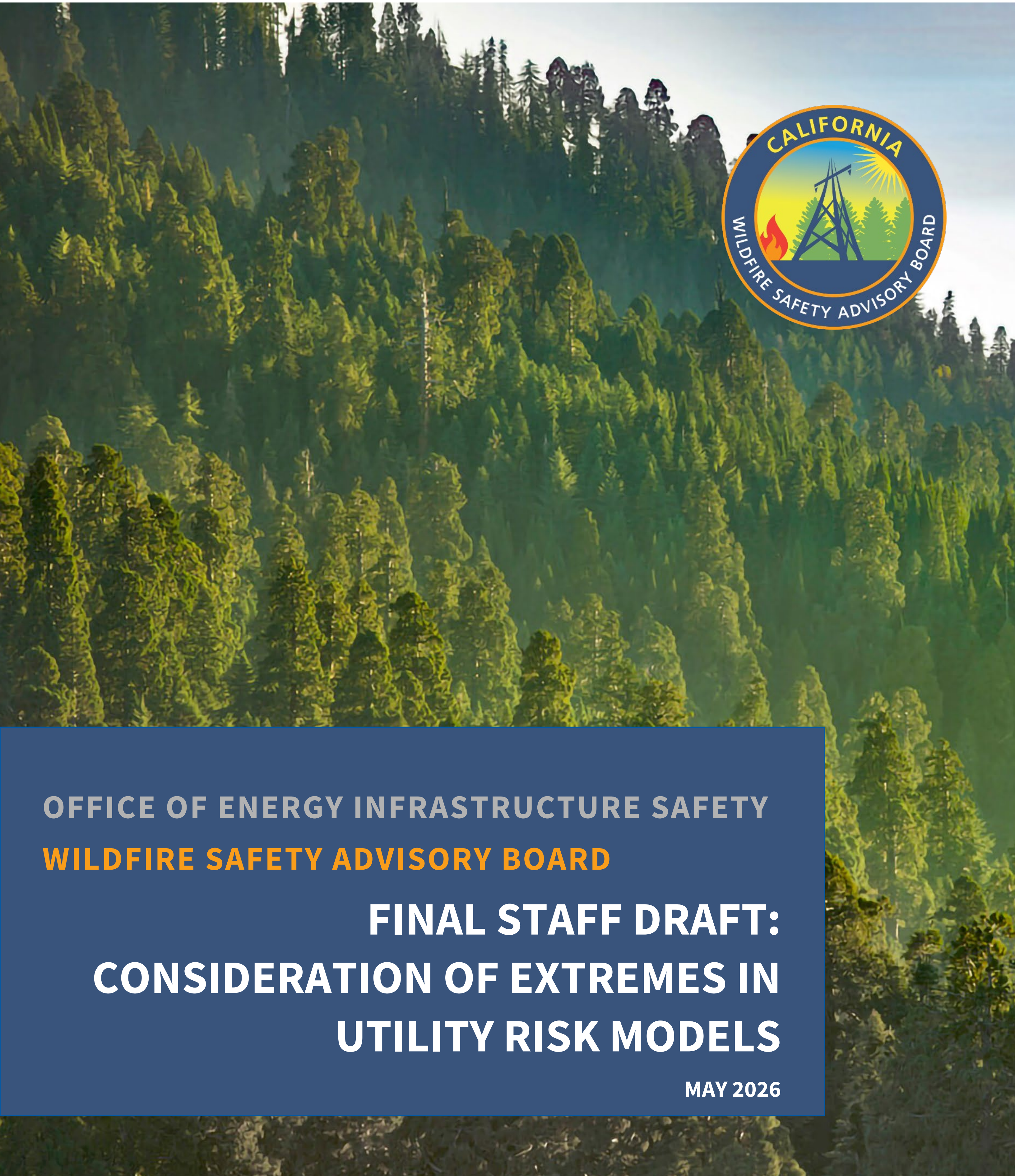


OFFICE OF ENERGY INFRASTRUCTURE SAFETY

WILDFIRE SAFETY ADVISORY BOARD

FINAL STAFF DRAFT: CONSIDERATION OF EXTREMES IN UTILITY RISK MODELS

MAY 2026

TABLE OF CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

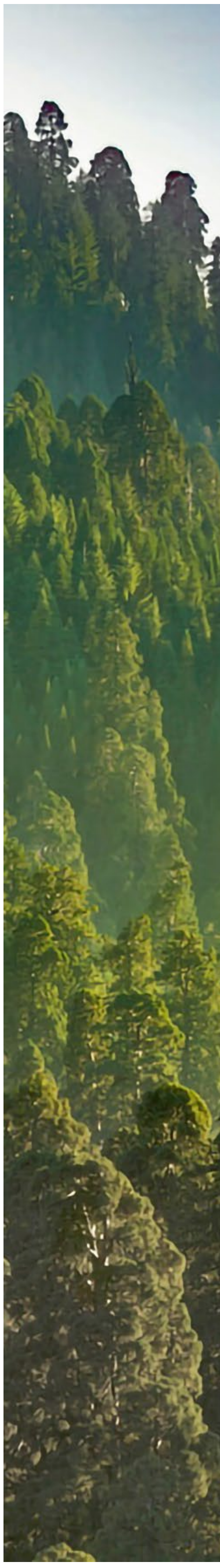
This report evaluates whether utility wildfire risk models adequately represent realistic extreme wildfire scenarios. The Wildfire Safety Advisory Board prepared this report in response to an Office of Energy Infrastructure Safety request following the January 2025 Los Angeles Fires, which occurred under extreme conditions of high winds, low humidity, and a large amount of vegetation growth following multiple wet years.

A key question in evaluating "adequacy" of risk models is in how model results are used. Utilities apply wildfire risk models in two primary decision contexts: near-term operations and long-term planning. Operations models support real-time safety decisions using forecasts, field observations, thresholds, and expert judgment. Planning models support longer-term mitigation selection, capital investment prioritization, and regulatory analysis.

Utilities represent extreme wildfire conditions in planning models primarily through historical weather and fuel inputs, which has both strengths and limitations. Historical fire-weather day selection ensures realistic combinations of conditions but may not capture the full range of compound extremes or future climate-driven risk conditions. The key issue is whether extreme inputs meaningfully influence outputs used for ranking riskiest circuits, estimating absolute risk, and planning mitigation.

Wildfire spread uncertainty increases for extreme wildfire conditions and introduces additional uncertainty into consequence estimates. The wildfire spread models most commonly used by utilities rely on equations developed using lower wind-speed laboratory data. At higher wind speeds, ember casting changes wildfire spread dynamics. Ember cast modeling also has a high degree of uncertainty. Planning model outputs that rely on wildfire spread modeling therefore require caution, particularly when used to estimate absolute risk values.

