PACIFIC GAS & ELECTRIC COMPANY

SECTION 4

LESSONS LEARNED AND RISK TRENDS

4.1 Lessons Learned: How Tracking Metrics on the 2020 Plan Has Informed the 2021 Plan

Describe how the utility's plan has evolved since the 2020 Wildfire Mitigation Plan (WMP) submission. Outline any major themes and lessons learned from the 2020 plan and subsequent implementation of the initiatives. In particular, focus on how utility performance against the metrics used has informed the utility's 2021 WMP.

Pacific Gas and Electric Company's (PG&E) wildfire mitigation strategy continues to be structured around three strategic imperatives: reducing wildfire ignition potential, enhancing situational awareness, and reducing the impact of Public Safety Power Shutoff (PSPS) events. The 2021 WMP focuses on further maturing these imperatives based on lessons learned from the implementation of our 2019 and 2020 WMP. While PG&E delivered on the programs included in the 2020 WMP, we also identified several gaps in our execution in 2020 and lessons learned that we are focused on resolving through our 2021 WMP and oversight of the workstreams in 2021. The primary gaps identified and lessons learned from 2020 include risk prioritization of Enhanced Vegetation Management (EVM) work, prioritizing the scheduling and execution of system inspections, and the quality of vegetation management activities, as discussed below. PG&E's 2021 WMP also presents a significant step forward in our risk modeling, due to both overall improvements in our toolset for analyzing risk and lessons learned from the past few years. Finally, we also continue to refine the delivery and execution of our PSPS program, particularly as it relates to partnering and communicating with the communities and customers impacted by PSPS events.

The remainder of this section includes the following subsections:

- Subsection (a): Lessons learned for EVM risk prioritization;
- Subsection (b): Lessons learned regarding system inspection prioritization and execution;
- Subsection (c): Lessons learned on vegetation management quality improvements;
- Subsection (d): Risk modeling improvements; and,
- Subsection (e): PSPS improvements.

(a) Enhanced Vegetation Management Risk Prioritization

In 2020, PG&E identified, and other external parties including the Federal Monitor provided feedback, that the execution of EVM work was not aligned with our risk prioritization model. In some cases, and for a number of reasons including the longer cycle time associated with completing the more densely vegetated sections of our system, lower priority circuit segments were being completed before higher priority circuit segments.

For 2021, PG&E is resolving this gap through increased control and validation of the workplan. First, we have implemented an updated risk model (described in Section 4.5.1) to inform the selection of which circuit segments to work in 2021. In

2021, we will target the highest risk circuit segments and we have increased the controls around the actual circuit segments that will be completed. The newly formed Wildfire Risk Governance Steering Committee (WRGSC) is directly approving the selection of EVM work locations and monitoring regular reporting of work completed to ensure actual work is aligned with the planned risk reduction. Second, we have revised our internal incentive metric associated with EVM work to require that at least 80 percent of the work be performed in the top 20 percent of the risk ranking of circuit segments[1] otherwise the incentive metric will be assessed to be a 0. Through the improved risk prioritization, program controls and metric updates, our investments in EVM will help maximize wildfire risk reduction. This learning is also being applied to the System Hardening program where the updated risk model is also being used to target projects and the incentive metric structure has been set up the same way to require that 80 percent of the system hardening miles completed are in the top 20 percent of the risk ranking (or areas where assets must be rebuilt due to an actual wildfire).

(b) System Inspection Prioritization and Execution

By identifying potential issues on PG&E assets in High Fire Threat Districts (HFTD) before they have a chance to fail, the system inspection program is a critical aspect of PG&E's wildfire risk mitigation activities. However, in 2020, PG&E did not properly manage and prioritize the execution of system inspections in the highest risk areas. In some cases, assets outside of HFTDs were inspected before higher wildfire risk assets had been completed. In 2021, PG&E is resolving this issue by applying the same updated risk model mentioned for EVM and system hardening to prioritize and order the system inspections workplan. We are going to complete all inspections in HFTD areas before the late summer peak of wildfire season[2] and the WRGSC is also directing the establishment and execution of the system inspections workplan. Through the increased oversight, focus on aligning to the risk prioritization and earlier completion of inspections in HFTD areas, PG&E's critical system inspection program will provide increased wildfire risk mitigation value in 2021 and going forward.

(c) Vegetation Management Quality Improvements

Vegetation contacts with powerlines remain the leading cause of California Public Utilities Commission (CPUC or Commission) reportable ignitions in HFTD areas. Managing vegetation in proximity to powerlines is therefore one of the most important wildfire risk mitigation activities, but also one of the most challenging given the dynamic nature and volume of trees in PG&E's service territory. In 2020, we identified steps to further improve the quality and consistency of our vegetation management work.

---

1 The incentive metric for 2021-2023 not only measures the number of miles completed (1,800 miles per year) but also requires that 80% of the work completed over that three year period be in the top 20% of circuit segments on the risk buydown curve or be in areas impacted by actual wildfires. If less than 80% of the miles counted fit that criteria then the metric performance will be a 0, regardless of how many total miles were completed.

2 Before September 1, with the possible exception of locations where an inspection was attempted before September 1 but access restrictions, customer refusals or other external factors prevent initial completion of the inspection.

For 2021, PG&E is deploying substantially increased resources to validate the quality of our vegetation management work and respond more quickly to any concerns raised, internally or externally about vegetation management work. PG&E anticipates more than tripling our work verification workforce by adding more than 200 inspectors to increase our ability to verify that vegetation management was completed to meet state and federal standards and PG&E's own expectations. We will also be performing work verification (post-tree work inspections) on 100 percent of work performed in HFTDs, both for EVM and routine vegetation management programs. PG&E will also be deploying technology to capture objective snapshots of the condition of vegetation throughout HFTDs through ground-based Light Detection and Ranging (LiDAR) to further validate work completion and time-stamped conditions across our system. Finally, PG&E will be staffing a centralized team of arborists to investigate any concerns or findings raised by internal or external parties to ensure timely follow-up, appropriate resolution and adequate closure of any issues identified. Together these efforts, along with ongoing improvements to processes and tools (like work tracking systems), will improve PG&E's vegetation management performance, quality and consistency in addressing vegetation, one of the most important and challenging wildfire risks facing PG&E's utility infrastructure.

(d) Risk Modeling Improvements

Implementing the 2021 Wildfire Distribution Risk Model, which is discussed in much more detail in Section 4.5.1 below, has allowed PG&E to advance our predictive analytics capabilities and practices. For example, the 2019-2020 Wildfire Risk Model used in the 2019 and 2020 WMPs deployed industry best practices around model performance metrics after the model was in use, as an after-the-fact quality check. The Equipment Probability of Ignition and Vegetation Probability of Ignition Models now used for the 2021 WMP use the same performance metrics in a proactive manner, to evaluate the accuracy of the model before it is deployed.

Another resource leveraged more fully during the development of the 2021 Wildfire Distribution Risk Model was benchmarking with risk modeling experts from peer utilities, particularly in California. Through regular, ongoing collaboration meetings experts from PG&E, San Diego Gas & Electric Company (SDG&E), Southern California Edison Company (SCE), Australian utilities and others have partnered to learn about each other practices, challenges and learnings.

The 2021 WMP includes risk models that provide a deeper granularity of risk analysis, for example, the 2020 WMP distribution line scoring of circuits and Circuit Protection Zones (CPZ) was heavily scrutinized, so for the 2021 WMP, PG&E has analyzed and made more uniform Circuit Segments to apply to models across the distribution system.

Data accuracy and data validation practices continue to improve. In 2020, we saw the first phase implementation of a data aggregation platform that forms a foundation for a "single source" of data. This is a significant step in PG&E's efforts to mature these two foundational capabilities.

Finally, PG&E has received comments from both the Safety Policy Division (SPD) and parties in the 2020 Risk Assessment Mitigation Phase (RAMP) proceeding (Application 20-06-012) requesting PG&E to analyze PSPS consequences to customers at a more granular level than at an enterprise level risk. PG&E also understands that SDG&E through its Wildfire Next Generation System,[3] is evaluating PSPS consequences and considered customer impacts in its RSE calculations for this WMP. PG&E supports these requests to analyze and model PSPS customer impacts and made an initial attempt at this evaluation in its first Quarterly Report in its response to Condition Guidance-1 examining customer reliability only, though we understand that additional consequences, such as safety and financial, are also of interest to stakeholders. PG&E intends to explore modeling these additional consequences. PG&E also supports SDG&E's effort to consider the reduction of PSPS consequences to customers in its mitigation Risk Spend Efficiency (RSE) calculations for system hardening activities such as covered conductor deployment or undergrounding of overhead circuits in HFTD areas.

PG&E has constructed an initial PSPS consequence model at the enterprise level, and although our risk models are not yet evolved enough to assess PSPS consequence at a circuit or circuit segment level, we currently intend to develop this capability for use in the second half of 2021. PG&E expects to work collaboratively with the other California utilities to further advance this modeling.

(e) PSPS Program Improvements

While PG&E is committed to taking actions that further make PSPS events smaller, we will not deviate from the purpose of PSPS events, to prevent catastrophic wildfire ignitions during the most severe and highest risk wildfire conditions. To that end, we are assessing what conditions that may drive an expansion in the scope of PSPS events, for example known, high-risk vegetation conditions adjacent to powerlines that may have been outside of previous PSPS event footprints may drive the inclusion of such lines in 2021 PSPS events. As of Quarter 1 2021, PG&E is continuing to determine the mechanics of the possible expansion of PSPS criteria and then needs to analyze the likely impact of that criteria in comparison to the actions being taken (such as increased sectionalizing devices) to make PSPS events smaller.

In addition to the scope of PSPS events, PG&E is also working to improve customer resources and engagement before, during and after PSPS events. With two years of experience with significant PSPS events, PG&E is further grounding our outreach, programs and services in customer and stakeholder feedback, research, and data to continuously improve. We will use this feedback and research to, among other things: continue to refine our Community Resource Center strategy working in close collaboration with our county, tribal and Community-Based Organization (CBO) partners, and enhance solutions for customers that are like to see "repeat impacts" due to multiple PSPS events. Another dimension where we will continue to use data to direct our activities is in the deployment of specialized material and resources. During the 2020 PSPS season, PG&E deployed a substantial amount of in-language material to provide accessible PSPS information for non-English speaking customers and communities. PG&E is continuing to gather data and feedback to assess how best to support customers with limited English proficiency. It may be that more material on PG&E's website is less valuable than continuing to strengthen our partnerships with

3 SDG&E WMP Quarterly Report, Guidance-1 and SDGE-3, September 9, 2020.

CBOs who already have relationships with and support those customers and communities.

4.2 Understanding Major Trends Impacting Ignition Probability and Wildfire Consequence

Describe how the utility assesses wildfire risk in terms of ignition probability and estimated wildfire consequence, including use of Multi-Attribute Risk Score (MARS) and Multi-Attribute Value Function (MAVF) as in the Safety Model and Assessment Proceeding (S-MAP)[11] and RAMP, highlighting changes since the 2020 WMP report. Include description of how the utility distinguishes between these risks and *the risks to safety and reliability. List and describe each "known local condition" that the utility monitors per General Order (GO) 95, Rule 31.1, including how the condition is monitored and evaluated.*

PG&E has substantially updated its wildfire risk modeling and risk assessment tools for this 2021 WMP. Section 4.5 provides an introduction and in-depth explanation of the updated models in use for 2021. This Section 4.2 follows the 2021 WMP template in explaining the use of established risk modeling tools (MAVF and MARS, defined below). Many readers may benefit by first reviewing Section 4.5 to understand PG&E's overall wildfire risk assessment and modeling approach for the 2021 WMP, before coming back to the detailed discussion in this section.

The remainder of this section includes the following subsections:

- Subsection (a): PG&E's use of MAVF to assess wildfire ignition probabilities and estimated consequences, and to translate these from natural units into a unitless risk score for MARS;

- Subsection (b): PG&E's wildfire risk assessment and bowtie analysis;

- Subsection (c): How PG&E distinguishes between wildfire risks and other safety and reliability risks;

- Subsection (d): A description describes of "known local conditions" as that term is used in General Order (GO) 95, Rule 31.1; and,

- Subsection (e): Responses to Actions identified in Wildfire Safety Division's (WSD) evaluation of PG&E's Remedial Compliance Plan (Actions PGE-3 (Class A), PGE-4 (Class A), and PGE-6 (Class A)) and in WSD's evaluation of PG&E's First Quarterly Report (Actions PGE-1 subpart 1(ClassB), PGE-4 (Class B), PGE-5 (Class B), and PGE-15 (Class B)) that are related to the substance of this section.

(a) Use of MAVF and MARS

Pursuant to Decision (D.) 18-12-014, PG&E implemented the S-MAP Settlement Agreement in 2019, including the development of an MAVF and Risk Bowtie for Wildfire analysis. PG&E employs an MAVF to combine all potential consequences of the occurrence of a risk event and create a single measurement of value known internally as MARS.[4] An MAVF consists of the following components:

- Attributes
- Ranges
- Natural Units
- Weights
- Scaling Function

D.18-12-014 also provides six principles to use in determining the MAVF components: Attribute Hierarchies, Measured Observations, Comparison, Risk Assessment, Scaled Units, and Relative Importance.

The key components of the MAVF that PG&E used for assessing wildfire-related risks, and how they adhere to the principles, are shown Table PG&E-4.2-1 below and are described in the discussion following the table.

TABLE PG&E-4.2-1: KEY COMPONENTS OF MAVF

Attribute	Range	Natural Units	Weight	Scaling Function
Safety	0 - 100	Equivalent Fatalities (EF)/ event	50%	Non- Linear
Electric Reliability	0 – 4 Billion	Customer Minutes Interrupted (CMI)/ event	20%	Non- Linear
Gas Reliability	0 – 750,000	Customers affected/event	5%	Non- Linear
Financial[5]	0 - $5 Billion	$/event	25%	Non- Linear

- Ranges: Pursuant to D.18-12-014, the smallest observable value of an Attribute is the low end of the range, and the largest observable value is the high end of the range. PG&E interprets the largest observable value to be a reasonable value informed by historical events and plausible large-consequence scenarios. In PG&E's analysis and risk framework, event consequences are not capped at the high end of the range, but rather, the range is a specification required in the scaling function.
    - The high end of the Safety Attribute Range, set to 100, is an order-of- magnitude value informed by recent events.

4 D.18-12-014, p. 17, 2018 S-MAP Revised Lexicon: *MAVF*.

5 Pursuant to D.18-12-014 and D.16-08-018, utility shareholders' financial interests are to be excluded from the General Rate Case (GRC) and RAMP risk evaluation and risk mitigation considerations.

- The high end of the Electric Reliability Range (4 Billion CMI) was based on the most severe reliability impact from a single event of 3.6 billion CMI from the October 26, 2019 PSPS event.

- The Gas Reliability high end is based on a scenario of an outage at a critical gas facility.

- The Financial Attribute's high end represents a financial loss commensurate with an Energy Crisis-type event.

- Natural Units: EF is defined as the sum of Public, Employee and Contractor Fatalities and Serious Injuries per event occurrence. Serious Injuries are defined as situations that require hospitalization of an individual pursuant to existing Federal and State reporting guidelines.[6] Fatalities and Serious Injuries are converted to EFs using the multiplicative factors 1.00 and 0.25, respectively. The conversion rate from Serious Injury to EF is based on information available from Federal sources.[7]

- Scaling Function: The Non-Linear Scaling Function is used to convert each Attribute from its Natural Unit to Scaled Units.[8] It consists of the following segments, with each segment intended to represent events that are either operational (i.e., encountered in the course of regular operations), critical or catastrophic.

    - For natural units from 0 to 1 percent of the Range (operational/moderate events): Linear function from 0 to 0.1 Scaled Units.

    - For natural units from 1 percent to 10 percent of the Range (critical events): Quadratic function from 0.1 to 5 Scaled Units.

    - For natural units from 10% to 100+% of the Range (catastrophic events): Linear function from 5 to 100 Scaled Units.

D.18-12-014 directs utilities to use Expected Value when calculating the Consequence of Risk Event (CoRE) and use the scaling function to capture aversion to extreme

---

6 Pipeline and Hazardous Materials Safety Administration (PHMSA) §191.3Definitions: Incident (see also: https://www.phmsa.dot.gov/data-and- statistics/pipeline/pipeline-facility-incident-report-criteria-history) and D.98-07-097 (Amended April 27, 2006), Findings of Fact 3 and Appendix B, Accident Report Requirements 3 (see also: https://www.cpuc.ca.gov/General.aspx?id=2090).

7 See "Treatment of the Values of Life and Injury in Economic Analysis," Table 2-3, Federal Aviation Administration (FAA) Office of Aviation Policy and Plans, Updated September 2016, (available at: https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/econ- value-section-2-tx-values.pdf).

8 D.18-12-014, pp. 17-18; 2018-S-MAP Revised Lexicon: Scaled Unit of an Attribute: a value that varies from 0 to 100.

outcomes or indifference over a range of outcomes. Under PG&E's Non-Linear scaling function, the risk score, as measured by Scaled Units, will be low for operational events, but increases exponentially as critical events approach catastrophic (but low probability) levels. Once catastrophic levels are attained the function assigns 10 times higher score for each potential increase in Natural Units when compared to operational events. This captures aversion to critical and catastrophic outcomes and gives higher priority to controls and mitigations that affect them.