Targeted improvements can strengthen planning models for use under realistic extreme wildfire conditions. The report makes four recommendations: Energy Safety should be cautious in basing decisions on modeled absolute risk values and to fully implement the 2025 WSAB risk modeling recommendations; require utilities to compare circuit risk rankings using expected values and maximum or tail values; and require utilities to test and report on alternatives or supplements to wildfire spread models when calculating wildfire consequence under realistic extreme scenarios.



1. INTRODUCTION

On March 1, 2025, the Office of Energy Infrastructure Safety (Energy Safety) sent a letter seeking advice from the Wildfire Safety Advisory Board (WSAB).[1] This letter requested recommendations on best practices in vegetation management and utility risk model adequacy. This report is a response to the request on risk model adequacy.

1.1 About the Wildfire Safety Advisory Board

Public Utilities Code (PUC) section 326.1 established the WSAB, a seven-member body of wildfire and utility policy experts appointed by the Governor, Speaker of the Assembly, and Senate Committee on Rules. Each member of WSAB brings a unique perspective and their own expertise. Additional information about WSAB, its members, and its prior recommendations, advisory opinions, and meetings can be found on the WSAB website.[2]

The current members of the WSAB are:

- Ralph Armstrong
- Marybel Batjer
- Jessica Block, Chair
- Timothy Haines
- John Mader
- Chris Porter, Vice Chair
- Dr. Alexandra Syphard

PUC section 326.2 states that WSAB shall “[p]rovide other advice and recommendations related to wildfire safety as requested by the Office of Energy Infrastructure Safety.”

1.2 Energy Safety Request

The Energy Safety request on risk model adequacy was:

> **Risk Model Adequacy in Light of Los Angeles Fires.** January fires in Los Angeles occurred in conditions of extreme wind and extremely high vapor pressure deficit after a wet two years that allowed for much vegetation growth. We request your expertise to advise us as to whether the risk models used by electric utilities adequately consider the circumstances Southern California faced in January and other realistic extreme scenarios. If the risk models do not adequately consider these realistic extreme scenarios, we request your recommendations on how electrical utilities

---

[1] 2025 Energy Safety Request.

[2] Wildfire Safety Advisory Board.

should modify their risk models to provide more useful outputs for informing electric utility planning and operations.[3]

For the purposes of this report, "Los Angeles Fires" refers primarily to the Palisades and Eaton Fires, which burned from January 7–31, 2025. The Palisades Fire burned 23,488 acres over 24 days, causing 12 fatalities and destroying 6,837 structures.[4] The Eaton Fire burned 14,021 acres over the same period, causing 19 fatalities and destroying 9,414 structures.[5] Both fires were driven by extreme weather and fuel conditions. At least ten other wildfires occurred in Los Angeles County in the same period.

This report primarily uses relative humidity rather than vapor pressure deficit. Both compare the amount of moisture the air is holding to the maximum amount of moisture the air could hold at a given temperature.[6, 7] While vapor pressure deficit has been argued to be a more direct measure of the atmosphere's "drying power," relative humidity is widely available in forecasts and historical meteorological data.[8]

This report reviews the risk models of three investor-owned utilities (IOUs): Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E). Specifically, it reviews the consequence part of risk calculation — not the likelihood part.

1.3 Conditions During Los Angeles Fires

Energy Safety noted the Los Angeles Fires occurred under "conditions of extreme wind and extremely high vapor pressure deficit after a wet two years that allowed for much vegetation growth." Characterizing conditions helps establish what "extreme" means in the context of Energy Safety's request. The meteorological record confirms that this combination of drivers aligned to produce conditions that were both rare and highly conducive to large, destructive fires.

1.3.1 Wind and Relative Humidity

During the Los Angeles Fires, maximum hourly-averaged wind speeds on January 7 exceeded the 98th percentile at the three nearest weather stations.[9] Wind gusts reached 70–80 miles per hour (mph) with isolated gusts near 100 mph.[10]

---

[3] 2025 Energy Safety Request.

[4] 2025 Palisades Fire.

[5] 2025 Eaton Fire.

[6] Vapor Pressure Deficit.

[7] Understanding RH.

[8] Vapor Pressure Deficit.

[9] Unprecedented LA Fires.

[10] SCE PSPS Post Event, page 8 and App. C.

At the same time, relative humidity dropped suddenly. In Malibu Canyon, relative humidity dropped from 36 percent on January 4 to 13 percent on January 7.[11] This sudden decrease dried fuels and increased the likelihood of ignition and the potential rate of spread of a fire.

1.3.2 Precipitation and Fuel Load

Southern California received well-above-average rainfall from 2022–2024, which produced large amounts of grass and shrub growth.[12, 13] Satellite imagery showed that the Los Angeles region had 30 percent greater values of normalized difference vegetation index (NDVI) than average.[14] NDVI is a measure of plant health and biomass.[15] As 2024 turned hot and dry, with almost no rain after April, that vegetation cured into fine, highly flammable fuel.[16] This created a continuous fuel bed capable of carrying fire rapidly under wind-driven conditions.[17]

1.3.3 Fire Weather Index

The fire weather index (FWI) combines variables such as wind, relative humidity, precipitation, fuel load, and temperature to scale fire danger.[18] The fire weather index reached record-high daily values across the Los Angeles region during the Los Angeles Fires (Figure 1).[19]

---

[11] Unprecedented LA Fires.

[12] 2024 Atmospheric Rivers.

[13] 2024 Fuels Advisory.

[14] Fuel for California Fires.

[15] NDVI and Crop Growth.

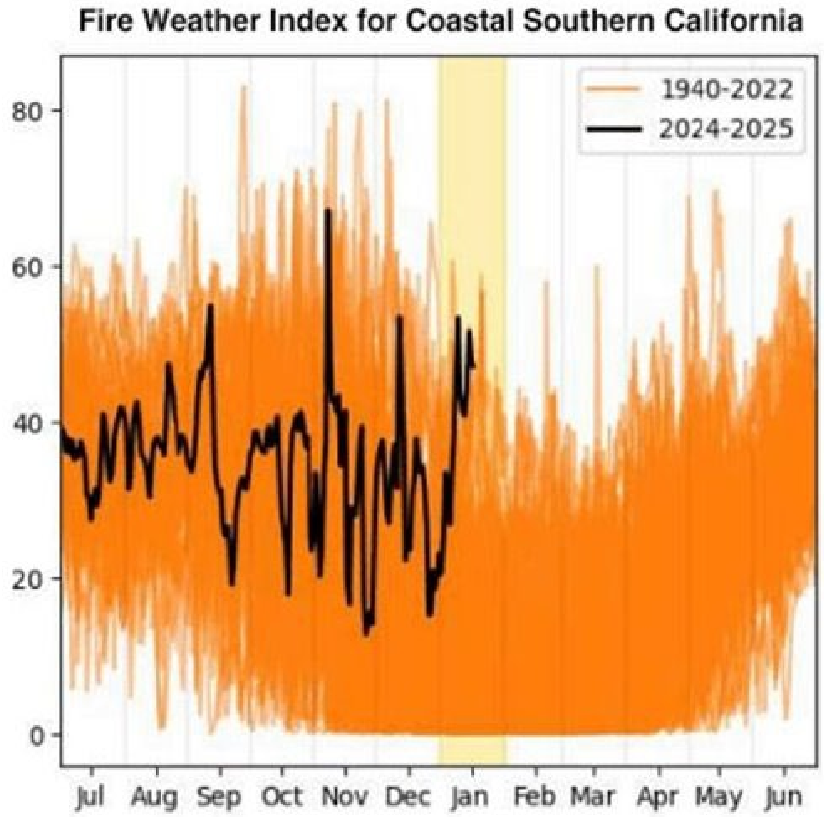
[16] Unprecedented LA Fires.

[17] 2025 Flammable Flora California.

[18] Fire Weather Index System.

[19] Climate Change and LA Fires.

Figure 1. Daily FWI based on global climate modeling. January is highlighted in yellow. Record daily highs were observed during January 2025.[20]



1.4 Approach and Structure of This Report

Model "adequacy" will depend on how utilities use model outputs to support real-world decisions. Energy Safety asked whether utility risk models "adequately consider the circumstances Southern California faced in January and other realistic extreme scenarios." To address this question, this report evaluates both the conditions utilities input into their models and how those conditions influence outputs used for decision-making. Section 2 describes how utilities use models, distinguishing between operations and planning models. Section 3 outlines how utilities select weather and fuel inputs for their models. Section 4 evaluates utility modeling of extreme conditions and describes limitations of using wildfire spread models.

The report then integrates these findings in Section 5 and discusses model adequacy based on intended use, the differences between relative and absolute risk values, and alternatives to current consequence calculations. Section 6 addresses comments received on a draft version of this report. Finally, Section 7 details four recommendations based on the analysis presented here.

---

[20] Climate Change and LA Fires.

2. PRIMARY USES OF RISK MODELS

"Utility planning and operations" in the Energy Safety request refers to different time scales for utility decisions. Utilities use operations models to support real-time and near-term (hours to days) decisions about system safety and reliability. These models combine real-time weather data, near-term forecasts, and grid status data to guide immediate actions, including de-energization and rapid crew deployment.

Utilities use operations models as one of several sources of information in making real-time decisions, e.g., on whether to activate a public safety power shutoff (PSPS). In that case, wildfire risk calculations are weighed against the potential customer impact of a PSPS event. Utilities complement operations model outputs with direct input from meteorologists, fire behavior analysts, and fire agencies.[21, 22] Field crews also inform operations decisions, observing conditions on the ground.[23]

Utilities use planning models for long-term project selection and determining mitigation strategies. These are used to rank circuits by risk (relative use of risk value). Utilities report more information for circuits ranked as highest risk in their wildfire mitigation plans (Figure 2).[24] Utilities also use risk values, not merely to rank circuits, but also to report the amount of risk that mitigation projects reduce (Figure 3) and to develop cost-benefit analyses. [25]

---

[21] SCE Email Exchange.

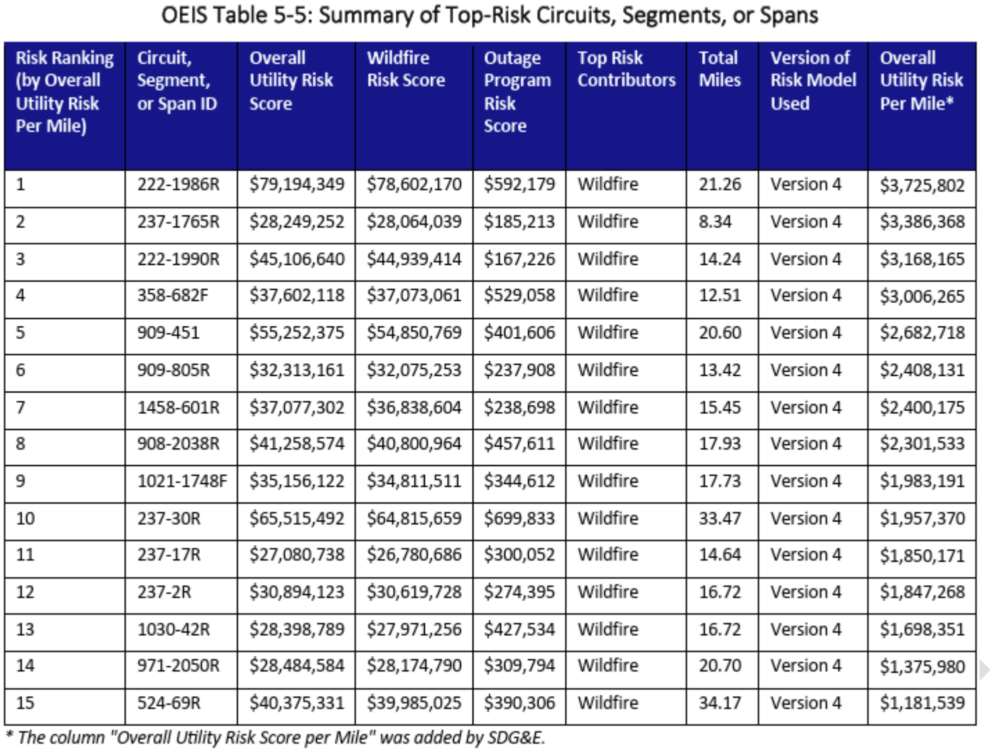
[22] SDG&E Email Exchange.

[23] SDG&E Email Exchange.

[24] OEIS, WMP Guidelines, Section 5.

[25] OEIS, WMP Guidelines, Section 6.

Figure 2. An example of a list of highest-risk circuits, ranked by overall utility risk per mile.[26]