When PG&E evaluates potential event consequences, it does not cap them at the Range high end per se, but pursuant to D.18-12-014,[9] PG&E places a ceiling of 100 on converted Scaled Units, i.e., if a modeled risk event's consequence in Natural Units goes above the Attribute Range, the converted Scaled Unit will be 100. This provides a way to compare the relative importance of different Attributes using Attribute Weights, consistent with the Relative Importance principle.[10] Also, by capping, PG&E recognizes that catastrophic risks must be mitigated, and it is immaterial to consider one risk to be "more" or "less" catastrophic than another (e.g., a financial loss of $5 billion or $5.2 billion) when evaluating alternatives.

Environmental consequences of an event are accounted for financially (i.e., as part of the Financial consequences) because there is a lack of commonly accepted ways to measure non-monetary environmental consequences. This makes the use of non-monetary environmental Attributes inconsistent with the principle of Measured Observations.

In PG&E's risk modeling, Attribute levels (e.g., the financial consequence of a risk event) are assumed to be uncertain and are represented by well-defined probability distributions. PG&E uses Monte-Carlo simulations of risk events based on these probability distributions to calculate MAVF consequence levels (in Scaled Units or MARS) and thus Risk Scores, consistent with the Risk Assessment principle.

Overall, the S-MAP conforming risk assessment has not changed substantially since the 2020 WMP. However, there have been a few important changes including:

- Fire Weather Warning nomenclature was changed to Red Flag Warning (RFW) for clarity; and,
- Tranches were updated to incorporate the 2021 Wildfire Distribution Risk Model to provide more granularity in the risk assessment

These changes are described in more detail in Subsection (b) below.

(b) Wildfire Risk Assessment and Bowtie Analysis

Consistent with D.18-12-014, PG&E assesses wildfire risk and estimated wildfire consequences in a bowtie analysis.

---

9 *Id.*

10 D.18-12-014, Attachment A, Step 1A, No 7. MAVF Principle 6 –Relative Importance. Page A-6.

FIGURE PG&E-4.2-1: WILDFIRE RISK “BOWTIE” ANALYSIS (PG&E SERVICE TERRITORY; OVERHEAD CIRCUITS - ALL VOLTAGE CLASSES)

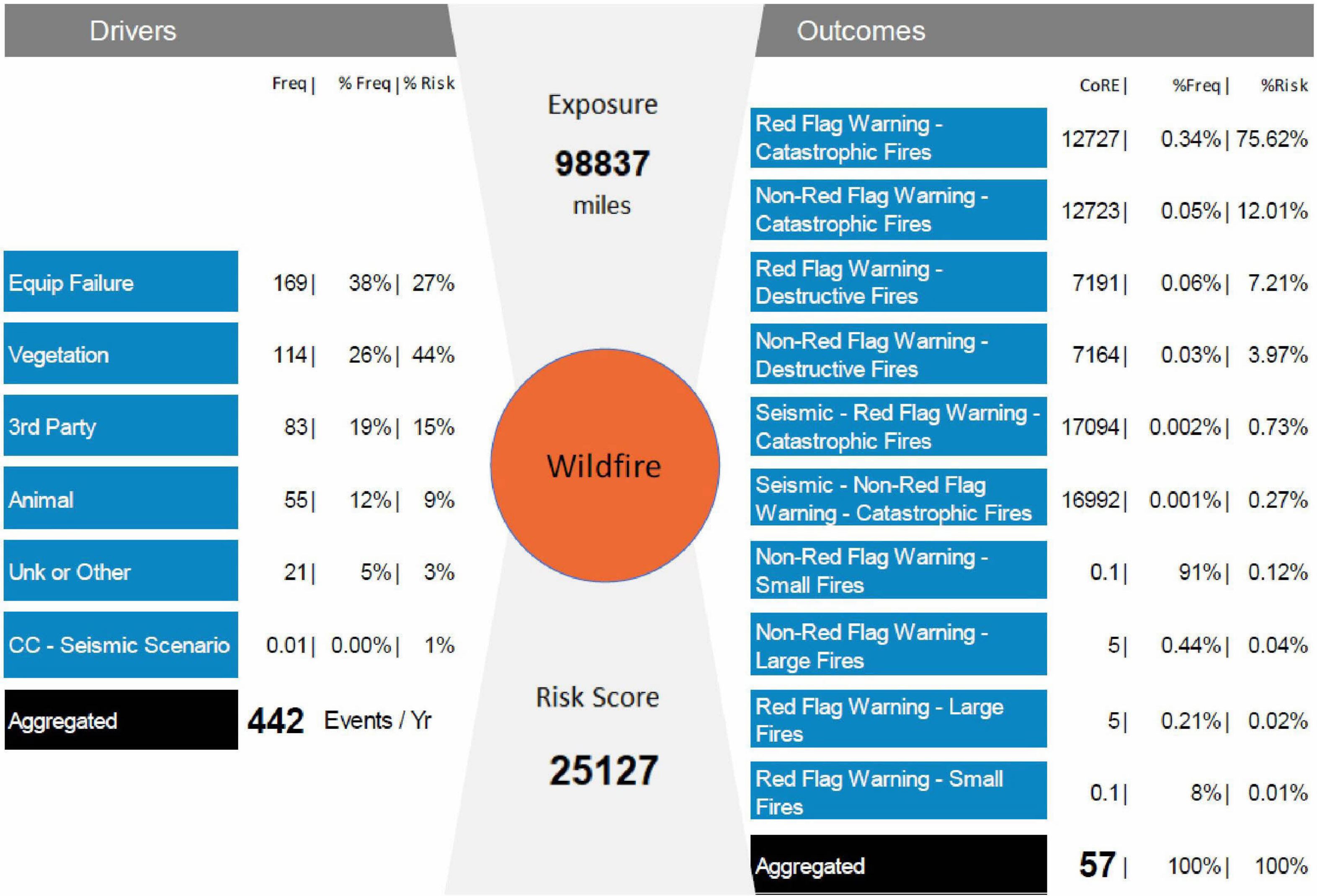


FIGURE PG&E-4.2-2: WILDFIRE RISK "BOWTIE" ANALYSIS (PG&E HFTD ONLY; DISTRIBUTION VOLTAGE OVERHEAD CIRCUITS)

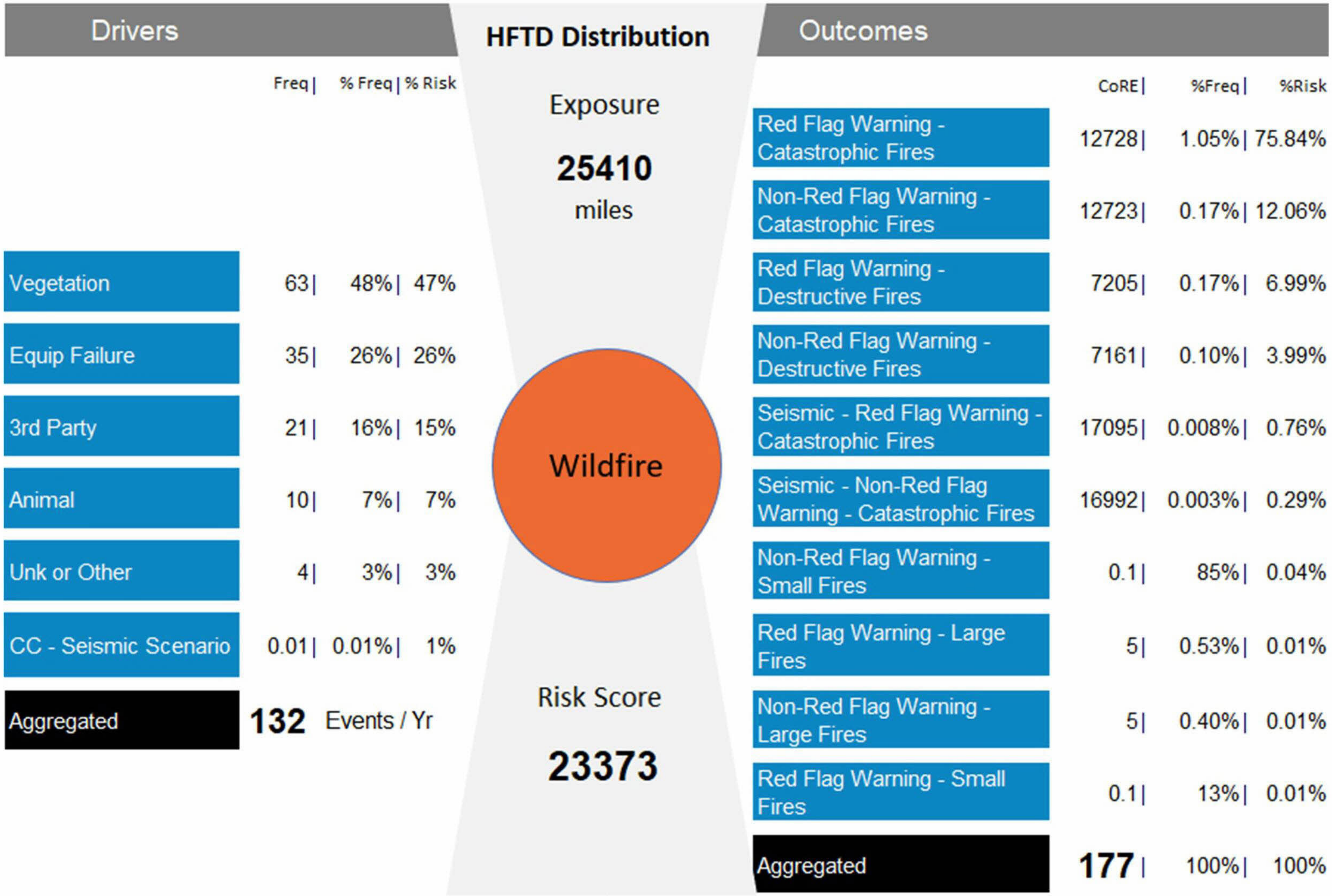
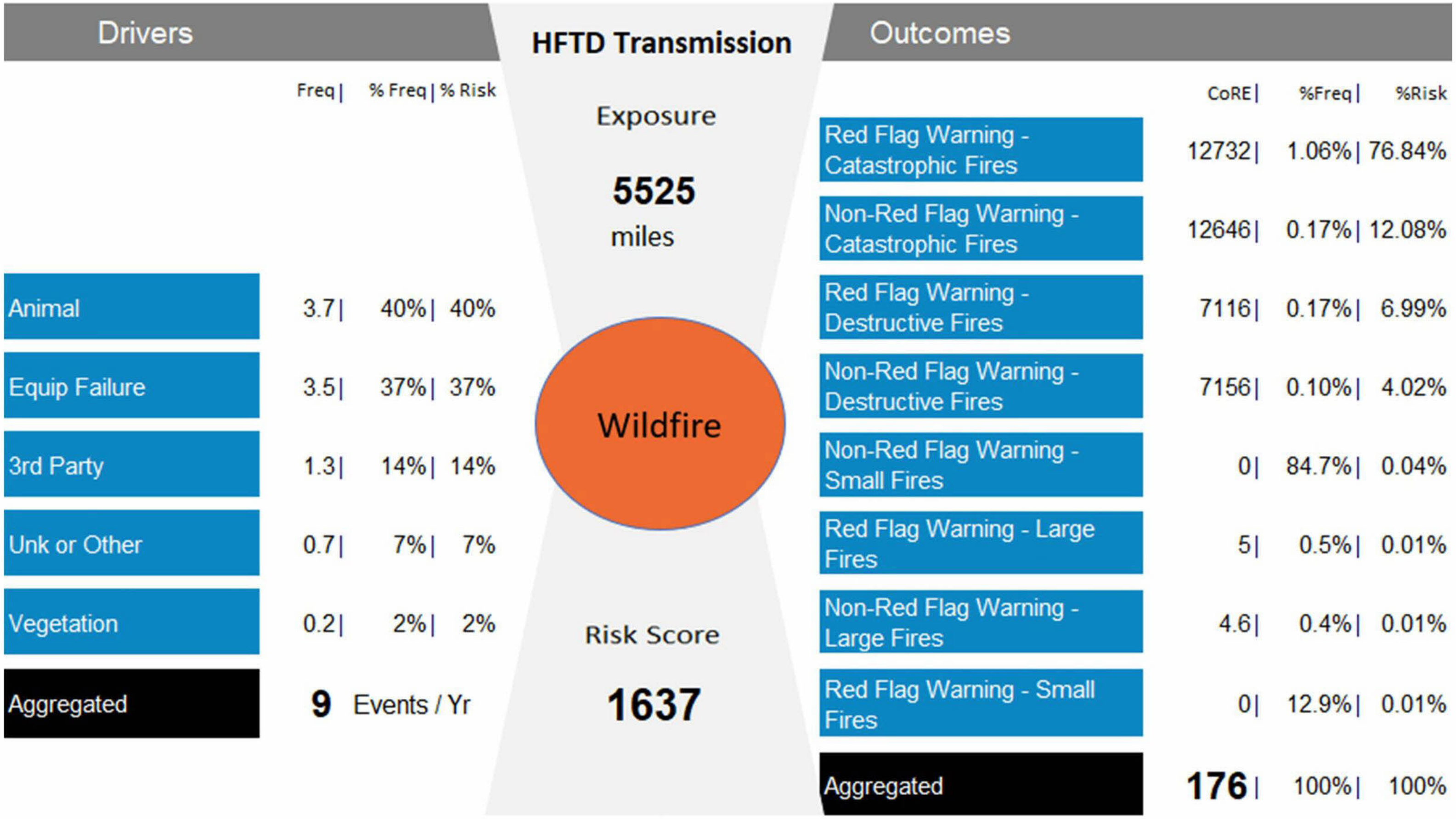


FIGURE PG&E-4.2-3: WILDFIRE RISK "BOWTIE" ANALYSIS (PG&E HFTD ONLY; TRANSMISSION VOLTAGE OVERHEAD CIRCUITS)



PG&E provides a summary below of the elements of the bowtie analyses in Figures PG&E-4.2-1, 4.2-2, and 4.2-3 above:

1. Drivers - Ignition Frequencies: Shown on the left of the visuals above, the current S-MAP conforming bowtie is derived from normalizing the ignitions by Transmission and Distribution overhead line miles of exposure reported annually to the CPUC. In accordance with D.14-02-015, PG&E annually reports to the CPUC fire incidents that may be associated with PG&E facilities and that meet the following conditions: (a) a self-propagating fire of material other than electrical and/or communication facilities; (b) the resulting fire traveled greater than one linear meter from the ignition point; and (c) PG&E has knowledge that the fire occurred. The S-MAP conforming model discussed in detail in PG&E's 2020 RAMP Report currently has ignitions reported to the CPUC for years 2015 through 2019. Though PG&E is still finalizing the 2020 reportable ignition data in preparation for its annual report, preliminary 2020 data is used in the model.[11]

2. Total Exposure: Shown in the center of the visuals above across all Tranches: 98,837 circuit miles of overhead Transmission and Distribution voltage conductor covering PG&E's service territory. Since the 2020 WMP and 2020 RAMP Report, PG&E has received feedback from WSD, Safety Policy Division (SPD), and various stakeholders that the level of tranching was not adequate to represent the risk profiles of PG&E's system. In response to this feedback, in the 2021 WMP, PG&E is introducing the 2021 Wildfire Distribution Risk Model, in combination of the requirements of S-MAP, to further delineate wildfire risk across PG&E's system at a more granular level, specifically with regard to electric distribution facilities. PG&E aggregated this circuit segments from the 2021 Wildfire Distribution Risk Model into circuit level granularity in HFTD areas. Aggregating to the circuit level better aligns with other construction, inspection, and maintenance programs across PG&E. In the cases of EVM and System Hardening, those major programs are assessed with even more granularity. Details regarding the 2021 Wildfire Distribution Risk Model are described in Section 4.5.1. PG&E is also currently developing a 2022 Wildfire Transmission Risk Model that will focus on electric transmission facilities.

3. Outcomes - Wildfire Consequences: There is a wide range of potential public safety risks resulting from a fire ignition associated with PG&E assets. In the overwhelming majority of cases, fire ignitions do not end up a large wildfire because they are extinguished quickly and/or do not propagate far. However, in some cases, ignitions can result in larger wildfires. PG&E uses fire incidents from

---

11 PG&E's 2020 fire incident data will be submitted to the CPUC by April 1, 2021 per D.14-02-015. As such, PG&E's 2020 fire incident data report may contain data that has been revised from the data used in this risk analysis.

the California Department of Forestry and Fire Protection (CAL FIRE) database to estimate the safety and financial consequences of wildfire. For each fire incident, the CAL FIRE dataset provides the location, size, number of destroyed/damaged structures, and the number of fatalities/injuries. Reliability consequences are estimated by using distribution customer minutes for outages that were associated with CPUC reportable ignitions and known fires associated with those outages. PG&E is providing a more granular outcomes of consequences, as shown on the right side of the bowtie, on ignitions in terms of three variables:

a. The size/destructiveness of the fire that resulted from the ignition. PG&E's categorization of fire size is based on the following definitions:

- Catastrophic: A fire that destroys 100 or more structures and results in a serious injury and/or fatality.
- Destructive: A fire that destroys 100 or more structures but does not result in a serious injury or fatality.
- Large: A fire that burns 300 or more acres but does not meet the definition of a Destructive or Catastrophic fire.
- Small: A fire that burns fewer than 300 acres.

b. Whether the ignition took place on a day and in an area in which a RFW was in place or not. RFW is a forecast warning issued by the National Weather Service (NWS) in the United States to inform the public, firefighters, and land management agencies that conditions are ideal for wildland fire combustion and rapid spread.[12] The potential consequences of ignitions are higher when an RFW is in effect.[13]

---

12 Precise temporal and spatial mapping analysis of RFW conditions is conducted by utilizing RFW GIS shapefiles from: https://mesonet.agron.iastate.edu/request/gis/watchwarn.phtml. (as of June 16, 2020).