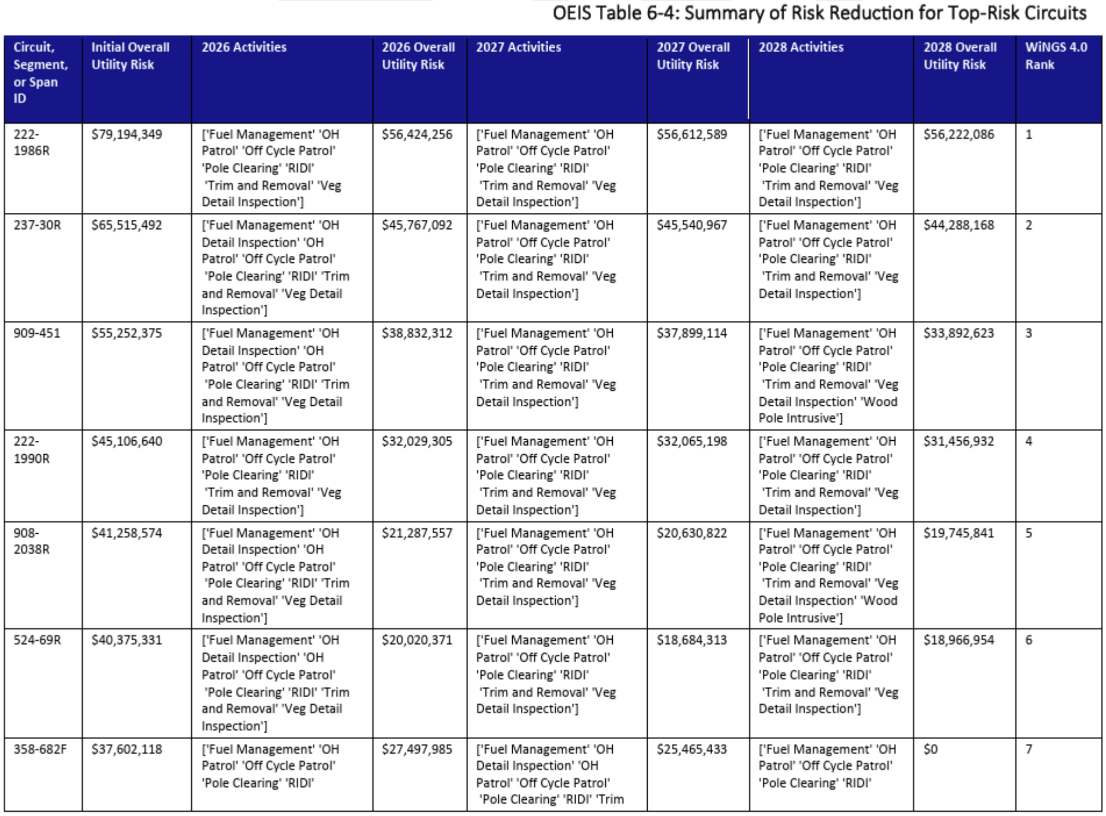


OEIS Table 5-5: Summary of Top-Risk Circuits, Segments, or Spans

Risk Ranking (by Overall Utility Risk Per Mile)	Circuit, Segment, or Span ID	Overall Utility Risk Score	Wildfire Risk Score	Outage Program Risk Score	Top Risk Contributors	Total Miles	Version of Risk Model Used	Overall Utility Risk Per Mile*
1	222-1986R	$79,194,349	$78,602,170	$592,179	Wildfire	21.26	Version 4	$3,725,802
2	237-1765R	$28,249,252	$28,064,039	$185,213	Wildfire	8.34	Version 4	$3,386,368
3	222-1990R	$45,106,640	$44,939,414	$167,226	Wildfire	14.24	Version 4	$3,168,165
4	358-682F	$37,602,118	$37,073,061	$529,058	Wildfire	12.51	Version 4	$3,006,265
5	909-451	$55,252,375	$54,850,769	$401,606	Wildfire	20.60	Version 4	$2,682,718
6	909-805R	$32,313,161	$32,075,253	$237,908	Wildfire	13.42	Version 4	$2,408,131
7	1458-601R	$37,077,302	$36,838,604	$238,698	Wildfire	15.45	Version 4	$2,400,175
8	908-2038R	$41,258,574	$40,800,964	$457,611	Wildfire	17.93	Version 4	$2,301,533
9	1021-1748F	$35,156,122	$34,811,511	$344,612	Wildfire	17.73	Version 4	$1,983,191
10	237-30R	$65,515,492	$64,815,659	$699,833	Wildfire	33.47	Version 4	$1,957,370
11	237-17R	$27,080,738	$26,780,686	$300,052	Wildfire	14.64	Version 4	$1,850,171
12	237-2R	$30,894,123	$30,619,728	$274,395	Wildfire	16.72	Version 4	$1,847,268
13	1030-42R	$28,398,789	$27,971,256	$427,534	Wildfire	16.72	Version 4	$1,698,351
14	971-2050R	$28,484,584	$28,174,790	$309,794	Wildfire	20.70	Version 4	$1,375,980
15	524-69R	$40,375,331	$39,985,025	$390,306	Wildfire	34.17	Version 4	$1,181,539

** The column "Overall Utility Risk Score per Mile" was added by SDG&E.*

Figure 3. An example of calculated risk reduction after mitigation activities.[27]



OEIS Table 6-4: Summary of Risk Reduction for Top-Risk Circuits

Circuit, Segment, or Span ID	Initial Overall Utility Risk	2026 Activities	2026 Overall Utility Risk	2027 Activities	2027 Overall Utility Risk	2028 Activities	2028 Overall Utility Risk	WiNGS 4.0 Rank
222-1986R	$79,194,349	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$56,424,256	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$56,612,589	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$56,222,086	1
237-30R	$65,515,492	['Fuel Management' 'OH Detail Inspection' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$45,767,092	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$45,540,967	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$44,288,168	2
909-451	$55,252,375	['Fuel Management' 'OH Detail Inspection' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$38,832,312	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$37,899,114	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection' 'Wood Pole Intrusive']	$33,892,623	3
222-1990R	$45,106,640	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$32,029,305	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$32,065,198	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$31,456,932	4
908-2038R	$41,258,574	['Fuel Management' 'OH Detail Inspection' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$21,287,557	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$20,630,822	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection' 'Wood Pole Intrusive']	$19,745,841	5
524-69R	$40,375,331	['Fuel Management' 'OH Detail Inspection' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$20,020,371	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$18,684,313	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim and Removal' 'Veg Detail Inspection']	$18,966,954	6
358-682F	$37,602,118	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI'	$27,497,985	['Fuel Management' 'OH Detail Inspection' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI' 'Trim	$25,465,433	['Fuel Management' 'OH Patrol' 'Off Cycle Patrol' 'Pole Clearing' 'RIDI'	$0	7

3. RISK MODEL INPUTS

Wildfire risk model inputs include weather, fuels, topography, and asset characteristics. Operations models use real-time or near-term meteorological and fuel data and forecasts. In contrast, the three large IOUs derive planning model weather and fuel inputs from historical conditions. Utility subject matter experts select specific days from historical records to represent high-fire-likelihood days. PG&E uses 571 “worst weather days” drawn from 2003–2022 historical data.[28] SDG&E uses data from 2013–2021 that includes 125 “worst fire weather days.”[29] SCE uses data from 1980–2021 and divides its service territory into 13 fire climate zones. These zones vary in the number of “fire weather days,” from 29 in the Central Sierras to 464 in Tehachapi.[30]

4. MODEL UNCERTAINTIES UNDER EXTREME CONDITIONS

In its June 2025 Recommendations to the Office of Energy Infrastructure Safety (2025 Recommendations to Energy Safety), WSAB emphasized the importance of understanding and communicating uncertainty in utility wildfire risk models and provided actionable recommendations.[31] While these recommendations did not focus on extreme conditions, they are relevant to the questions in the Energy Safety request as well.