In a February 19, 2020 letter to PG&E providing feedback on information that PG&E provided in workshops held on January 13, 2020 and February 4, 2020, TURN recommended that "for clarity" PG&E use "Fire Weather *Conditions* instead of *Warning*" when classifying outcomes. At the time of the workshop, PG&E used the term "Fire Weather Warning" to refer to elements of the NWS Red Flag Warning. PG&E's use of RFWs to categorize outcomes is appropriate because it is a simple, objective metric from a trusted third-party (NWS) that serves as a reasonable proxy for fire weather conditions.

13 PG&E's 2021 Wildfire Distribution Risk Model assumes that starting in 2023 the probability that an ignition occurs at a location and day that RFW is in effect will increase in 5-year increments based on the Cal-Adapt Wildfire Data.

c. For catastrophic fires, only, whether the catastrophic fire is associated with a seismic event.

(c) Wildfire Risk Assessment Compared With Other Safety and Reliability Risks

All Enterprise Risks on PG&E's Risk Register might have safety and reliability consequences. The consequences are modeled separately for each risk. In developing probabilities and consequences for wildfire risks, PG&E uses a mix of internal and external data to model wildfire drivers and consequences (safety and reliability impacts on the risk). Safety and Reliability consequences/attributes (per S-MAP terminology) are also modeled separately and combined into a risk score using the MAVF. PG&E's risk approach, including how wildfire risks and other non-wildfire safety and reliability risks are addressed, is discussed in more detail in Section 7.1.A.

(d) List and Description of "Known Local Conditions" as That Term is Used in GO 95, Rule 31.1

GO 95, Rule 31.1 directs PG&E to design, construct and maintain a facility in accordance with accepted good practice for the intended use and known local conditions. For the purposes of risk assessment, PG&E utilized HFTD and non-HFTD areas as its known local conditions. PG&E developed its S-MAP conforming bowtie for the wildfire risk by creating separate tranches for HFTD and non-HFTD areas. The higher risk scores and RSE values for mitigations in the HFTD areas enables a clear case for prioritization of wildfire mitigation initiatives in HFTD areas. For additional information on PG&E's evaluation of HFTD areas, including the development of its HFRA Map identifying risk areas beyond HFTDs, please see Section 4.2.1.

(e) Responses to RCP Actions

ACTION PGE-3 (Class A)

In its 2021 WMP update, PG&E shall describe how financial consequence and spend is weighted within the MAVF.

Response:

A summary of the weighting of financial consequences and spend is provided in Table PG&E-4.2-1 above. PG&E described how financial consequences and spend are weighted within MAVF in more detail in its 2020 RAMP Report, Chapter 3 Risk Modeling and Risk Spend Efficiency, page 3-4 through 3-18 (see Attachment _). An excerpt of the relevant portions from the 2020 RAMP Report, pp. 3-5 to 3-7 and 3-14 to 3-15, is provided below. The 2020 RAMP Report itself includes a much more detailed discussion of scaling, weighting and how the financial and spend consequence is factored into MAVF.

Implementing MAVF Principle 1 – Attribute Hierarchy

Principle 1 requires that Utilities identify Attributes that are combined in a hierarchy such that the top level Attributes are categories and the lower level Attributes, or sub-Attributes, are observable and measurable.[14]

PG&E identified four Attributes: (1) Safety, (2) Electric Reliability, (3) Gas Reliability, and (4) Financial, each with one lower-level Attribute.

1) "Safety" has one lower-level observable and measurable attribute: EF.

2) "Electric Reliability" has one lower-level observable and measurable attribute: Customer Minutes Interrupted (CMI).

3) "Gas Reliability" has one lower-level observable and measurable attribute: Number of Customers Affected.

4) "Financial" has one lower-level attribute: U.S. Dollars. Pursuant to D.18-12-014 and D.16-08-018, shareholders' financial interests are excluded.[15]

Implementing MAVF Principle 2 – Measured Observations

MAVF Principle 2 requires that each lower-level Attribute have its own minimum and maximum range expressed in natural units that are observable during ordinary operations and as a CoRE.[16] Table PG&E-4.2-2 below summarizes PG&E's Attributes and associated ranges.

TABLE PG&E-4.2-2: STEP 1A, PRINCIPLE 2 – MEASURED OBSERVATIONS

Line No.	Attribute	Natural Unit of Attribute	Range
1	Safety	EFs	0 – 100
2	Electric Reliability	CMI	0 – 4 billion
3	Gas Reliability	Number of Customers Affected	0 – 750 thousand
4	Financial	Dollars	0 – 5 billion

The S-MAP Settlement Decision defines the low and high end of the Range of the Natural Unit to be a smallest and largest observable value from a risk event.[17] PG&E uses the term Upper Bound to denote the highest value in a Range. However, given the uncertainty in what the largest observable outcome of a risk event might be, PG&E

14 D.18-12-014, Attachment A, p. A-5, No. 2.

15 D.18-12-014, p. 29, and D.16-08-018, p. 193, Conclusion of Law (COL) 37.

16 D.18-12-014, Attachment A, p. A-5, No. 3.

17 D.18-12-014, Attachment A, p. A-3.

defines the Ranges based on historical events and plausible high -consequence scenarios. PG&E defines each of the natural units of the Attribute as follows:

- An Equivalent Fatality is defined as the sum of Fatalities and Serious Injury Equivalents per event occurrence. Serious Injury is defined as an injury that requires in-patient hospitalization of an individual pursuant to existing Federal and State reporting guidelines.[18,19] Fatalities and Serious Injuries are converted to EFs using the factors shown in Table PG&E-4.2-3. The conversion rate from Serious Injury to EF is based on the disutility factors for Serious Injuries relative to Fatality available from Federal sources.[20] The Upper Bound of the Range for the Safety Attribute is based on EFs resulting from the Camp Fire rounded up to 100.

TABLE PG&E-4.2-3: EQUIVALENT FATALITY CONVERSION FACTORS SIMULATED FATALITY OR SERIOUS INJURY QUANTITIES

Line No.	Type	Equivalent Factor
1	Fatality	1.00
2	Serious Injury	0.25

- The Electric Reliability Upper Bound is based on the October 26-29, 2019 PSPS event consequence of approximately 3.6 billion CMI rounded up to 4 billion.
- The Gas Reliability Upper Bound is based on a scenario of an outage at a critical gas facility.
- The Upper Bound of the Financial Range represents a financial loss commensurate with a 2000-2001 Energy Crisis-type event. Costs related to recent wildfires were not used to set the Upper Bound because, pursuant to D.18-12-014, utility shareholders' financial interests are excluded from consideration.

---

18 PHMSA § 191.3, Definitions: Incident. See also: <https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-facility-incident-report-criteria-history>, accessed June 25, 2020.

19 D.98-07-097, Appendix B, Accident Report Requirements, par. 3. See also, <https://www.cpuc.ca.gov/General.aspx?id=2090>, accessed June 22, 2020.

20 See FAA Office of Aviation Policy and Plans, Treatment of the Values of Life and Injury in Economic Analysis, p. 2-3, Table 2-3, Updated September 2016, accessed June 19, 2020, at: <https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/econ-value-section-2-tx-values.pdf>.

Implementing MAVF Principle 6 – Relative Importance

MAVF Principle 6 states that each Attribute should be assigned a weight reflecting its importance relative to other Attributes defined in the MAVF.[21]

PG&E uses the Attribute Weights shown in Table PG&E-4.2-4.

TABLE PG&E-4.2-4: ATTRIBUTE WEIGHTS

Line No.	Attribute	Weight
1	Safety	50%
2	Electric Reliability	20%
3	Gas Reliability	5%
4	Financial	25%

PG&E assigned the Attribute Weights to reflect the relative importance of moving each Attribute from its least desirable level (i.e., Upper Bound) to its most desirable level (i.e., zero). For example, the Attribute Weights reflect PG&E's view that it is twice as valuable to move the Safety Attribute from 100 to 0 EFs as it is to move the Financial Attribute from $5 billion to $0. Assigning 50 percent weight to the Safety Attribute is in line with PG&E's emphasis on safety and is also consistent with the S-MAP Settlement Decision's requirement for a minimum 40 percent weighting for Safety.[22]

ACTION PGE-4 (Class A)

In its 2021 WMP update, PG&E shall submit a table describing its risk assessment techniques used for each initiative in the format used by SCE. [See SCE RCP at 9]

Response:

PG&E has included a table describing the risk assessment techniques used for each initiative into Table 12 in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx.

ACTION PGE-6 (Class A)

In its 2021 WMP update, PG&E shall provide a timeline that shows when it expects each individual *initiative in its WMP to be incorporated into its risk modeling.*

Response:

PG&E has included a timeline for incorporation of WMP initiatives into risk modeling for initiatives impacted by risk *model* will be located in Table 12 in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. Specifically, these are initiatives for

---

21 D.18-12-014, Attachment A, p. A-6, No. 7.

22 D.18-12-014, p. 66, COL 5.

which the proposed mitigations will be largely determined by insights from wildfire risk models.

ACTION PGE-1 (Class B):

1) further describe why either ignition risk and wildfire consequence risk is calculated instead of calculating both, and

2) provide an explanation for each initiative as to why it either reduces ignition risk or wildfire consequence risk, but not both.

Response:

1) For each initiative, PG&E identified if the activity reduces ignition risk or wildfire consequence risk. PG&E considers ignition risk as the likelihood of a risk event (LoRE) and wildfire consequence risk as the consequence of a risk event (CoRE). Once this is determined, the overall wildfire risk is calculated by multiplying LoRE x CoRE. For each initiative, PG&E takes the difference between the baseline wildfire risk and the mitigated wildfire risk to quantify the risk reduction.

2) Explanation for each initiative determining reduction in ignition risk or wildfire consequence risk will be provided in Feb. 26 submission.

ACTION PGE-4 (Class B)

1) Clarify what is meant by "the likelihood of a large 300-acre fire of exponentially spreading and becoming catastrophic or destructive is closer to 70 percent";
2) Provide the percentage of ignitions that lead to fires greater than 300-acres;
3) Explain why PG&E finds 300-acres to be of significant value;
4) Define what PG&E's understanding of "catastrophic" fire is in the context of less than 1 percent of ignitions leading to a catastrophic fire; and
5) Provide the percent of ignitions that lead to catastrophic fires during Red Flag Warning (RFW) conditions.

Response:

1. PG&E wrote in the First Quarterly Report that "the likelihood of a large 300-acre fire of exponentially spreading and becoming catastrophic or destructive is closer to 70 percent, especially during Red Flag Warning (RFW) conditions." This meant that during RFW conditions, there is approximately a 70 percent chance that a large wildfire (*i.e.*, 300 acres or greater) started with an ignition involving PG&E's electric equipments in an HFTD area results in destroying 100 or more structures.
2. Out of ignitions reviewed from 2015-2019 related to PG&E's electric equipment, the percentage of ignitions that lead to fires greater than 300 acres was 0.9 percent.
3. The Annual CALFIRE Redbook provides incident data for Large Fires 300 Acres and Greater. This data includes the number of structures destroyed and the number of fatalities. PG&E used this dataset to model the consequences of a large fire because this dataset includes more incidences of large fires (283 large

fires for PG&E's Territory for 2015-2019) than wildfires caused by PG&E's ignitions. Thus, this became a natural breakpoint on analysis of consequence of an ignition.

4. For the purpose of risk analysis, PG&E defines "catastrophic fires" as fires 300 acres or greater that result in 100 or more structures destroyed and one or more fatalities.
5. Out of the 2,200 ignitions from 2015-2019 reviewed, there were 131 ignitions during RFW conditions, and 5 out of the 131 ignitions fell into this "catastrophic" category. Thus, the percent of ignitions that lead to catastrophic fires during RFW conditions was approximately 4 percent.

ACTION PGE-5 (Class B)

1) Provide in-depth explanations as to how a failure rate of 70 percent for Priority A tags, 50 percent for Priority B tags, and 1 percent for Priority E and F tags was calculated.

2) Provide an in-depth explanation as to how a power-line failure rate from vegetation of 70 percent was calculated.

3) Describe the SMEs used to determine such failure rates.

4) Implement industry standard and best practices into determining such failure rates, or describe how such have been implemented.

Response:

1. In order to estimate the benefits of performing a control that PG&E has historically undertaken (e.g., operations and maintenance), we proposed using the tag severity as a way to estimate the probability of a failure if left unaddressed.

Given that, when an asset is identified with a Priority A tag, those tags are expected to be fixed immediately or at least made safe and a repair scheduled within 30 days. The expectation here is that if something is marked as a Priority A, it is unlikely to last through a Priority B tag, which is to be addressed within 90 days. Using that assumption, PG&E estimated that something that is tagged with Priority A is expected to fail between the duration of correction between an A and a B tag, or between 30-90 days. As such, a Priority A tag is estimated to fail within 60 days. To annualize this, PG&E estimates that there is a 1.0 – (60/365) = ~84 percent chance of failure. This was conservatively reduced to 70 percent after review with the PG&E team.

When an asset is identified with a Priority B tag, those tags are expected to be fixed within 90 days. The expectation here is that if something is marked as a Priority B, it is unlikely to last through a Priority E tag, which is to be addressed within 1 year. Using that assumption, PG&E estimated that something that is tagged with Priority B is expected to fail between the duration of correction between an B and a E tag, or between 90-365 days. As such, a Priority B tag is estimated to fail within 227.5 days. To annualize this, PG&E estimates that there is a 1.0 – (227.5/365) = ~38 percent chance of failure. This was adjusted to 50 percent after review with the PG&E team.

When an asset is identified with a Priority E tag, those tags are expected to be fixed within 1 year. The expectation here is that if something is marked as a Priority E, it is unlikely to last through a Priority F tag, which is to be addressed within 5 year. Using that assumption, PG&E estimated that something that is tagged with Priority E is expected to fail between the duration of correction between an E and a F tag, or between 1-5 years. As such, a Priority E tag is estimated to fail within 2.5 years. However, at the time of the filing, because of the influx of Priority E and F tags identified on the system, and that assets in HFTD areas get inspected or re-assessed more frequently, PG&E set the probability to 1 percent to acknowledge the existence of the tags but not overstate their impacts, as those Priority E & F tags are monitored consistently.

2. We found it challenging to estimate what might occur if we were not performing control activities. Specifically with vegetation, PG&E performs maintenance on significant amounts of trees in our system territory, and still see vegetation be the largest driver to ignitions in HFTD. With no basis for proving the counter-factual, PG&E used the same estimation as with assets and inspections to ensure consistency across how tags are utilized. In reviewing the 70 percent assumption, PG&E had to weigh how vegetation compared against asset failure. When assets fail, it can create sparks that could ignite. Similarly, unmaintained vegetation coming in contact with PG&E equipment provides fuel for ignitions to occur. PG&E did not have better data to challenge the 70 percent assumption to be higher or lower, and ultimately, maintained this for consistency.

3. SMEs used to approximate the failure rates include members of Risk Management, Asset Strategy, Inspection, and the Vegetation organization.

4. PG&E is engaged in various wildfire best practice forums to discuss ways to perform better estimations. PG&E continues to benchmark practices with other California utilities and is also engaged in working groups as part of the International Wildfire Risk Management Consortium.

ACTION PGE-15 (Class B)

1) Describe why it used a linear relationship between probability of fire type and time passed

2) Provide supporting materials showing a linear relationship.

Response:

1. PG&E used a linear relationship to be conservative as it relates to the probability of fire type to time passed. Because PG&E only had fire simulation data for 2-hour and 8-hour spread, despite expecting the relationship to be exponential, PG&E used a linear relationship as a conservative estimate as a stated assumption.

2. Attached is the ‘Technosylva Fire Probability’ dataset (See attachment “2021WMP_ClassB_Action-PGE-15_Atch01”), which includes the outputs of the probability of a small, large, and destructive based on an 8 hour and 2 hour spread. Summarized in a table is the probability of a small, large, and destructive probabilities between the 2 time frames.

4.2.A. Contribution of Weather to Ignition Probability and Estimated Wildfire Consequences

A) Describe how the utility monitors and accounts for the contribution of weather to ignition probability and estimated wildfire consequence in its decision-making, including describing any utility-generated Fire Potential Index or other measure (including input variables, equations, the scale or rating system, an explanation of how uncertainties are accounted for, an explanation of how this index is used to inform operational decisions, and an explanation of how trends in index ratings impact medium-term decisions such as maintenance and longer-term decisions such as capital investments, etc.).

This section describes the teams, tools and models PG&E has deployed to assess the contribution of weather to wildfire risk. In order to understand the real-time to short-term weather and fire risk (hour to week ahead), PG&E’s meteorology department utilizes real-time weather station data and weather model data from multiple models. These weather model data are utilized to drive dead fuel moisture (DFM) and live fuel moisture (LFM) models, which ultimately feed together into PG&E’s Fire Potential Index (Utility FPI or FPI) Model and Outage Producing Winds (OPW) Model to inform PSPS. For longer-term decisions such as grid-hardening, PG&E utilizes climatological weather datasets and fire spread simulations across a range of historical fire weather days to inform investment decisions where the risk is highest over the long-term.

PG&E’s Meteorology team is comprised of 15 scientists, most with advanced degrees in scientific fields with diverse backgrounds in operational meteorology, utility meteorology, outage prediction, fire science, data science, cloud computing, atmospheric modeling, application development and data systems development. The team is comprised of alumni from the San Jose State University (SJSU) Fire Weather Research Laboratory (https://www.fireweather.org/), former wildland firefighters, former NWS forecasters, and Veterans of the Marine Corps and United States Air Force.

The remainder of this section includes the following subsections:

- Subsection (a): Weather considerations for PSPS events generally;
- Subsection (b): Operational weather forecasting models and climatological datasets informing PSPS;
- Subsection (c): The weather analysis contributing to PSPS events on the distribution system;
- Subsection (d): Determination of the minimum fire potential conditions;
- Subsection (e): Utility Fire Potential Index Model;

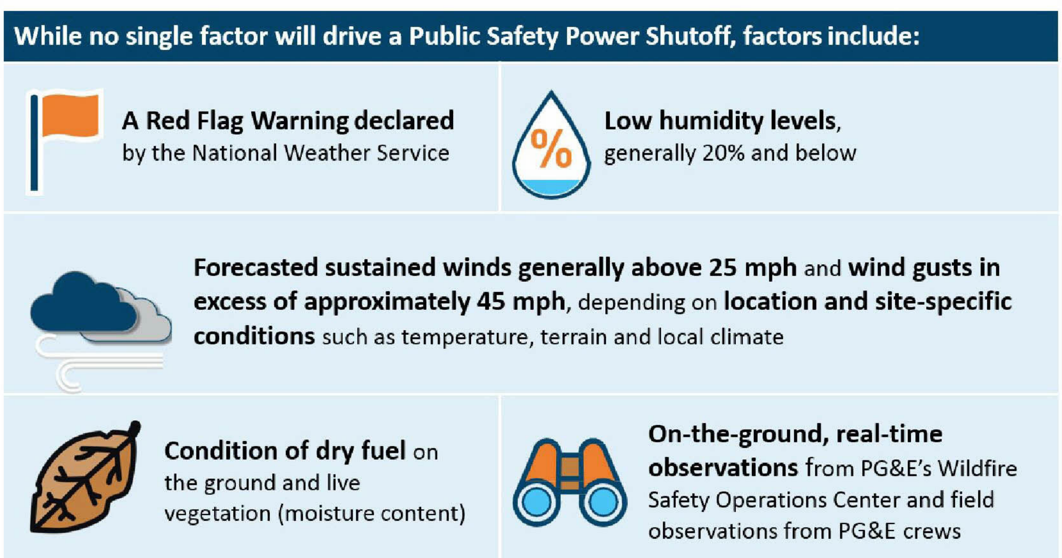
- Subsection (f): Outage Producing Winds Model;
- Subsection (g): Black swan conditions;
- Subsection (h): The weather analysis contributing to PSPS events on the transmission system;
- Subsection (i): Development and use of climatology data;
- Subsection (j): Long-term risk assessment and weather input into models; and,
- Subsection (k): Responses to Actions identified in WSD's evaluation of PG&E's Remedial Compliance Plan (Action PGE-5 (Class A)).

(a) Weather Considerations for PSPS Events Generally

No single factor drives the determination that a PSPS is necessary, as each situation is dynamic and unique. The main drivers of PSPS are described below, but PG&E also carefully reviews external forecast information from the NWS (i.e., Red Flag Warnings), the Northern and Southern Geographic Area Coordination Centers (GACC) and the National Oceanic and Atmospheric Administration (NOAA) Storm Prediction Center to ultimately decide to de-energize portions of the grid for public safety. In the days leading up to a PSPS event, PG&E Meteorologists participate on interagency conference calls hosted by either the Northern or Southern CA GACC where NWS meteorologists and GACC meteorologists discuss their forecast of upcoming events. PG&E greatly appreciates this collaboration and the opportunity to coordinate with external and independent forecast agencies on upcoming risk periods.

The general conditions that are present during PSPS events are presented in Figure PG&E-4.2-4.

FIGURE PG&E-4.2-4 – GENERAL PSPS CONDITIONS



As will be discussed in more detail below, PG&E's relies on its Large Fire Probability Models for distribution and transmission for every PSPS assessment. However, in addition to these models, PG&E carefully reviews an array of available data and federal forecast information to verify that multiple authorities recognize an upcoming or imminent period of risk:

- On-the-ground observations from field observers
- Red Flag Warnings from the NWS
- High Risk forecasts of Significant Fire Potential from the GACC
- Fire weather outlooks from the Storm Prediction Center (SPC), which is part of the NWS
- The California Weather Threat Briefing provided to California Office of Emergency Services (Cal OES) by the NWS Western Region, Regional Operations Center

(b) Operational Weather Forecast Models and Climatological Datasets Informing PSPS

Before discussing the methodology that PG&E utilizes for PSPS, it is important to have a better understanding of operational weather forecast models and climatological datasets. PG&E leverages multiple external and internal numerical weather models in each PSPS assessment. One of the primary drivers is output from the PG&E Operational Mesoscale Modeling System (POMMS), which is a version of the National Center for Atmospheric Research-Weather Research and Forecasting Model. This model provides weather forecast data (e.g., wind, temperature, relative humidity) at 2 x 2 km model resolution out 105 hours and is updated four times each day. This modeling framework provides forecast data for >45,000 model "grid points" across PG&E's service territory. These "grid-points" can be thought of like virtual weather stations where data can be extracted. PG&E also coupled Live Fuel and Dead Fuel Models into POMMS, to provide dead and live fuel moisture forecasts across the same 2 x 2 km model domain for PSPS assessments. A more detailed discussion of PG&E's numerical weather and fuels systems can be found in Section 7.3.2.

PG&E utilized the same weather model configuration to produce a 30-year, hour-by-hour historical weather and fuels climatology also at 2 x 2 km resolution. This climatology provides over 45,000 "grid points" in the same domain as the forecast model where historical data can be extracted each hour going back 30 years. This is a powerful dataset that was combined with historical outages and fires to better understand the meteorological and fuel moisture levels that contribute to large fires.

(c) Analysis of Weather Contribution for Distribution PSPS Events

PG&E evaluates the risk for a catastrophic fire caused by PG&E distribution equipment as the probability of an outage leading to an ignition combined with the consequence or growth potential of a resulting fire. There are three key inputs of PG&E's meteorological and fuels analysis to determine PSPS criteria on the distribution system:

- Minimum Fire Potential Conditions being met

- PG&E's Distribution Large Fire Probability Model (LFP_D) comprised of the following:
  - OPW Model
  - Utility FPI Model
- Distribution "Black Swan" criteria

The minimum Fire Potential Conditions are a weather and fuels filter based on relative humidity values and fuel moisture values that must be exceeded for PSPS to be considered. These values were established from an examination of historical fire occurrence in PG&E's territory as well as information published by federal agencies regarding fire behavior and criteria used to issue warnings to the public. The exact criteria used in the minimum fire potential conditions are described later in this section.

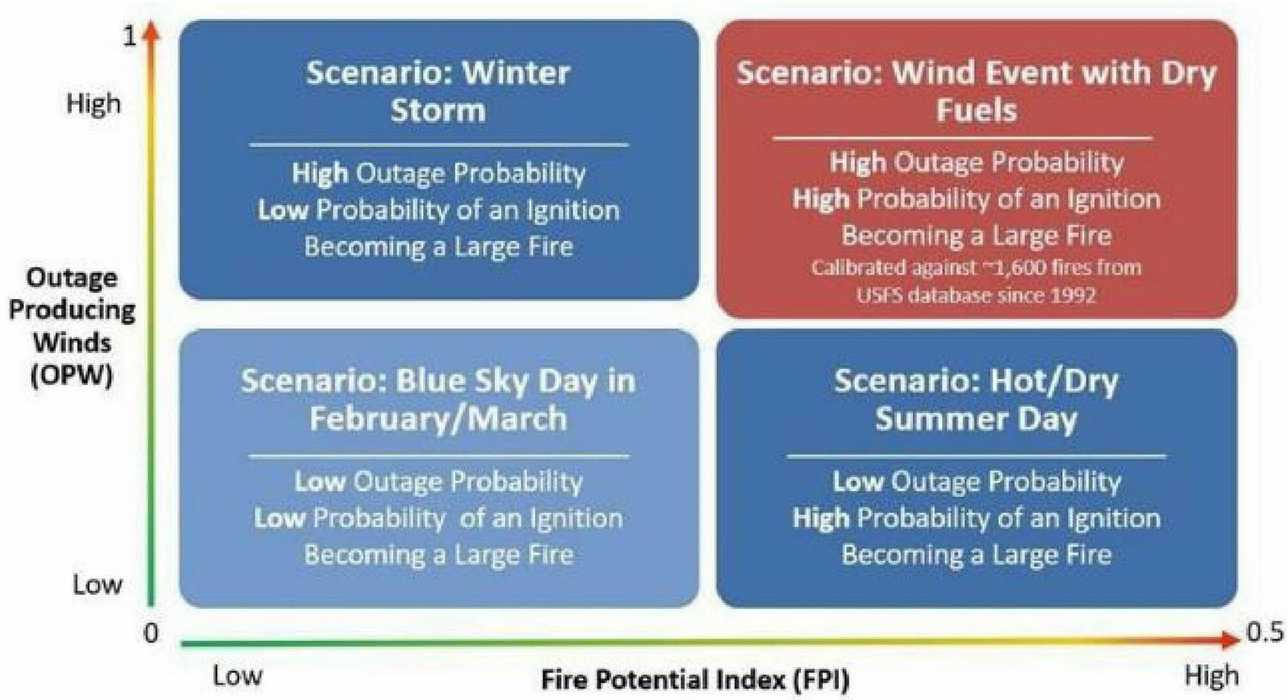
Once the minimum Fire Potential Conditions are met, PG&E then considers the output from the LFP_D Model on the distribution system. The LFP_D Model is a product of the OPW and Utility FPI Models, which are combined in both space and time. The LFP_D is given by the equation below.

$$LFP_D = OPW * FPI$$

The LFP_D Model provides hourly output for each grid cell in PG&E's weather model domain (>45,000 cells in the PG&E territory) and highlights locations that have concurrence of an increased probability for large fires and increased probability of wind-related outages on PG&E's distribution system. The LFP_D Model was backcast through PG&E's 30-year climatology to establish a guidance value for PSPS. The goal of this analysis was to ensure large fires of the past would have been identified by LFP_D Model while balancing customer impacts by limiting PSPS events to the extent possible. This involved evaluating the LFP_D for large wind-driven fires in the past to ensure events such as the 2017 Northern California Fires and 2018 Camp fire would be identified by the guidance, as well as determining the annual number and size of PSPS events that would have occurred in the past using the established guidance value.

Figure PG&E-4.2-5 below represents the conceptual risk framework of how OPW and Utility FPI Models are used to forecast PSPS events for distribution facilities. For example, PSPS is considered when there is concurrence of high FPI and high OPW in space and time, which represents locations that have a high wind-related outage probability and high probability of large fires.

FIGURE PG&E-4.2-5: FIRE RISK MODEL INTERACTION: OUTAGE PRODUCING WINDS AND FIRE POTENTIAL INDEX



In addition to LFP_D, PG&E also evaluates areas that meet its "Black Swan" criteria. These are areas that have a low likelihood of observing an outage, but critical conditions that may lead to explosive wildfire growth. The Black Swan criteria are described in more detail in Subsection (g) below.

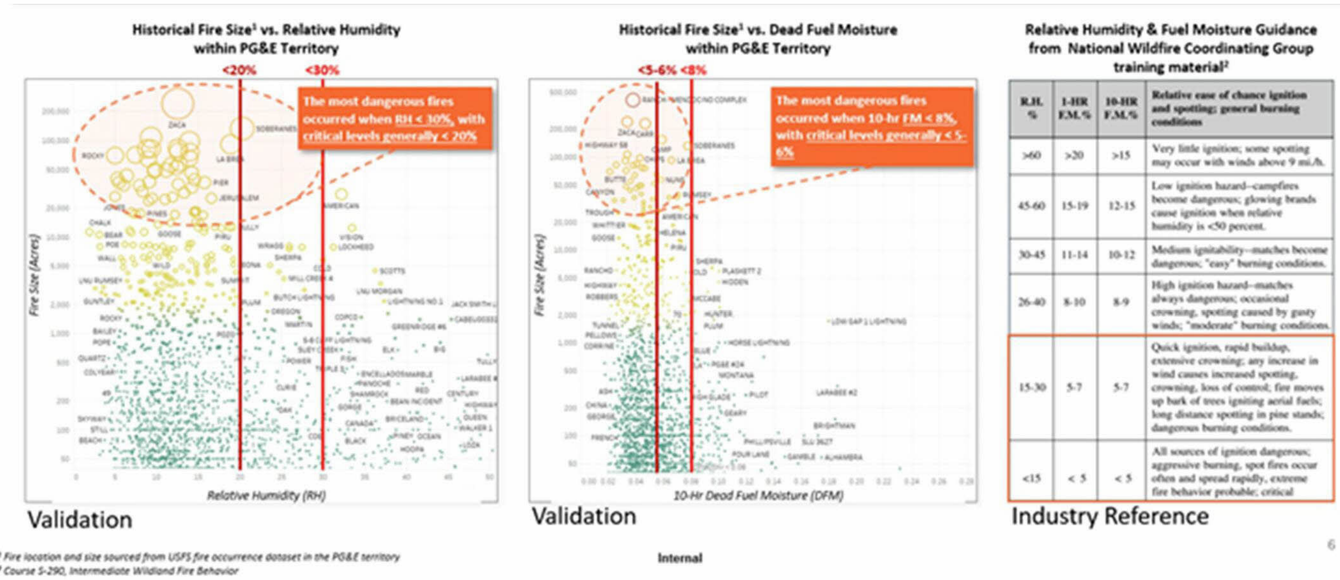
(d) Minimum Fire Potential Conditions

The first step in determining the scope of a PSPS event is evaluating the minimum Fire Potential Conditions in space and time. This serves as a weather and fuels filter based on relative humidity values and fuel moisture values that must be met for PSPS to be considered. The values utilized were established from an examination of historical fire occurrence in PG&E's territory in relation to the weather and fuel conditions during each fire, as well as Fire Danger information published by federal agencies.

PG&E first conducted a review of National Wildfire Coordinating Group (NWCG) training material and next completed an analysis of all large fires in the PG&E territory from 1992 - 2018 to determine the minimum fire potential conditions that must be met before PSPS is considered. The fire information was sourced from a United States Forest Service (USFS) fire occurrence database, while weather and fuels information were sourced from PG&E's 30-year climatology (discussed in more detail below).

Figure PG&E-4.2-6 below represents some of the agency training material and validation that was performed by PG&E. For each fire in the USFS database, the weather and fuel moisture data were extracted from PG&E's 30-year climatology in space and time. A review of past fires revealed, for example, that fires that eventually grow larger than 10,000 acres most often occur when Relative Humidity (RH) is less than 30 percent and the 10-hour DFM is less than 8 percent. This aligns with training material in NWCG material offered in course S-290 (Intermediate Wildland Fire Behavior), where RH and DFM values above 25% and 8%, respectively, would produce "moderate" burning conditions whereas drier conditions would be more dangerous.

FIGURE PG&E-4.2-6: AGENCY TRAINING MATERIALS AND PG&E VALIDATION



R.H. %	1-HR F.M.%	10-HR F.M.%	Relative ease of chance ignition and spotting; general burning conditions
>60	>20	>15	Very little ignition; some spotting may occur with winds above 9 mi./h.
45-60	15-19	12-15	Low ignition hazard--campfires become dangerous; glowing brands cause ignition when relative humidity is <50 percent.
30-45	11-14	10-12	Medium ignitability--matches become dangerous; "easy" burning conditions.
26-40	8-10	8-9	High ignition hazard--matches always dangerous; occasional crowning, spotting caused by gusty winds; "moderate" burning conditions.
15-30	5-7	5-7	Quick ignition, rapid buildup, extensive crowning; any increase in wind causes increased spotting, crowning, loss of control; fire moves up bark of trees igniting aerial fuels; long distance spotting in pine stands; dangerous burning conditions.
<15	< 5	< 5	All sources of ignition dangerous; aggressive burning, spot fires occur often and spread rapidly, extreme fire behavior probable; critical

Similar analyses were conducted on the 100 hour and 1,000-hour DFM time-lagged classes to determine when large fires most often occur. For example, there is very low historical precedence based on this analysis for large fires to occur when the 1000-hour DFM is greater than 14 percent.

Another important element considered in the minimum fire potential conditions is wind speeds. PG&E recognizes that PSPS events should not be conducted when gusty winds are not present even though the FPI may be high due to hot and very dry weather alone. To establish a minimum wind speed value, PG&E first reviewed RFW guidance from the NWS. A Red Flag Warning means warm temperatures, very low humidity, and stronger winds are expected to combine to produce an increased risk of fire danger. Many NWS offices have developed their own RFW criteria and most offices consider wind speed when issuing an RFW. Some NWS offices consider wind gusts over 35 mph, while others utilize a minimum sustained wind from 15-25 mph, while others use a matrix approach dependent on the combination of RH and wind speed.