When inputs to the most commonly used wildfire spread models reflect extreme conditions such as the Los Angeles Fires, uncertainty increases in model outputs. Utilities use wildfire spread models that are based on the Rothermel equations, which were developed using laboratory data with wind speeds below 12 mph, which correspond to field conditions of approximately 30 mph.[32, 33] At higher wind speeds, models become less reliable and can produce outputs with “severely elongated elliptical shapes due to the high eccentricity at high wind speeds.”[34] The Los Angeles Fires occurred with wind gusts recorded up to 100 mph.[35]

---

[26] SDG&E 2026-2028 WMP Table 5-5, page 63.

[27] SDG&E 2026-2028 WMP Table 6-4, page 143.

[28] 2025 PG&E Data Request, OEIS_001_Q24.

[29] 2025 SDG&E RAMP, page 30.

[30] SCE, 2026-2028 WMP, page 86.

[31] 2025 Recommendations to Energy Safety.

[32] Model for Predicting Fire Spread, page 21.

[33] Fire Response to High Wind Speeds, pages 1-2.

[34] Fire Spread Simulations, page 2.

[35] LA’s Critically Dry Conditions.

At higher wind speeds, embers—small pieces of burning debris or vegetation—can carry large distances, changing the dynamic of wildfire spread.[36] Rothermel-based spread models do not explicitly account for ember casting.[37] To address this gap, modelers can append separate spotting modules to predict maximum spotting distances from torching trees and wind-driven surface fires.[38] These modules were originally designed for flat or regularly undulating terrain and cannot be straightforwardly applied to complex topography where winds, terrain, and canopy vary.[39] Ember cast modeling remains a scientific frontier characterized by a high degree of uncertainty, particularly under extreme conditions. Technosylva noted in public comments that it plans to release a model to explicitly account for ember risk by using statistical proxies for ember generation, transport, and ignition. Ember casting was largely blamed for the "chaotic and destructive" nature of the Los Angeles Fires.[40]

5. DISCUSSION

This analysis decomposed the Energy Safety request into evaluation of model inputs and uncertainties, applied to wildfire risk operations models and planning models. In this section we discuss adequacy considering each of these elements. As noted in Section 1, a key question in evaluating adequacy of risk models is in how utilities use both relative and absolute model results.

5.1 Operations Models: Adequacy

Because operations models use real-time data and near-term forecasts as inputs, utilities are not selecting representative inputs in the same way they do for planning models. Utilities can be expected to faithfully incorporate data and forecasts of extreme conditions into operations models and decision-making. Further, when operations models' outputs exceed threshold values, the amount of exceedance may not affect the decisions made. Given the complexity and real-time nature of operational decision-making, WSAB does not currently have any recommendations on the operations models.

5.2 Planning Models: Historical Data Do Not Include All Realistic Extremes

While using historical data for model inputs ensures that the combinations of conditions (e.g., wind, temperature, fuel moisture) are realistic, it also means individual variables cannot be scaled independently. Further, limiting the historical period from which fire weather days are drawn may not account for the full range of fire weather conditions outside of that period. For

---

[36] Spot Fire Distance.

[37] WildEST Documentation.

[38] Wildfire Analyst Models and Inputs.

[39] Limitations and Assumptions.

[40] Burning Embers Flew Miles.

example, SCE noted that “recent events in California, including the [Los Angeles Fires], highlight that relying solely on historical wildfire data may not fully capture the range and severity of the potential tail risk events.”[41] The approach also does not account for rare conditions that would be realistic extremes but have not yet been observed; nor does it account for potential changes to realistic extremes that could occur under climate change.

However, it does not immediately follow that the models are not adequately considering extremes. The more important question is whether adding more extreme values would change how utilities use model outputs. Here, differentiating between uses of relative (ranked) outputs and absolute outputs further divides the problem.

5.3 Planning Models: Relative and Absolute Risk Values

Regulatory requirements influence how utilities generate and use planning model outputs. The California Public Utilities Commission (CPUC), in its Risk-Based Decision-Making Framework (RDF), requires utilities to “use expected value for the Cost-Benefit Approach-based measurements and calculations of [Consequence of Risk Event]” values.[42] An expected value is the probability-weighted average of all possible outcomes within a distribution.[43] The RDF also permits utilities to perform an alternative analysis, such as tail value, in addition to the expected value analysis.[44] Energy Safety, in its Wildfire Mitigation Plan (WMP) Guidelines, also requires each electrical corporation to “describe how it identifies and evaluates options for mitigating wildfire…consistent with the CPUC guidelines associated with the [RDF].”[45]

As noted in Section 2, planning model outputs are used both to rank circuits or circuit segments and for cost-benefit analysis. Ranking risk values of each circuit, or circuit segment, relative to the risk of any other circuit or circuit segment is comparing risk modeling outputs to risk modeling outputs. Using absolute values of risk for cost-benefit analysis is comparing risk model outputs not to other risk model outputs, but to external, measurable quantities such as cost.

PG&E and SDG&E have reported expected values. SDG&E noted that incorporating additional, more extreme scenarios would likely produce minimal change in expected value.[46] This impacts uses of both relative and absolute values—small changes in the expected value probably do not have big impacts either on the ranking or on cost-benefit analysis.

---

[41] SCE, Power Law White Paper, page 1.

[42] RDF Appendix A, pages 14-15.

[43] Probability and Statistics, page 25.

[44] RDF Appendix A, page 18.

[45] WMP Guidelines, page 64.

[46] SDG&E Email Exchange.

SCE has used maximum consequence values (of its selected fire weather days) to represent catastrophic wildfires. However, "even the use of the maximum consequence values may underrepresent the risk at certain locations given that the risk is likely to increase over time."[47] Use of mean risk lowers absolute risk values, as SCE reports in its 2026–2028 Wildfire Mitigation Plan.[48] However, it is not clear whether using more extreme inputs would change the relative risk values (i.e., circuit rankings). That is, it is not clear whether using more extreme inputs would push all model results to higher consequences uniformly, or if there are meaningful variations in circuit ranking by extreme risk or expected risk.

The 2025 Recommendations to Energy Safety identified the need for caution when interpreting absolute risk values. The report noted that even updated fuel models have an average mean absolute percentage error of 37% for rate of spread (ROS) estimations. The report indicated that all California IOUs use a single wildfire spread model, while comparing multiple models may give a fuller representation of the range of uncertainties. The report pointed out that collapsing consequence distributions to single values is an incomplete representation of the results. The report stated that utilities do not fully describe the uncertainties in likelihood modeling. Finally, the report highlighted that utilities report risk results to improbable levels of precision—up to 15 decimal places. PG&E also states that wildfire spread models provide "poor correlation" between results and real-world observations of structures destroyed.[49] The additional sources of uncertainty in modeling extreme conditions described in this report further reinforce the need for caution when relying on absolute risk values.