The Northern CA GACC, a federal forecast agency, was also consulted about wind speed criteria used to generate high-risk forecasts for winds. High Risk Days are issued by the GACCs when fuel and weather conditions are predicted that historically have resulted in a significantly higher than normal chance for a new large fire or for significant growth on existing fires. Based on personal communications with GACC fire weather meteorologists, wind speed criteria generally range from 30-40 mph gusts depending on RH and fuel moisture values associated with an event.

The NOAA Storm Prediction Center is another federal forecast agency that generates fire weather outlooks (https://www.spc.noaa.gov/products/fire_wx/). The SPC is responsible for forecasting meteorological conditions which, when combined with the antecedent fuel conditions, favor rapid growth and spread of a fire should an ignition occur.

The SPC issues three categorical risk areas to highlight fire weather threats in their fire weather outlooks: elevated, critical, or extremely critical for temperature, wind and RH. Two other forecast categories are also used to address dry thunderstorms.

The SPC guidance for critical areas is as follows:

- Dry Fuels
- Sustained winds 20 mph or greater
- Relative humidity at or below regional thresholds (<15% in CA)
- Temperatures at or above 50-60 degrees F, depending on the season
- Concurrency of the above criteria for 3 hours or more

The SPC extremely critical guidance contains more stringent criteria such as sustained wind speeds 30 mph and greater, for example.

To generally align with federal forecast agency forecasts of high fire risk, a forecast wind speed value of 20 mph sustained is utilized in the minimum fire potential conditions PG&E considers. A summary of minimum fire potential conditions is shown in Table PG&E-4.2-5 below. Identification of these conditions in space and time is the first step when determining a PSPS event. Additional outage potential, fire potential, and Black Swan criteria are then utilized to determine the ultimate scope of a PSPS event, which is discussed later in this section.

TABLE PG&E-4.2-5: MINIMUM FIRE POTENTIAL CONDITIONS

Logic	Variable	Sign	Value
&	Fire Potential Index (FPI)	>	0.2
&	Sustained Wind Speed mph	>	20
&	Dead Fuel Moisture (DFM) 10hr	<	8%
&	Dead Fuel Moisture (DFM) 100hr	<	10%
&	Dead Fuel Moisture (DFM) 1000hr	<	14%
&	Relative Humidity (RH)	<	30%

(e) The Utility Fire Potential Index

PG&E developed and calibrated the Utility FPI Model using its 30-year climatology dataset combined with a USFS fire occurrence dataset in the PG&E territory. The Utility FPI Model is considered in PG&E's models for potential distribution and transmission PSPS events and is also used to evaluate field work to help mitigate fire ignitions. The Utility FPI Model combines several factors including a fire weather index (wind, temperature, and humidity) with fuel moisture data (10-hour dead fuel moisture and live fuel moistures), and landcover type (grass, shrub/brush, or forest).

The Utility FPI Model is a logistic regression model and is related to the probability of a small fire becoming a large fire. The Utility FPI Model forecast describes the potential for fires to spread rated on a scale from "R1" (lowest) to "R5" (highest). The Utility FPI Model is run at 2 x 2 km resolution and provides hourly forecasts out four days. Fire Danger forecasts from the federal National Fire Danger Rating System available at WFAS.net, provide a day ahead forecast only; thus, the ability to model the FPI multiple days ahead allows PG&E to communicate the stakeholders and customers that a PSPS may be needed.

(f) The Outage Producing Winds Model

In 2020, PG&E revised its OPW Model. The revised version represents the next generation distribution outage model building on the 2019 OPW model. The OPW Model was built from the ground up and is focused on supporting mitigation of utility caused wildfire risk through PG&E's PSPS program and other wildfire risk mitigation programs.

The OPW Model is based on an analysis of windspeeds from PG&E's 30-year weather climatology and approximately 400,000 sustained and momentary outages occurring on distribution grid from 2008 to 2020. Damages and hazards from PG&E's 2019 PSPS events were also included in the training set. Excluded from the outage data are outages due to snow, rain and lightning, and outages due to non-weather driven major events such as fires and earthquakes.

The OPW Model forecasts the probability of unplanned outages associated with wind events occurring in PG&E's service area. The output of the OPW Model is a measure of the probability of an outage in specific parts of PG&E's service territory based on forecasted wind speed. The OPW Model is driven by PG&E's high-resolution weather modeling output, POMMS, at both 2 km and 3 km resolution. Outage producing winds are forecast four times per day with the hourly outage probabilities for each grid cell with a forecast horizon of 84 hours ahead for the 3 km resolution, and 105 hours ahead for 2 km resolution. These winds vary across PG&E's system based on differences in topography, vegetation and climatological weather exposure in different parts of PG&E's service territory.

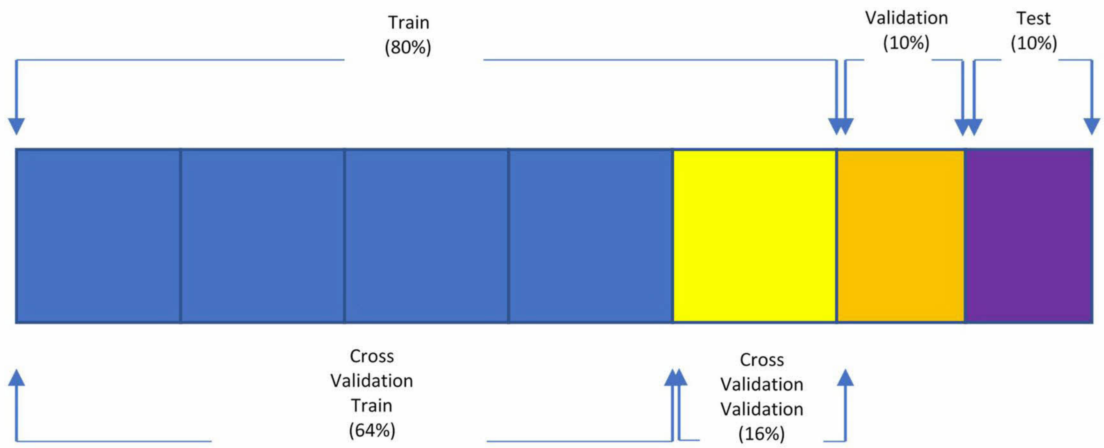
Outage nodes are created to relate historical outages to nodes, and then the nodes to POMMS grid cells. The geographic area of a node is as a function of distribution line mile density. Spatially contiguous nodes of similar line miles per node were created using a genetic growth algorithm. Approximately 23,000 logistic functions are fit for each of the node-cell pairs, to the observations of windspeeds in that cell, and whether an outage was observed on the node. The OPW of the node is then the mean of the OPW of the node-cell models for that node. This approach is referred to as Multiple Instance Learning in the literature and performs well where the labels of the grid cells (instances) is not well known, but the labels of the outage nodes (bags) is well known, while retaining information from the cells, i.e., the windspeeds. The outage-node-cell relation allows wind-outage relationships to be learned for localized areas, and outage probabilities to be compared across the territory.

Alternative OPW Model formulations were evaluated, including circuit level models, and circuit-cell level models. Due to the high variability of lengths of PG&E's approximately

3,300 circuits, these models were found to be less granular for the longer circuits which are spreading the weather information over too large of an area, and too small for the shorter circuits, with insufficient observation of outages to train the model.

There were between 27 to 1029 outages over the 13 years per node for training the model, with a mean of 261 outages per node. The nodes are an imbalanced classification problem, with a mean Positive Class Fraction of 0.25 percent.

FIGURE PG&E-4.2-7: TRAIN-VALIDATION-TEST SETS



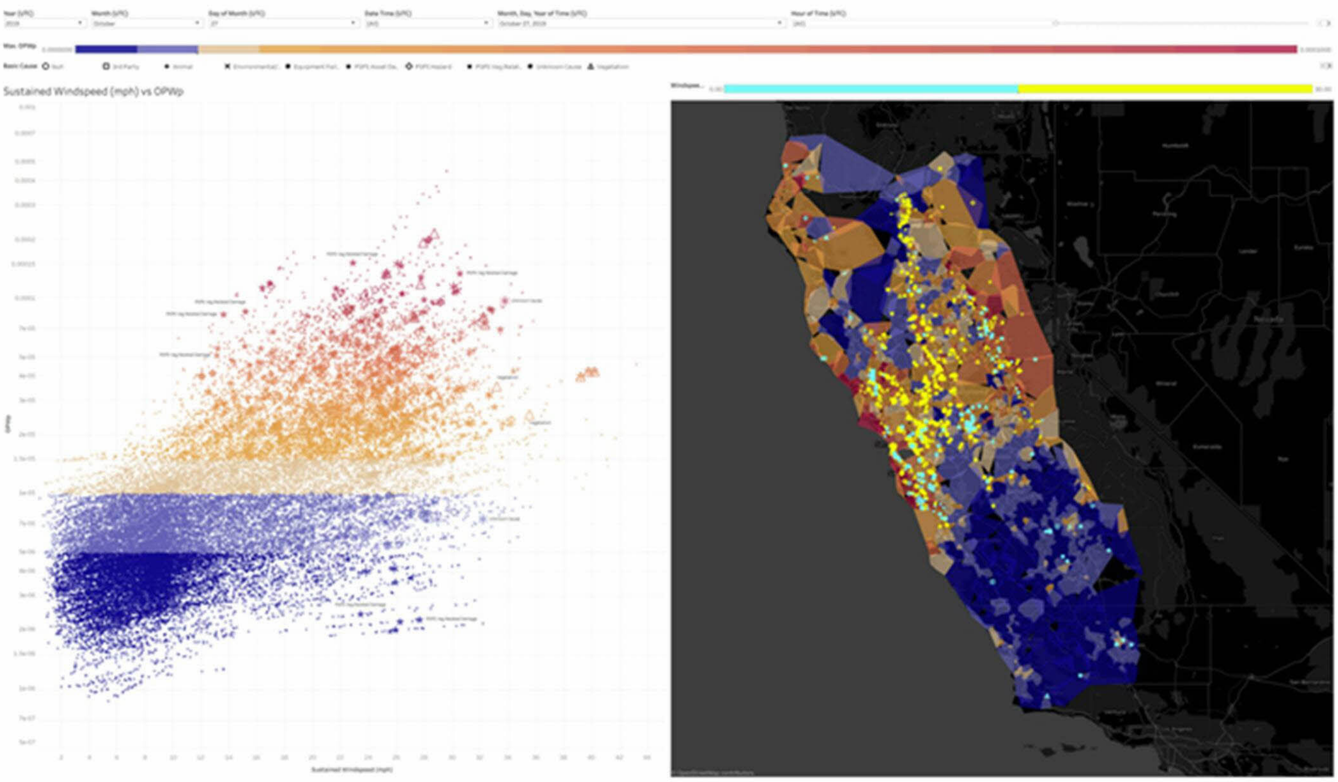
The statistical evaluation metrics of Average precision divided by Positive Class Fraction and Area under the Receiver Operating characteristic curve are calculated using the models training on the training sets and evaluated on the validation set as shown in Figure PG&E-4.2-7 above. The test split is withheld for potential future model selection. Average precision summarizes the precision-recall curve as the weighted mean of precisions achieved at each discrimination threshold with the increase in recall from the previous threshold used as the weight. Positive Class Fraction is the fraction of positive class labels out of all labels. Average precision divided by Positive Class Fraction, has an average across the nodes of 7.4. For reference, a naïve model will an Average Precision divided by Positive Class Fraction of 1. The Receiver Operating Characteristic (ROC) curve plots the true positive rate against the false positive rate for each discrimination threshold. The area under the ROC curve, has an average across the nodes of 0.57. For reference, a naïve model will have an area under the ROC curve of 0.5.

A positive correlation is observed between positive class fraction and model performance indicating greater imbalance nodes are more difficult to predict. Tier 2 and Tier 3 HFTDs observe stronger model performance with stronger relationships of outages to windspeeds given typically higher vegetation risk. The San Joaquin Valley Tier 1 area is of note with high class imbalance, weaker relations of outages to windspeeds, and thus weaker model performance.

In order to further evaluate model skill before operational implementation for PSPS, an interactive dashboard was created to visualize and analyze the actual outages versus

OPW hour-by-hour for over 300 high impact historical weather days for subject matter expert review. Operational meteorologists used the dashboard to evaluate model performance against key historical storm events by evaluating the timing of weather onset compared to modeled outage probability increases, and relative magnitude of outage probabilities against actual outage data. Figure PG&E-4.2-8 below represents a snapshot of the OPW dashboard.

FIGURE PG&E-4.2-8: SNAPSHOT OF OPW DASHBOARD



(g) Black Swan Conditions

In 2020, PG&E introduced an evaluation of Black Swan conditions to review low probability, high consequence events. The inclusion of Black Swan Guidance allows PG&E to identify lines that may show, for example, low wind-related outage probability but may experience conditions that have been present in some past, catastrophic fire incidents. This allows a pass at capturing outage and potential ignition events that are much rarer. These potential outage pathways include animal contacts, third party contacts, foreign debris contacting lines (e.g., metallic balloons), etc. A review of 2020 CPUC-reportable fire ignitions originating from PG&E assets showed that approximately one-third of ignitions were caused by third-party or animal contact with PG&E assets.

The guidance values utilized for Black Swan are presented in Table PG&E-4.2-6 below. If these conditions are forecast, the distribution line is considered for PSPS under Black Swan regardless of LFP_D. These utilize the same fuel dryness factors aside from the sustained wind speed, RH and FPI. The 30-mph sustained wind speed was chosen as it aligns with the SPC wind-speed classification of “Extremely-Critical” conditions employed in their categorical risk assessment. In the future, PG&E may also consider fire spread consequence output as part of its Black Swan Guidance.

The SPC guidance for Extremely-Critical areas are as follows:

- Very Dry Fuels
- Sustained winds 30 mph or greater
- Relative humidity at or below 1/3 lower than regional thresholds
- Temperatures at or above 60-70 degrees F, depending on the season
- Concurrency of the above criteria for three hours or more

Table PG&E-4.2-6 below provides further information regarding the values for black swan conditions on PG&E's distribution system.

TABLE PG&E-4.2-6: PG&E DISTRIBUTION BLACK SWAN CONDITIONS

Logic	Variable	Sign	Value
&	Fire Potential Index (FPI)	>	0.3
&	Sustained Wind Speed mph	>	30
&	Dead Fuel Moisture (DFM) 10hr	<	8%
&	Dead Fuel Moisture (DFM) 100hr	<	10%
&	Dead Fuel Moisture (DFM) 1000hr	<	14%
&	Relative Humidity (RH)	<	20%

(h) Analysis of Weather Contribution for Transmission PSPS Events

There are three key inputs of PG&E's meteorological analysis to determine PSPS criteria on the Transmission system:

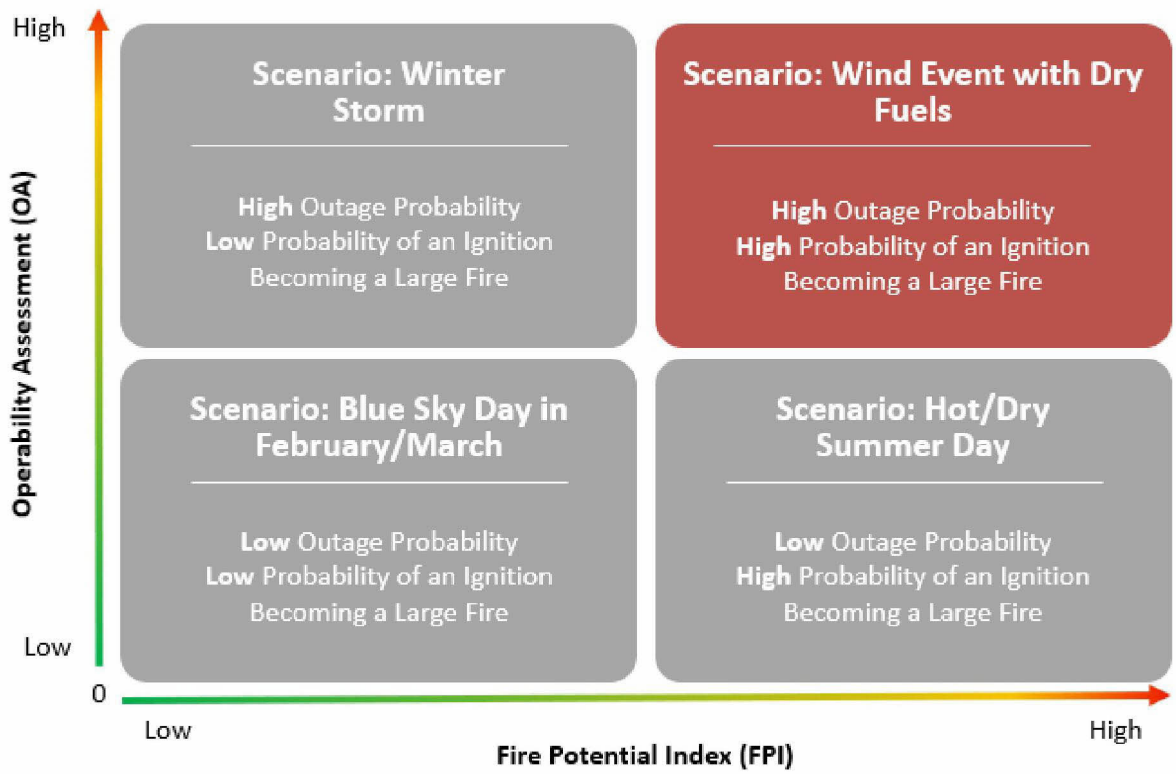
- Minimum Fire Potential Conditions
- PG&E's Transmission Large Fire Probability Model (LFP_T) comprised of the following:
  - Transmission Operability Assessment Model (OA Model)
  - Utility FPI Model
- Transmission "Black Swan" criteria

For transmission, the same general risk framework is utilized as is used for distribution (see Figure PG&E-4.2-9 below); however, the distribution OPW Model is replaced with the OA Model, which provides a forecasted probability of failure for each transmission structure. The OA Model and Utility FPI Model are combined in both space and time to form PG&E's Transmission Large Fire Probability model (LFP_T), which is presented below:

$$LFP_T = OA * FPI$$

Figure PG&E-4.2-9 below represents the conceptual risk framework of how the OA Model and the Utility FPI Model are used to forecast PSPS events for transmission facilities.