5.4 Planning Models: Alternative Consequence Approaches

Some utilities have reduced their reliance on wildfire spread models to produce consequence values. SCE is developing a hybrid framework that combines its deterministic wildfire spread model-based Wildfire Integrated Model with a probabilistic consequence model. This hybrid approach was "designed to bridge the precision and granularity of deterministic models, with the capability to understand a full range of probabilistic outcomes to better capture rare, but potentially catastrophic tail risk events."[50] SCE also noted the need for supplemental models as the approach used for the wildfire spread models "limits [the model's] ability to capture the full range of possible outcomes, particularly those rare, but high-impact events, which occur under dynamic conditions."[51]

PG&E uses a distinct approach to estimating wildfire consequence values that reduces its reliance on wildfire spread models. It assigns consequence values based on three conditional

---

[47] SCE, 2025 WMP Update, page 43.

[48] SCE, 2026–2028 WMP, page 577.

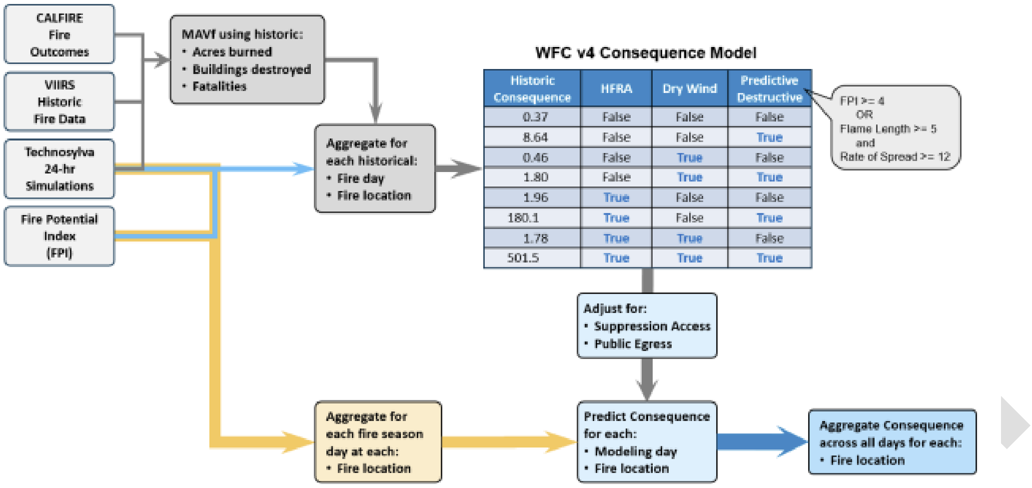
[49] PG&E, 2026-2028 Data Response, GPI_001_Q002.

[50] Power Law, page 36.

[51] Power Law, page 33-34.

variables: whether the asset is in a high-fire risk area (HFRA), whether there are dry wind conditions in the simulated day, and whether a potential fire would be destructive. Wildfire spread modeling informs a portion of the "potentially destructive" conditional (Figure 4). PG&E uses multiple points of data in this approach, rather than relying on a single source.

Figure 4. PG&E base consequence table describing inputs and evaluations. Wildfire spread models contribute "Flame Length" and "Rate of Spread" values.[52]



Historic Consequence	HFRA	Dry Wind	Predictive Destructive
0.37	False	False	False
8.64	False	False	True
0.46	False	True	False
1.80	False	True	True
1.96	True	False	False
180.1	True	False	True
1.78	True	True	False
501.5	True	True	True

Given the known limitations and uncertainties of Rothermel-based wildfire spread models, it is worth exploring alternative approaches to calculating consequence. For example, further analysis could evaluate how much additional information PG&E derives from combining the Rothermel-derived flame length and rate of spread with fire potential index (FPI), as opposed to using FPI independently. More broadly, utilities could evaluate alternative approaches such as machine learning models, probabilistic consequence models, or FPIs. Without wildfire spread models, utilities could still calculate wildfire consequence, and alternate methods may better support planning for realistic extreme conditions.

6. PUBLIC COMMENT

WSAB staff published a draft version of this report for public comment and received one submission. Technosylva provided four comments, organized in two sets, the first set of which were on Section 4 "Model Uncertainties Under Extreme Conditions." Technosylva's first comment states that "[w]ind-driven fires are particularly well captured by our models," and "Technosylva has evaluated 5,000+ fires and published findings in a 2023 paper (Cardil et al., 2023) documenting model improvements for performance under extreme conditions." Neither of these statements contradict WSAB's claim that "models become less reliable and

---

[52] PG&E 2026-2028 WMP, Figure 5.2.2.2-1, page 70.

produce ‘severely elongated elliptical shapes due to the high eccentricity.’” Further, Technosylva cites Cardil et al. (2023) to support its model performance under extreme conditions; however, that study's definition of “high wind speed” was winds above 30 km/h (18.6 mph), far below the wind speeds and gusts that characterized the 2025 Los Angeles fires, as described in Section 1.3.1.

The second comment was that Technosylva’s planned 2026 release of the “Urban Conflagration and Dynamic Building Loss Factor (dBLF) models explicitly account for ember risk by using wind speed, dead fuel moisture, and canopy height as statistical proxies for ember generation, transport, and ignition — enabling building loss probability calculations without tracking individual ember trajectories.” This report includes an updated description of ember casting in wildfire spread models to incorporate this anticipated release.

Technosylva’s second set of comments addressed Sections 5.2 and 5.3 and included, in quotation marks, the following statement: “[c]urrent deterministic wildfire spread models fail to accurately capture extreme, rare ‘tail risk’ events.” This is not a quotation that was in the draft report. Technosylva replies to its own statement, “This characterization does not apply to the Technosylva platform. Our system includes Monte Carlo simulations based on the selection of extreme weather days to capture extreme consequences, and probabilistic modeling for individual simulations to capture uncertainty in ongoing incidents (Ramirez et al, [sic] 2011). Neither approach is deterministic.” Technosylva’s wildfire spread model is deterministic, though as it noted, the larger Technosylva model can use probabilistic elements. Technosylva representatives stated their model could go into “probabilistic mode” for operations; however, that is not part of their standard offering.[53] Technosylva also describes its “[d]eterministic & probabilistic simulations to incorporate uncertainty and identify vulnerable areas” on its website.[54]

As discussed in Section 5.2, sampling from historical data cannot accurate represent conditions that fall outside the historical record, even when using Monte Carlo simulations. Technosylva acknowledges this, stating, “While our consequence models, and most notably updates with the Urban Conflagration (UC) models, deal with extreme, rare events to address Wildland Urban Interface (WUI) risk, simulations are currently focused on 8 or 24-hour spread windows and historical weather.”

Technosylva points to a statement made in the draft report that “utilities have noted that wildfire spread models demonstrate a ‘poor correlation’ between their results and real-world observations of actual structures destroyed.” Technosylva’s final comment addresses its accuracy in matching ROS but does not address structure damage.