FIGURE PG&E-4.2-9: FIRE RISK MODEL INTERACTION: OPERABILITY ASSESSMENT AND FIRE POTENTIAL INDEX



PG&E partnered with a third party to develop the OA Model for transmission. This model combines historical wind speeds for each structure, historical outage activity, and the condition of assets based on inspection programs to help understand the wind-related failure probability of each structure. The OA Model can be driven with forecast wind speeds to output the probability of failure at the structure level each hour.

(i) PG&E's Development and Use of Climatology Data

Working with external experts, PG&E Meteorology improved its operational weather model and historical datasets in 2020 by increasing the model granularity from 3 x 3 km to 2 x 2 km, and creating a new 30-year weather, dead fuel and live fuel moisture climatology at 2 x 2 km resolution. This hourly climatology provides data from ~45,000 grid points across the PG&E territory. These grid points can be thought of like virtual weather stations where data can be extracted from each point for any hour over the past 30 years. The variables included in this climatology are weather outputs (wind speed, temperature, relative humidity, precipitation, etc.), dead fuel moisture for the 1-, 10, 100, 1000-hour dead fuels, and live fuel moisture for chamise and manzanita plant species.

This is a valuable and sizable dataset. For example, there are ~12 billion data points for a single variable (e.g., wind speed) available in the climatology (45,000 grid points * 30 years * 8,760 hours/year). The actual data size is much larger as PG&E's modeling domain extends well beyond the bounds of the PG&E territory. All told, the PG&E weather and fuels climatology contains more than 100 billion data points that can be extracted in space and time across the past 30 years in the PG&E territory.

In order to process these large datasets and run climatological analyses, dedicated infrastructure was built in the Amazon Web Services (AWS) cloud to store these datasets and spin up computational resources on-demand to perform numerous studies with these climatology datasets.

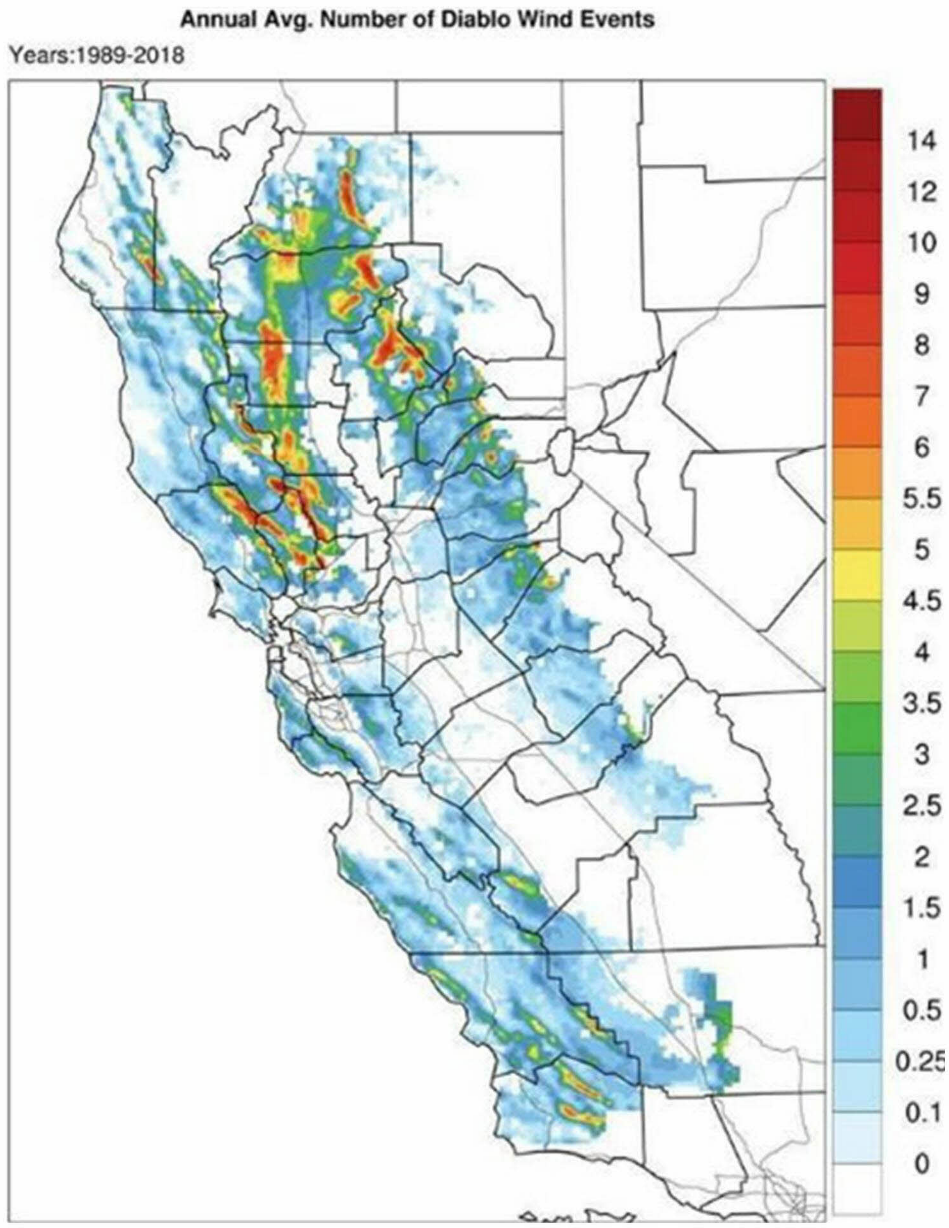
To build the OPW and Utility FPI Models, data were extracted from the climatology at the nearest virtual weather station (i.e., grid point) at the time the fire or outage incident occurred. This data was then used to develop the OPW and Utility FPI models. Once the models were developed, they are then operationalized in the forecast model to provide a 4-day look ahead at the weather, the probability of wind-caused outages, and the probability of large fires. When constructing models for PSPS, PG&E was able to reconstruct its LFP Models through the climatology so that large, catastrophic fires in the past would have been captured by the model, while also looking at the number of times per year and on average, customers would be impacted during a PSPS event.

With this climatology, other studies can be performed to determine where offshore winds events and PSPS events are most often expected to occur. These offshore wind events are commonly known as Diablo or Santa Ana wind events. The Diablo wind is a dry, northeast wind that occurs over northern California. These events are critical to consider as the vast majority of destructive fires in California history have occurred during dry, offshore wind events. Figure PG&E-4.2-10 below presents the average frequency of offshore (Diablo) wind events across the PG&E territory. For this analysis, a dry, Diablo wind event was defined as an event lasting at least 3 hours, having sustained winds >20 mph, wind direction from the north to northeast (offshore), and a FPI indicating dry conditions. This analysis shows the relative frequency of these events is higher in the North Bay Area and northern Sierra than in other portions of the PG&E territory. This study also revealed dry, offshore wind events are most common in Autumn, as expected. These patterns generally held true in 2019 and 2020 as the majority of PSPS events occurred during autumn across the northern half of PG&E's territory and impacted communities more often in these locations.[23]

---

[23] PG&E is also working with Argonne National Laboratory to conduct a climate change modeling study to determine if the location and or frequency of Diablo wind events may change by mid-century. The results of this study are expected to be completed in 2021, but preliminary analysis reveals that the North Bay, Northern Sierra and Sacramento Valley will continue to be hot-spots for Diablo wind events.

FIGURE PG&E-4.2-10: 30-YEAR HISTORICAL ANNUAL AVERAGE OF "DIABLO WIND EVENTS" GEOGRAPHICALLY



(j) Long-Term Risk Assessments And Weather Input Into Models

Climatology data is also used to determine which circuits have the overall highest risk of large fires over the long-term. This is a separate assessment from PSPS, as large fires can and have occurred during low and moderate wind speeds and are mostly fuels or plume-dominated. A range of meteorological data sets are used as inputs to the ignition probability models described in Section 4.3. Table PG&E-4.2-7 below itemizes the meteorological data sets used in the 2021 Wildfire Distribution Risk Model as inputs to the Vegetation Probability of Ignition Model and the Equipment Probability of Ignition Model described in Section 4.3. In all cases these are historical data sets used as a proxy to represent forecasted future conditions.

TABLE PG&E-4.2-7: METEOROLOGICAL DATASETS USED IN 2021 WILDFIRE DISTRIBUTION RISK MODEL

Covariate	Category	Source	Spatial Resolution	Units	Descriptions
100-hour fuels	Meteorological data	gridMET	~4km	%	Unless otherwise noted, all GRIDMET data aggregated from 2014 to 2016. The dead fuel moisture data were obtained from GRIDMET, and the “100-hour-fuels” feature was included in the model. The exact GRIDMET variable use is known as fm-100 and is a standard fire modeling metric of fuel dryness for fuels about 1-3” in diameter - intermediate sized fuels.
1000-hour fuels	Meteorological data	gridMET	~4km	%	fm-1000, as defined above, but for 3-8” in diameter.
burn index	Meteorological data	gridMET	~4km		the US, the National Fire Danger Rating System (USNFDRS) Burning Index (BI)
energy release	Meteorological data	gridMET	~4km		USNFDRS Energy Release Component (ERC)
precipitation average	Meteorological data	gridMET	~4km	Mm	Daily precipitation average
specific humidity	Meteorological data	gridMET	~4km	kg/kg	Specific humidity
vapor pressure deficit avg	Meteorological data	gridMET	~4km	kPa	Measure how much water is in the air compared to how much it could hold at the given temperature. VPD drives evapotranspiration and is the mechanism for fuels drying out during fire season.
temperature max average	Meteorological data	gridMET	~4km	K	Average of daily maximum temperature in Kelvin (recall that it is sensed via satellite)
wind avg	Meteorological data	RTMA	~2.5km	m/s	Hourly average wind speed at 10m, averaged from 2016 to 2018
wind max	Meteorological data	RTMA	~2.5km	m/s	Annual 99th percentile hourly wind speed at 10m assessed over 2016 to 2018
windy summer day pct	Meteorological data	RTMA	~2.5km		The percentage of days with sustained hourly wind speeds over 15 mph
gusty summer day pct	Meteorological data	RTMA	~2.5km		The percentage of days with sustained hourly wind speeds over 20 mph

(k) Response to RCP Actions

ACTION PGE-5 (Class A):

In its 2021 WMP update, PG&E shall:

1) Refile the updated OPW and wind analysis data;

2) Provide detail on how it has verified the accuracy of its OPW model; and

3) How it accounts for less granularity in historic weather data due to fewer deployed weather stations.

Response:

Details regarding PG&E's updated OPW Model above addressing questions (1) and (2) are found in Section 4.2.A(f) above. Regarding question (3), PG&E uses the 30-year climatology of historic weather to train the OPW Model, which is on a 3 km and 2 km grid, and does not suffer from the challenge of lower weather station density in the past compared to now.

4.2.B. Contribution of Fuel Conditions

B) Describe how the utility monitors and accounts for the contribution of fuel conditions to ignition probability and estimated wildfire consequence in its decision-making, including describing any proprietary fuel condition index (or other measures tracked), the outputs of said index or other measures, and the methodology used for projecting future fuel conditions. Include discussion of measurements and units for live fuel moisture content, dead fuel moisture content, density of each fuel type, and any other variables tracked. Describe the measures and thresholds the utility uses to determine extreme fuel conditions, including what fuel moisture measurements and threshold values the utility considers "extreme" and its strategy for how fuel conditions inform operational decision-making.

PG&E's Utility FPI Model, Dead Fuel Model, and Live Fuel Model are discussed in detail as part of our discussion of Advanced Weather Modeling in Section 7.3.2.1.2. In 2020, PG&E deployed a Dead Fuel Model on the cloud capable of predicting the moisture content of multiple DFM fuel classes (i.e., DFM 1hr, DFM 10hr, DFM 100hr, DFM 1000hr) at 2 x 2 km resolution. PG&E also deployed 2 x 2 km Live Fuel Model for Chamise as well as Manzanita plant species. These are machine-learning models developed using National Fuel Moisture Database (NFMDB) observations. In addition to creating new forecast models, PG&E created a 30-year climatology of DFM and LFM output at 2 x 2 km resolution as well. These historical datasets allow PG&E meteorologists and data scientists to evaluate the fuel conditions present during historical fires.

PG&E also created a new Live Fuel Model using remotely-sensed satellite data. The Live Fuel Model is trained on field observations. PG&E is taking steps to bolster these observations and to provide them to the public, to help validate existing models and enable more accurate models to be developed in the future as they can take advantage of many more observations. To this end, PG&E partnered with SJSU in 2019 and 2020 to sample LFM at multiple locations in the HFTD areas within the Bay Area and share that data broadly. In 2020, PG&E also established an internal LFM sampling program to complement samples collected by state and federal across Northern and Central CA. This network consists of 30 locations where plant species such as Chamise and Manzanita are sampled to measure the amount of fuel moisture in these plants throughout the seasonal cycle. Samples are collected in the field and shipped to PG&E's chemistry laboratory for processing. The results of all measurements are uploaded and made publicly available via the NFMDB. These observations are critical to train and validate high resolution live fuel moisture models and satellite-derived live fuel moisture products and will be helpful for PG&E and others to train the next generation of Live Fuel Model.

4.2.1 Service Territory Fire-Threat Evaluation and Ignition Risk Trends

Discuss fire-threat evaluation of the service territory to determine whether an expanded HFTD is warranted (i.e., beyond existing Tier 2 and Tier 3 areas). Include a discussion of any fire threat assessment of its service territory performed by the electrical corporation, highlighting any changes since the prior WMP report. In the event that the electrical corporation's assessment determines the fire threat rating for any part of its service territory is insufficient (i.e., the actual fire threat is greater than what is indicated in the CPUC Fire Threat Map and HFTD designations), the corporation shall identify those areas for consideration of HFTD modification, based on the new information or environmental changes. To the extent this identification relies upon a meteorological or climatological study, a thorough explanation and copy of the study shall be included.

List and describe any macro trends impacting ignition probability and estimated wildfire consequence within utility service territory, highlighting any changes since the 2020 WMP report:

1. *Change in ignition probability and estimated wildfire consequence due to climate change;*

2. *Change in ignition probability and estimated wildfire consequence due to relevant invasive species, such as bark beetles;*

3. *Change in ignition probability and estimated wildfire consequence due to other drivers of change in fuel density and moisture;*

4. *Population changes (including Access and Functional Needs population) that could be impacted by utility ignition;*

5. *Population changes in HFTD that could be impacted by utility ignition;*

6. *Population changes in WUI that could be impacted by utility ignition;*

7. *Utility infrastructure location in HFTD vs non-HFTD; and*

8. *Utility infrastructure location in urban vs rural vs highly rural areas.*

In this section, we describe the High Fire Risk Area (HFRA) Map that PG&E has developed. The HFRA Map is currently used in scoping PSPS events and may be used in the future for other purposes, such as prioritizing inspections and work. Subsection (a) describes PG&E's development of the HFRA Map.

This section also includes a list of macro trends impacting ignition probability and estimated wildfire consequences. This information is included in Subsection (b).

(a) Development of PG&E's High Fire Risk Area Map

In 2020, PG&E started the development of its territory wide HFRA Map which is a purpose-built map for use in scoping PSPS events. The HFRA Map considers catastrophic fire risk factors and utility infrastructure and was developed by considering incremental changes to the HFTD map boundaries to add areas where risk factors for the potential of catastrophic fire from utility infrastructure ignition during offshore wind events is higher. In developing the HFRA Map, we aimed to accomplish the following:

1. Ensure all areas of catastrophic wildfire risk are fully captured in PG&E's PSPS program;

2. Identify areas that could be removed from the PSPS scope as they do not pose the risk of a catastrophic wildfire during offshore wind events;

3. Dedicate resources and processes that allow for on-going refinement of the HFRA Map accounting for changes in land use, climate, and PG&E's infrastructure while utilizing new modeling tools as they become available to inform catastrophic fire risk; and

4. Work with internal teams to ensure PSPS project workplans (e.g., system hardening, PSPS sectionalization) are informed by existing HFRA boundaries and capture/document recommendations for future review and refinement.

In the second quarter of 2020, we completed the first version of the HFRA Map which identified approximately 115 areas that are not included in HFTD areas to be included in our PSPS scope. These HFRA Map areas vary from small boundary adjustments (e.g., 0.25 acres) to larger areas (e.g., hundreds of square miles) where ignitions could lead to catastrophic fires during offshore wind events. Many of the larger areas do not contain high numbers of customers or PG&E assets as they are in rural, hard to access locations where a fire could grow and spread rapidly. Table PG&E-4.2-8 below provides a summary of the areas added to the HFRA Map that are in addition to HFTD areas.

TABLE PG&E-4.2-8: HIGH LEVEL SUMMARY OF ADDITIONS TO HFTD AREAS

Polygons Added	115
Customers added to PSPS Scope	3,000
Distribution Circuit Miles within polygons	620
Transmission Circuit Miles within polygons	230

A map of the added areas is provided below in Figure PG&E-4.2-11, which shows the HFTD map (Yellow and Red) with added HFRA Map areas in green. Figure PG&E-4.2-12 is more granular and shows how the HFRA Map identified a specific risk area outside a Tier 3 HFTD area. As well as expanding the PSPS Scope beyond the HFTD Map, PG&E is considering the removal of areas that are within the HFTD from PSPS scope and may do so in 2021.

FIGURE PG&E-4.2-11: HFTD AREAS WITH HFRA MAP ADDITIONS

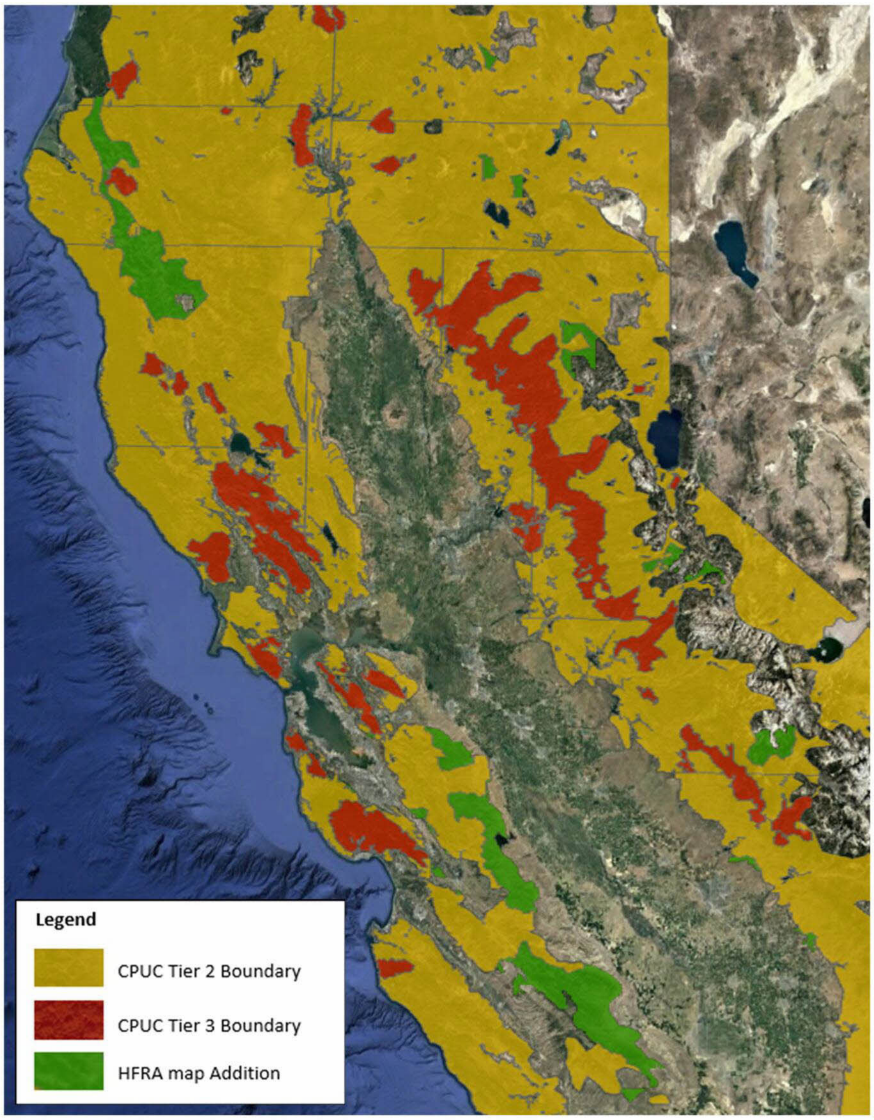
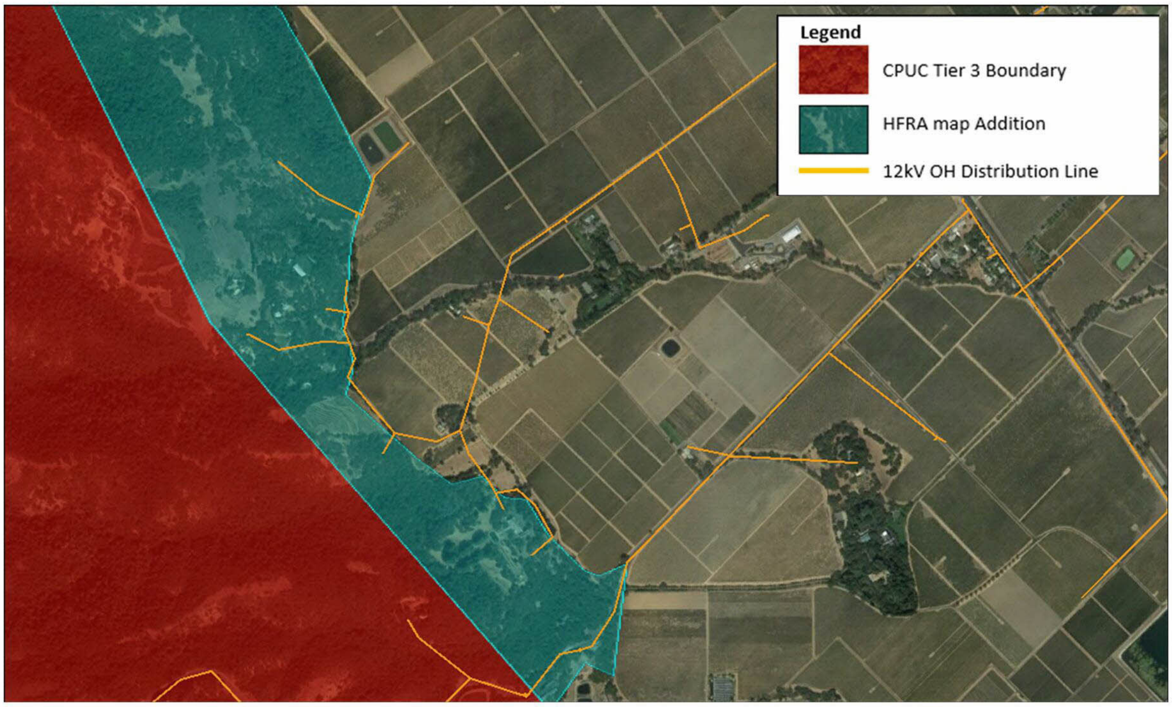


FIGURE PG&E-4.2-12: HFTD TIER 3 BOUNDARY WITH HFRA ADDITIONS



The HFRA Map was developed using the following process:

1. Areas were identified by subject matter experts familiar with local area and fire history for potential addition to the HFRA Map.

2. A centralized team reviewed all areas slated for addition utilizing PG&E's analytical datasets and tools while documenting the criteria (see below) as to why the areas should or should not be added.

3. The areas for addition were then reviewed by a third party for additional feedback. See Section 4.4.2 for further information on the HFRA Map external review.

The following criteria was considered and documented with regard to areas included in the HFRA Map:

1. Is the area consistent with surrounding HFTD areas?

2. Does the area have significant slope/potential for an uphill fire propagated by an offshore wind event?

3. Does the area have a high fuel load?

4. Is the area in proximity to wildland fuels?

5. Is there development in high risk land use areas?

6. Are there insufficient firebreaks given the exposure?

PG&E will continue to evaluate the inclusion of additional areas requiring wildfire reduction activity in future WMPs based upon information obtained during the implementation and evaluation of PG&E's annual plan. In addition, PG&E will continue to mature its tools to analyze wildfire risk using available data, climatology and fire spread modeling to inform potential adjustments to the HFTD areas. These analytics may lead to additional future recommendations.

(b) Macro Trends Impacting Ignition Probability and/or Wildfire Consequence

PG&E has identified the following macro-trends that may impact wildfire ignition probability and/or wildfire consequences:

TABLE PG&E-4.2-9: MACRO TRENDS IGNITION PROBABILITY AND/OR WILDFIRE CONSEQUENCE

Rank	Macro trends	Comments
1	Change in ignition probability and estimated wildfire consequence due to climate change	Several key climate change trends are influencing variable periods of extreme wildfire risks in Northern California. These trends significantly increase wildfire ignition risks around utility networks. Warmer winters are causing increases in rainfall rather snow, resulting in a decrease to the snowpack. This reduces available water resources earlier in summer months, stressing vegetation and increasing available fuels. Compounding the shift from snow to rain are extended dry periods following summer months deeper into fall and early winter. Northeast winds are more common in fall and winter months in Northern California and if not accompanied by rainfall or other atmospheric moisture wildfire risks continue to increase despite the presence of lower temperatures. Ignitions that occur under these conditions can result in large conflagrating wildfires that can further promote risk associated with Northern California's abundant fuel and extreme terrain resulting in fires that develop their own devastating weather. ***Reference***: OEHHA: https://oehha.ca.gov/epic/changes-climate/precipitation. "Extremely dry and extremely wet years have become more common in California. On average, the state receives 75 percent of its annual precipitation from November through March, with 50 percent occurring from December through February. As the winter months have become warmer in recent years, more precipitation has been falling as rain instead of snow over the watersheds that provide most of the state's water supplies." "The last decade also includes the driest consecutive four-year period, from 2012 to 2015." "Warming temperatures, declining snowpack, and earlier spring snowmelt runoff can create stresses on vegetation" ***Reference:*** National Geographic: https://www.nationalgeographic.com/science/2019/10/climate-change-california-power-outage/.

TABLE PG&E-4.2-9: MACRO TRENDS IGNITION PROBABILITY AND/OR WILDFIRE CONSEQUENCE
(CONTINUED)

Rank	Macro trends	Comments
2	Change in ignition probability and estimated wildfire consequence due to relevant invasive species, such as bark beetles	Invasive species create landscape level concerns that have significant potential to impact areas within and adjacent to utility rights-of-way (ROW). Effects can extend well beyond the ROW making effective mitigation challenging for utilities without more holistic engagement and support from surrounding landowners and stakeholders. Of concern to utilities are both invasive plant and insect species. Invasive insect species, such as bark beetles, can exacerbate forest health concerns and result in hazardous tree conditions that require repetitious monitoring and mitigation by utilities. Native insect species, under stressed environmental conditions – like drought, can impose the same impacts and challenges. Invasive plant species in California tend to thrive in disturbed environments, often displacing native species. There is evidence that these invasions can change and intensify fire regimes. Landscape disturbance can be presented following fires, as well as during ROW maintenance and enhancements. Regardless of disturbance origin utilities are continually compelled to perform additional monitoring and mitigation to identify and control detrimental impacts associated with invasive species. ***References:*** Emergency Proclamation – Office of Governor https://www.ca.gov/archive/gov39/2015/10/30/news19180/index.html. PNAS – Invasive grasses increase fire occurrence and frequency across US ecoregions. “Fire-prone invasive grasses create novel ecosystem threats by increasing fine-fuel loads and continuity, which can alter fire regimes.” “The existence of an invasive grass-fire cycle is well known, evidence of altered fire regimes is typically based on local scale studies or expert knowledge.” “As concern about US wildfires grows, accounting for fire-promoting invasive grasses will be imperative for effectively managing ecosystems.”

TABLE PG&E-4.2-9: MACRO TRENDS IGNITION PROBABILITY AND/OR WILDFIRE CONSEQUENCE
(CONTINUED)

Rank	Macro trends	Comments
3	Change in ignition probability and estimated wildfire consequence due to other drivers of change in fuel density and moisture	PG&E's service territory has experienced noteworthy changes in both fuel density and moisture over the last several decades. These trends significantly increase wildfire ignition risks around utility networks. Fuel density is increasing while available moisture in critical wildfire risk periods is decreasing. This has been accompanied by increases in large tree mortality and overall changes in forest structure. Contributing factors cover a wide range of influences, including but not limited to; climate change, land use patterns, fire suppression and variable forest management practices. Forests are becoming denser with decreased presence of large trees and significant tree mortality over the last decade. Lands that are left unmanaged are subject to increases in accumulated dead and downed fuels that can be annually influenced by surrounding finer, flashier fuels following periods of rain or snowfall. ***Reference:*** PNAS: https://www.pnas.org/content/112/5/1458. ***Reference:*** California Energy Commission: https://www.energy.ca.gov/sites/default/files/2019-07/Projections_CCCA4-CEC-2018-014.pdf.

TABLE PG&E-4.2-9: MACRO TRENDS IGNITION PROBABILITY AND/OR WILDFIRE CONSEQUENCE
(CONTINUED)

Rank	Macro trends	Comments
4	Population changes (including Access and Functional Needs population) that could be impacted by utility ignition	Population in California and PG&E's territory continue to show projections for growth in decades to come. A fair amount of this growth continues in lands previously undeveloped and bordering, or in, fire prone wildland areas. Many utility customers have left the urban environment in favor of more fire prone areas for reasons unassociated with the associated wildfire risk. Current estimates suggest that at least 25 percent of California's residents already reside in areas subject to significant wildfire risk. With projection of upward population trends continuing, it is likely that populations in the Wildland Urban Interface (WUI) and/or the HFTD areas will relatedly increase. These trends may be compounded by the societal impacts of Covid-19. Housing trends in 2020 indicated a shift associated with stay-a-home orders and increased capability to telecommute. These emerging trends have indicated a desire to relocate from urban communities to more rural communities, many within the HFTD areas. The lack of availability and affordability of housing in lower wildfire risk urban areas within the PG&E territory are also factors that many residents evaluate and that all stakeholders, including policymakers, must consider as we all move forward. A significant, but variable and uncertain, portion of the population increases in higher wildfire risk areas will include customer with supplemental access or other functional needs. Utilities (and other stakeholders) will need to continue to engage in programs and education campaigns that inform and prepare all customers to mitigate these growing risks. ***References:*** LCAU: https://lcau.mit.edu/project/cataloguing- interface-wildfire-and-urban-development-california. PPIC: https://www.ppic.org/content/pubs/report/R_116HJ3R.pdf. HBI: http://www.homebuyinginstitute.com/news/california-housing-predictions-for-2021/. CNBC: Warming climate, population sprawl threaten California's future with more destructive wildfires, https://www.cnbc.com/2019/11/09/why-californias-wildfires-are-going-to-get-worse.html.
5	Population changes in HFTD that could be impacted by utility ignition	See PG&E's response to Item #4. Given the overall area of the HFTD areas as a percentage of PG&E's service territory (over 50%), it is likely that population growth in the HFTD areas will not be an exception to anticipated trends. In fact population growth in HFTD areas may exceed, at least in some areas, population growth in non-HFTD areas.
6	Population changes in WUI that could be impacted by utility ignition	See PG&E's response to Item #4. Given the overall area of the WUI as a percentage of PG&E's service territory, it is likely that population growth in WUI will not be an exception to anticipated trends. The HFTD map was informed by WUI data and tremendous overlap between the two categories exists within PG&E service territory.

TABLE PG&E-4.2-9: MACRO TRENDS IGNITION PROBABILITY AND/OR WILDFIRE CONSEQUENCE
(CONTINUED)

Rank	Macro trends	Comments
7	Utility infrastructure location in HFTD vs non-HFTD	PG&E anticipates limited net-addition of utility assets in the near future. Therefore the overall breakdown of assets between HFTD and non-HFTD areas is not expected to significantly evolve going forward. Nonetheless, the volume and location of utility infrastructure already in HFTD areas (~1/3rd of PG&E's overhead electric assets) presents a risk to be mitigated, which is the focus of this plan. When adding or replacing utility infrastructure, particularly in or near HFTD, siting decisions should complement other resiliency and hardening programs continually over the decades to come. Given the increased focus on upgrading, strengthening or replacing assets in HFTD, the location and characteristics of infrastructure in HFTD areas will see more significant changes as compared to Non-HFTD areas.
8	Utility infrastructure location in urban vs rural vs highly rural areas	See PG&E's response to Item #7. There is high correlation between the HFTD areas and rural/highly rural areas within PG&E's service territory. There is similar correlation between urban areas and non-HFTD areas. Therefore the trends impacting urban vs. rural are largely similar to those impacting HFTD vs. non-HFTD.

4.3 Change in Ignition Probability Drivers

Based on the implementation of the above wildfire mitigation initiatives, explain how the utility sees its ignition probability drivers evolving over the 3-year term of the WMP, highlighting any changes since the 2020 WMP report. Focus on ignition probability and estimated wildfire consequence reduction by ignition probability driver, detailed risk driver, and include a description of how the utility expects to see incidents evolve over the same period, both in total number (of occurrence of a given incident type, whether resulting in an ignition or not) and in likelihood of causing an ignition by type. Outline methodology for determining ignition probability from events, including data used to determine likelihood of ignition probability, such as past ignition events, number of risk events, and description of events (including vegetation and equipment condition).