On ROS estimations, Technosylva states “the average mean value is considered poor, which is incorrect. As Cruz and Alexander (2013) propose, ‘case [sic] is made for suggesting that a 35% error interval (i.e. approximately one standard deviation) would constitute a reasonable standard for model performance in predicting a wildland fire’s forward or heading rate of

---

[53] Call with Technosylva

[54] Technosylva Website

spread.'" A key focus of this report is using the appropriate model for its intended use. A 35% error interval of ROS may be an appropriate level and metric for operational use of wildfire spread models, particularly, as discussed in Section 5.1, when subject matter experts are in the room and can adjust model results based on perspectives from many real-time data sources. This is not the appropriate standard for electric utility planning purposes designed to target risk mitigation activities. While ROS is an important component to validate in the wildfire spread models, it is not the most appropriate validation metric for planning purposes. The perimeters a model produces are a more appropriate metric as they are a basis for calculation of consequence values (e.g., acres lost, structures damaged, structures destroyed, and lives lost).

Clarifying text was added to the Executive Summary, Section 4, and Section 5.3, but no substantive changes have been made to this report based on these comments.

7. RECOMMENDATIONS

Energy Safety requested WSAB's "expertise to advise us as to whether the risk models used by electric utilities adequately consider the circumstances Southern California faced in January and other realistic extreme scenarios. If the risk models do not adequately consider these realistic extreme scenarios, we request your recommendations on how electrical utilities should modify their risk models to provide more useful outputs for informing electric utility planning and operations."

WSAB has no recommendations on the adequacy or useful outputs of operations models at this time. WSAB recommends targeted improvements focused on transparency, model use, and consequence modeling to improve the adequacy of planning models and the usefulness of their outputs.

1. Energy Safety should fully implement the risk modeling recommendations in the 2025 Recommendations to Energy Safety.
2. Energy Safety should be cautious in basing decisions on absolute values of modeled risk.
3. Energy Safety should require utilities to compare circuit risk rankings using expected values and maximum or tail values.
4. Energy Safety should require utilities to test and report on alternatives or supplements to wildfire spread models when calculating wildfire consequence, including under realistic extreme scenarios.

References Table

Citation	Reference
2024 Atmospheric Rivers.	Center for Western Weather and Water Extremes, The Atmospheric Rivers of Water Year 2024: April Summary, Published April 9, 2024. URL: (https://cw3e.ucsd.edu/the-atmospheric-rivers-of-water-year-2024-april-summary/)
2024 Fuels Advisory.	National Interagency Fire Center, Fuels and Fire Behavior Advisory: California Grass and Herbaceous-Dominated Ecosystems, Published July 22, 2024. URL: (www.nifc.gov/sites/default/files/FireInformation/2024%20Advisories/Fuels_Fire_Behavior_Advisory_CA_Herbaceous_20240722.pdf)
2025 Eaton Fire.	California Department of Forestry and Fire Protection , Office of the State Fire Marshal, Eaton Fire, Published January 7, 2025, URL: (https://www.fire.ca.gov/incidents/2025/1/7/eaton-fire).
2025 Energy Safety Request.	Wildfire Safety Advisory Board, Energy Safety Request for Advice and Recommendations, Published March 3, 2025, URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=58046&shareable=true).
2025 Flammable Flora California.	McKenzie, B., Weather, Wind and Flammable Flora Fuel California Fires, Published January 14, 2025. URL: (https://news.virginia.edu/content/weather-wind-and-flammable-flora-fuel-california-fires)
2025 Hughes Fire.	California Department of Forestry and Fire Protection , Office of the State Fire Marshal, Hughes Fire, Published January 22, 2025, URL: (https://www.fire.ca.gov/incidents/2025/1/22/hughes-fire).
2025 Palisades Fire.	California Department of Forestry and Fire Protection, Office of the State Fire Marshal, Palisades Fire, Published January 7, 2025, URL: (https://www.fire.ca.gov/incidents/2025/1/7/palisades-fire).
2025 PG&E Data Request.	Office of Energy Infrastructure Safety, 2025 PG&E WMP Data Request Summary, Published May 22, 2025. URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=58531&shareable=true)
2025 Recommendations to Energy Safety.	Wildfire Safety Advisory Board, Recommendations to the Office of Energy Infrastructure Safety, Published June 9, 2025. URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=58654&shareable=true)
2025 SDG&E RAMP.	San Diego Gas and Electric, 2025 Risk Assessment Mitigation Phase, Published May 15, 2025. URL: (https://www.sdge.com/sites/default/files/regulatory/SDG&E%20-Risk-4%20Wildfire%20&%20PSPS_0.pdf)
2025 WMP Update.	Southern California Edison, 2025 Wildfire Mitigation Plan Update, Published November 4, 2024. URL:

Citation	Reference
	(https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=57581&shareable=true)
2026-2028 Data Response.	Pacific Gas & Electric, Wildfire Mitigation Plans Discovery 2026-2028 Data Response, Published May 20, 2025. URL: (https://www.pge.com/assets/pge/docs/outages-and-safety/outage-preparedness-and-support/2026-2028-GPI_001.zip)
2026-2028 WMP.	Pacific Gas & Electric, 2026-2028 Base Wildfire Mitigation Plan, Published December 30, 2025. URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=60012&shareable=true)
2026-2028 WMP.	San Diego Gas & Electric, 2026-2028 Base Wildfire Mitigation Plan, Published September 30, 2025. URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=59448&shareable=true)
2026-2028 WMP.	Southern California Edison, 2026-2028 Base Wildfire Mitigation Plan, Published October 27, 2025. URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=59549&shareable=true)
Burning Embers Flew Miles.	Los Angeles Times, Tiny Burning Embers Flew Miles, Causing L.A. Fire Destruction on Historic Scale, Published January 9, 2025. URL: (https://www.latimes.com/california/story/2025-01-09/burning-embers-flews-miles-brought-mass-destruction-across-l-a-county)
Call with Technosylva.	Grechanuk, P., Ratnathicam, I., and Walker, A. of Technosylva, meeting with WSAB staff, April 27, 2026.
Climate Change and LA Fires.	Masters, J., Climate change made deadly Los Angeles wildfires 35% more likely: new attribution study, Published January 28, 2025. URL: (https://yaleclimateconnections.org/2025/01/climate-change-made-deadly-los-angeles-wildfires-35-more-likely-new-attribution-study/)
CPUC Phase 4 Decision.	California Public Utilities Commission, Decision 25-08-032, Published August 28, 2025, URL: (https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M578/K198/578198350.PDF).
Ember Risk Modeling.	Roberts, M., Rawlinson, A., and Wang, Z. Ember risk modelling for improved wildfire risk management in the peri-urban fringes, Published April 2021. URL: (https://www.sciencedirect.com/science/article/abs/pii/S1364815220310136)
Fine Scale Hazard Mapping.	Jensen Hughes, Project #4 – Fine Scale Hazard, Risk and Vulnerability Mapping, Published February 22, 2024. URL: (https://firesafeojai.org/wp-content/uploads/2024/09/Fine_Scale_Risk_Mapping.pdf)

Citation	Reference
Fire Response to High Wind Speeds.	Butler, B., Quarles, S., Standohar-Alfano, C., Morrison, M., Jimenez, D., Sopko, P., Wold, C., Bradshaw, L., Atwood, L., Landon, J., O'Brien, J., Hornsby, B., Wagenbrenner, N., and Page, W., Exploring fire response to high wind speeds: fire rate of spread, energy release and flame residence time from fires burned in pine needle beds under winds 27 m s^{-1}, Published November 21, 2019. URL: (https://www.fs.usda.gov/rm/pubs_journals/2019/rmrs_2019_butler_b001.pdf)
Fire Spread Simulations.	Kim, M., Pais, C., and Gonzalez, M., Fire Spread Simulations using Cell2Fire on Synthetic and Real Landscapes, Published July 11, 2025. URL: (https://www.nature.com/articles/s41598-025-05706-6)
Fire Weather Index System.	National Wildfire Coordinating Group, CFFDRS: Fire Weather Index FWI System, Accessed February 4, 2026. URL: (https://www.nwcg.gov/publications/pms437/cffdrs/fire-weather-index-fwi-system)
Fire-Related Meteorological Quantity.	Seager, R., Hooks, A., William, A. Park, Cook, B., Nakamura, J., and Henderson, N., Climatology, Variability, and Trends in the U.S. Vapor Pressure Deficit, an Important Fire-Related Meteorological Quantity, Published June 1, 2025. URL: (https://journals.ametsoc.org/view/journals/apme/54/6/jamc-d-14-0321.1.xml)
Fuel for California Fires.	National Aeronautics and Space Administration, Fuel for California Fires, Published January 31, 2025. URL: (https://science.nasa.gov/earth/earth-observatory/fuel-for-california-fires-153896/)
Fuel Models.	Scott, J., and Burgan, R., Standard Fire Behavior Fuel Models: Set for Use with Rothermel's Surface Fire Spread Model, Published June 2005. URL: (https://gacc.nifc.gov/oncc/docs/40-Standard%20Fire%20Behavior%20Fuel%20Models.pdf)
LA's Critically Dry Conditions.	Bland, A., 'Literally off the charts': LA's critically dry conditions stun scientists as fires rage, Published January 15th, 2025. URL: (https://calmatters.org/environment/wildfires/2025/01/dry-danger-zone-california-fires-climate-change/)
Limitations and Assumptions.	FARSITE, Limitations and Assumptions (technical documentation), Accessed May 14, 2026. URL: (https://owfflammaphelp62.firenet.gov/LegacyFARSITE/Tech_Limitations_and_Assumptions.htm)
Model for Predicting Fire Spread.	Rothermel, R., A Mathematical Model for Predicting Fire Spread in Wildland Fuels, Published 1972. URL: (https://www.fs.usda.gov/rm/pubs_int/int_rp115.pdf)
NDVI and Crop Growth.	Li, C., Li, H., Li, J., Lei, Y., Li, C., Manevski, K., and Shen, Y., Using NDVI percentiles to monitor real-time crop growth, Published July 2019. URL:

Citation	Reference
	(https://www.sciencedirect.com/science/article/abs/pii/S0168169918318337)
Power Law White Paper.	Southern California Edison, 2026 RAMP Wildfire Power Law White Paper, Published November 3, 2025. URL: (https://webproda.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-policy-division/meeting-documents/sce-2026-ramp-power-law-white-paper_nov-2025.pdf)
Probability and Statistics.	Hansen, B. Probability and Statistics for Economists, Published 2017. URL: (https://dspace.unililzone.com/api/core/bitstreams/65f6c0b5-b43e-4a0c-aa98-a610053e69dc/content)
RDF Framework Appendix A.	California Public Utilities Commission, Risk-Based Decision-Making Framework Appendix A, Published April 26, 2024. URL: (https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M530/K252/530252716.PDF)
SCE Email Exchange.	Southern California Edison Wildfire Case Admin, email to WSAB staff, November 3, 2025.
SCE PSPS Post Event.	California Public Utilities Commission, SCE PSPS Post Event Report – January 2, 2025 to January 17, 2025, Published March 3, 2025. URL: (https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-and-enforcement-division/reports/psps-post-event-reports/2025/20250104sce-psps-post-event-reportdeenergizedfinal.pdf)
SDG&E Email Exchange.	Woldegiorgis, S. of SDG&E, email to WSAB staff, November 13, 2025.
Spot Fire Distance.	Albini, F., Spot Fire Distance from Burning Trees – A Predictive Model, Published July 1979. URL: (https://www.frames.gov/documents/behaveplus/publications/Albini_1979_INT-GTR-056_ocr.pdf)
Technosylva Website.	Technosylva, Wildfire Operations - One platform. Results in under 30 seconds, Accessed April 29, 2026. URL: (https://technosylva.com/products/wildfire-operations/)
Three Questions for Decision Support.	Grimm, V., Johnston, A., Thulke, H-H., Forbes, V., and Thorbek, P., Three questions to ask before using model outputs for decision support, Published September 20, 2020. URL: (https://pmc.ncbi.nlm.nih.gov/articles/PMC7527986/)
Understanding RH.	Dehumidifier Corporation of America, Understanding Relative Humidity and How to Control it Indoors, Accessed February 12, 2026. URL: (https://dehumidifiercorp.com/blog/understanding-relative-humidity-and-how-to-control-it-indoors/)
Unprecedented LA Fires.	Madakumbura, G., Thackeray, C., Hall, A., Williams, P., Norris, J., and Sukhdea, R., Study: Climate Change A Factor In Unprecedented LA Fires,

Citation	Reference
	Published January 13, 2025. URL: (https://sustainablela.ucla.edu/2025lawildfires)
Vapor Pressure Deficit.	Climate Signals, Explainer: What is Vapor Pressure Deficit(VPD)?, Accessed February 12, 2026. URL: (https://www.climatesignals.org/resources/explainer-what-vapor-pressure-deficit-vpd)
WildEST Documentation.	Vibrant Planet, Methods and outputs of Wildfire Exposure Simulation Tool (WildEST), Accessed May 14, 2026. URL: (https://www.pyrologix.com/reports/WildEST%20Documentation.pdf)
Wildfire Analyst Models and Inputs.	Technosylva, Wildfire Analyst Models and Inputs, Published March 14, 2022. URL: (https://www.sdge.com/sites/default/files/regulatory/OEIS-2022-04%20Attachement.pdf)
Wildfire Safety Advisory Board.	Office of Energy Infrastructure Safety, California Wildfire Safety Advisory Board, Accessed January 27, 2026. URL: (https://energysafety.ca.gov/what-we-do/wildfire-safety-advisory-board/)
WMP Guidelines.	Office of Energy Infrastructure Safety, Wildfire Mitigation Plan Guidelines, Published February 24, 2025. URL: (https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=58026&shareable=true)

OFFICE OF ENERGY INFRASTRUCTURE SAFETY
CALIFORNIA WILDFIRE SAFETY ADVISORY BOARD
www.energysafety.ca.gov

715 P Street
15th Floor
Sacramento, CA 95814
wsab@energysafety.ca.gov