For 2021, PG&E has updated the 2019-2020 Wildfire Model that was described in previous WMPs. The updated model is referred to as the 2021 Wildfire Distribution Risk Model because it addresses wildfire risks on PG&E's distribution system. PG&E is currently developing a 2022 Wildfire Transmission Risk Model for its transmission system and plans to have it completed in 2021 for use in informing and prioritizing work that will occur in 2022.

Consistent with past risk models, the risk scores in the 2021 Wildfire Distribution Risk Model are the product of the likelihood of an ignition event multiplied by the consequence of the event. For the 2021 Distribution Wildfire Risk Model, ignition probabilities were developed for the top risk drivers as outlined in the table below. The wildfire consequence values leveraged the Technosylva Fire Model and are calibrated to the system level wildfire MAVF risk scores reported in PG&E's 2020 RAMP Report. This section provides details on the ignition probabilities while a more detailed explanation of the 2021 Wildfire Distribution Risk Model is provided in Section 4.5.1.

Since the 2020 WMP, PG&E has adopted a consistent categorization of ignition probability drivers. PG&E's 2020 RAMP Report details the approach to ignition probability drivers. To create an accurate categorization of ignition drivers, a thorough analysis of historical data resulted in six (6) top level risk drivers and thirty-five (35) sub-drivers. The six (6) top level drivers for ignition are provided in Table PG&E-4.3-1.

TABLE PG&E-4.3-1: TOP LEVEL IGNITION DRIVERS

Ignition Probability Driver	Description	Detailed Risk Driver	How the Utility Expects to See Incidents Evolve Over the 3-year WMP Term
D1 – Equipment Failure	Events where failure of a PG&E asset such as a conductor, arrester, insulator, breaker, transformer, etc., caused a reportable ignition	Overall, the Equipment Failure risk driver accounts for 38% ignitions systemwide and 27% of ignitions in HFTD areas (26% for HFTD Distribution and 37% for HFTD Transmission). Conductor and splice/clamp/connector failures account for the majority of the equipment failure incidents.	Equipment and more specifically conductor caused wildfires are forecasted to decrease due to mitigation programs that are informed by the risk models described in this section.
D2 – Vegetation	Events where trees, tree limbs, and other vegetation came in contact with a PG&E asset, resulting in a reportable ignition	Overall, the Vegetation risk driver accounts for 26% of ignitions systemwide, 45% of ignitions in HFTD areas (48% for HFTD Distribution and 2% for HFTD Transmission).	Vegetation caused wildfires are forecasted to decrease due to mitigation programs that are informed by the risk models described in this section.
D3 – Third-Party Contact	Events where member(s) of the public or an object under their control come in contact with a PG&E asset, resulting in a reportable ignition. Examples of third-party contact include a vehicle hitting a distribution or transmission pole or a Mylar balloon hitting equipment or conductor.	The Third-Party Contact risk driver accounts for 19% of ignitions systemwide and 15% of ignitions in HFTD areas (16% for HFTD Distribution and 14% for HFTD Transmission).	No anticipated decrease in ignitions due to 3rd party contact. Programs designed to mitigate equipment and vegetation caused ignitions could potentially reduce the probability of third-party caused ignitions, but those programs have not been focused on locations with a high probability of such contact.

TABLE PG&E-4.3-1: TOP LEVEL IGNITION DRIVERS (CONTINUE)

Ignition Probability Driver	Description	Detailed Risk Driver	How the Utility Expects to See Incidents Evolve Over the 3-year WMP Term
D4 – Animal	Events where animals such as birds or squirrels came in contact with a PG&E asset, resulting in a reportable ignition.	The Animal risk driver accounts for 12% of ignitions systemwide and 10% of ignitions in HFTD areas (7% for HFTD Distribution and 40% for HFTD Transmission).	No anticipated decrease in ignitions due to animal contact. Programs designed to mitigate equipment and vegetation caused ignitions could potentially reduce the probability of animal caused ignitions, but those programs have not been focused on locations with a high probability of animal contact.
D5 – Unknown or Other	Events associated with PG&E assets, which led a reportable ignition, where evidence of the root cause of the ignition was not available	The Unknown or Other risk driver accounts for 5% of ignitions systemwide and 4% of ignitions in HFTD areas (3% for HFTD Distribution and 7% for HFTD Transmission).	No anticipated decrease in ignitions due to unknown or other events. Programs designed to mitigate equipment and vegetation caused ignitions could potentially reduce the probability of unknown or other caused ignitions, but those programs have not been focused on locations with a high probability of this category of events.
D6 – Seismic Scenario (Cross-Cutting)	Failure events caused by seismic activity. This risk is described further in Chapter 20 of the 2020 RAMP Report.	The Seismic risk driver is estimated to account for <1% of ignitions.	No anticipated decrease in ignitions due to seismic events.

The focus on the risk modeling and the resulting mitigation initiatives is on the vegetation and equipment failure modes as they represent a high percentage of the overall ignitions by cause. Combined with the Wildfire Consequence Model described in Section 4.5.1, the mitigation initiatives are designed to reduce the ignitions in the highest wildfire risk areas. It is important to note that as PG&E is mitigating areas of highest risk, reportable ignitions may not show a demonstratable decrease. This is due to the fact that ignition probability and wildfire consequence are not highly correlated. That is to say that locations with a high probability of ignition caused by vegetation or equipment failures generally may not be locations with high wildfire consequence.

In the remainder of this section, PG&E describes its methodology for determining ignition probability, the Equipment Probability of Ignition Model, and the Vegetation Probability of Ignition Model.

(a) Methodology for Determining Ignition Probability From Events

In support of risk-based Electric Operations planning, PG&E has developed distribution[24] asset risk models designed to quantify wildfire risks from the distribution system at planning and situational awareness timescales, support risk-based decision making, and enable reporting of risk reduction activities to regulators and the public. To do this, PG&E characterizes wildfire risk as:

Risk = Ignition Probability x Wildfire Consequence.

Both the probability (also referred to as likelihood) and the consequences of an ignition are conditioned, to a degree, on the environmental factors (i.e, wind and gust speeds, temperature, vegetation structure, and topography) experienced by distribution assets, and their age and other physical characteristics.

To answer the question of *where* ignition events are likely to occur, we have estimated fire season ignition probabilities using maximum entropy models (MaxEnt) pioneered in the modeling of ecological ranges of species. These models are trained on ignition (or outage) locations and gridded spatial (raster) environmental and asset attribute data. The data can draw from a specific time period, but the model itself is dedicated to spatial, not temporal, patterns. The MaxEnt Model provides relative scores or, if properly calibrated, probabilities for fire-season ignitions per "pixel" of input data.

In order to more accurately assess and define risks, in 2020 PG&E:

1. Replaced the regression equipment ignition likelihood from prior models with the Equipment Probability of Ignition Model

2. Replaced the regression vegetation ignition likelihood from prior models with the Vegetation Probability of Ignition Model

By incorporating these new models into the 2021 Wildfire Distribution Risk Model, PG&E was able to:

- Incorporate additional variables in the models, increasing accuracy (tree types, wind scores, ground cover);
- Model ignitions directly by utilizing the MaxEnt Model as compared to modeling proxies in prior models; and,
- Reduce overfit by developing training and testing datasets for model development.

A wide range of input data sets were used in developing both the Vegetation Probability of Ignition and the Equipment Probability of Ignition Models. Table PG&E-4.3-2 summarizes the data developed to date for use in these models. A more detailed description of the Vegetation Probability of Ignition and the Equipment Probability of Ignition Models is provided after Table PG&E-4.3-2.

---

24 PG&E defines voltages below 60 kV as distribution and voltages 60 kV and above as transmission.

TABLE PG&E-4.3-2: DATA USED TO DEVELOP PROBABILITY OF IGNITION MODELS

Data Set	Category	Source	Spatial resolution	Units	Descriptions
100-hour fuels	Meteorological data	gridMET	~4km	%	Unless otherwise noted, all GRIDMET data aggregated from 2014 to 2016. The dead fuel moisture data were obtained from GRIDMET, and the "100-hour-fuels" feature was included in the model. The exact GRIDMET variable use is known as fm-100, and is a standard fire modeling metric of fuel dryness for fuels about 1-3" in diameter - intermediate sized fuels.
1000-hour fuels	Meteorological data	gridMET	~4km	%	fm-1000, as defined above, but for 3-8" in diameter.
burn index	Meteorological data	gridMET	~4km		the US, the National Fire Danger Rating System (USNFDRS) Burning Index (BI)
energy release	Meteorological data	gridMET	~4km		USNFDRS Energy Release Component (ERC)
precipitation average	Meteorological data	gridMET	~4km	Mm	Daily precipitation average
specific humidity	Meteorological data	gridMET	~4km	kg/kg	Specific humidity
vapor pressure deficit avg	Meteorological data	gridMET	~4km	kPa	Measure how much water is in the air compared to how much it could hold at the given temperature. VPD drives evapotranspiration and is the mechanism for fuels drying out during fire season.
temperature max average	Meteorological data	gridMET	~4km	K	Average of daily maximum temperature in Kelvin (recall that it is sensed via satellite)
wind avg	Meteorological data	RTMA	~2.5km	m/s	Hourly average wind speed at 10m, averaged from 2016 to 2018
wind max	Meteorological data	RTMA	~2.5km	m/s	Annual 99th percentile hourly wind speed at 10m assessed over 2016 to 2018
windy summer day pct	Meteorological data	RTMA	~2.5km		The percentage of days with sustained hourly wind speeds over 15 mph
gusty summer day pct	Meteorological data	RTMA	~2.5km		The percentage of days with sustained hourly wind speeds over 20 mph

TABLE PG&E-4.3-2: DATA USED TO DEVELOP PROBABILITY OF IGNITION MODELS (CONTINUED)

Data Set	Category	Source	Spatial resolution	Units	Descriptions
tree height max	Tree data	Salo Sciences	100m		Tree height data were obtained from a third-party vendor, Salo, and the “tree-height-max” feature was developed by calculating the maximum tree height, in meters, for each 100m x 100m pixel area along the distribution grid, according to the processed satellite data provided by Salo. The satellite imagery was collected in November 2019.
tree height average	Tree data	Salo Sciences	100m		Same as above but taking the pixel average height.
impervious	Surface condition	NLCD	100m	%	NLCD imperviousness products represent urban impervious surfaces as a percentage of developed surface over every 30-meter pixel in the United States, scaled to 100m.
unburnable	Surface condition	LANDFIRE 2016 Surface Fuels Model	100m	%	The “un-burnable” feature is a land surface descriptor similar to imperviousness that includes surfaces that typically don’t ignite when a spark occurs. The feature was derived from several land use types within the 2016 LANDFIRE surface fuel model (USGS, 2016) and is the percentage of the 100m x 100m pixel identified as un-burnable. The land use types considered “un-burnable” in the composite spatial layer include: urban, snow/ice, agriculture, water, and barren.
local topography	Surface condition	NED National Elevation Database	100m		The relative topography of the area was also used as a feature in the model. The topographic position index (TPI) was extracted from a USGS national elevation dataset (NED) at 100-meter resolution. The TPI compares the cell elevation to the mean elevation for the local neighboring area (positive values are above the mean and negative values are below the mean) (The Nature Conservancy).

TABLE PG&E-4.3-2: DATA USED TO DEVELOP PROBABILITY OF IGNITION MODELS

Data Set	Category	Source	Spatial resolution	Units	Descriptions
hftd	HFTD	CPUC	100m		Categorical variable that is 1 for non-HFTD locations, 2 for Tier 2 and 3 for Tier 3.
Age	Asset data	EDGIS Conductors	100m		The estimated conductor age (the “estimated-age”) was calculated as the number of years since the installation year, as listed in ED-GIS. If the installation date was missing or invalid, then the estimated age in the STAR model dataset was used
Materials	Asset data	EDGIS Conductors	100m		The type of conductor material was split into one-hot encoded dummy variables, which identified conductor materials aluminum (Al), copper (Cu), and ACSR (“conductor-material-al,” “conductor-material-cu,” and “conductor-material-acsr,” respectively) as binary model features.
Size	Asset data	EDGIS Conductors	100m		The conductor size dataset was split into one-hot encoded dummy variables, which identified conductor size 2, 4, and 6 (“conductor-size-2,” “conductor-size-4,” and “conductor-size-6,” respectively) as binary model features. Lower numbers correspond with larger diameters.
Splice count	Asset data	EDGIS Conductors	100m		Splices were identified from the splices database table (Emili Scaief, 2020). In order to prevent splice locations from introducing bias to the model, only the Reliability Program splice records were used, which only included spans with more than three per phase.

TABLE PG&E-4.3-2: DATA USED TO DEVELOP PROBABILITY OF IGNITION MODELS (CONTINUED)

Data Set	Category	Source	Spatial resolution	Units	Descriptions
Coastal indicator	Asset data	EDGIS Conductors	100m		Coastal areas were identified using a binary feature in the model. Coastal areas within PG&E service territory were mapped internally in PG&E and conductors are tagged with a coastal indicator field in ED-GIS.

(b) Equipment Probability of Ignition Model

Ignition likelihood for equipment in 2021 was determined based on a probability analysis predicting ignitions in 100m x 100m pixels. The Equipment Probability of Ignition Model was trained on conductor failure related ignitions limited to fire season events and CPUC reportable ignitions from 2015 to 2018 and tested using the 2019 ignitions. The modeling technique used was a maximum entropy model. MaxEnt Model provides a way of estimating the relative occurrence rate given a fairly modest number of ignition locations the principle of maximum entropy states that the probability distribution which best represents the current state of knowledge is the one with the largest entropy, in the context of precisely stated prior data.

A range of variables were included in the initial modeling. These included meteorology data, PG&E asset data, and remote sensing data from government and private third parties. The most important variables for the Equipment Probability of Ignition Model are identified below in Table PG&E-4.3-3.

TABLE PG&E-4.3-3: VARIABLES IN EQUIPMENT PROBABILITY OF IGNITION MODEL

Variable	Permutation Importance
Non-burnable area	30.8
Daily precipitation, mean	29.8
Conductor material: ACSR	9.7
Estimated conductor age	8.9
Max tree height	4.3
Reliability Program splice	4.3
Vapor pressure deficit, mean	4.0
Conductor size: 2	3.4
Conductor size: 4	1.6
100-hour fuels, mean	1.1
Max temperature, mean	1.0
Wind speed, mean	0.9
Local topography	0.2
Conductor size: 6	0.1
Conductor material: Al	~0
Conductor material: Cu	~0

Using these variables, a probability of ignition was assigned for each 100m x 100m grid. These probabilities were indexed and calibrated to the total expected ignition frequency.

Given the amount of work required to develop new models, PG&E was only able to include in the Equipment Probability of Ignition Model used in the 2021 Wildfire Distribution Risk Model information regarding conductor failures. Updates to this model are planned on an annual basis. In 2021, we currently intend to include maintenance tag data and asset data in the Equipment Probability of Ignition Model and additional equipment failure models for poles and transformers. These additional equipment models will combine with an update to the conductor failure model to improve the predictive power of equipment caused ignition probabilities will be enhanced to better inform mitigation programs.

(c) Vegetation Probability of Ignition Model

Ignition likelihood for vegetation in 2021 was determined based on a probability analysis predicting ignitions in 100m x 100m pixels. The Vegetation Probability of Ignition Model was trained on vegetation ignitions limited to fires season evens and CPUC reportable ignitions from 2015 to 2018 and tested using the 2019 ignitions. This data set includes all vegetation related outages that resulted in an ignition. The modeling technique used was a maximum entropy model. The MaxEnt Model provides a way of estimating the relative occurrence rate given a fairly modest number of ignition locations. The principle of maximum entropy states that the probability distribution which best represents the current state of knowledge is the one with the largest entropy, in the context of precisely stated prior data.

Variables in the initial model included meteorology data, PG&E asset data, and remote sensing data from government and private third parties. The most important variables for the Vegetation Probability of Ignition Model are included below in Table PG&E-4.3-4.

TABLE PG&E-4.3-4: VARIABLES IN VEGETATION PROBABILITY OF IGNITION MODEL

Variable	Permutation Importance
tree-height-max	26.1
100-hour-fuels-avg	24.1
vapor-pressure-deficit-avg	21.6
gusty-summer-day-pct	6
Hftd	4.2
precipitation-avg	3.1
Impervious	2.8
specific-humidity-avg	2.4
burn-index-avg	2.3
wind-max	1.9
temperature-avg	1.6
windy-summer-day-pct	1
local-topography	0.8
tree-height-avg	0.8
1000-hour-fuels-avg	0.6
energy-release-avg	0.4

Using these variables, a probability of ignition was assigned for each 100m x 100m grid. These probabilities were indexed and calibrated to the total expected ignition frequency.

Updates to this model are planned on an annual basis. In 2021, PG&E currently intends to incorporate LiDAR informed tree species data so that the predictive power of vegetation caused ignition probabilities will be enhanced to better inform mitigation programs.

4.4 Research Proposals and Findings

Report all utility-sponsored research proposals, findings from ongoing studies and findings from studies completed in 2020 relevant to wildfire and PSPS mitigation.

4.4.1 Research Proposals

Report proposals for future utility-sponsored studies relevant to wildfire and PSPS mitigation. Organize proposals under the following structure:

1. ***Purpose of research** – Brief summary of context and goals of research;*
2. ***Relevant terms** – Definitions of relevant terms (e.g., defining "enhanced vegetation management" for research on* EVM*); and*
3. ***Data elements** – Details of data elements used for analysis, including scope and granularity of data in time and location (i.e., date range, reporting frequency and spatial granularity for each data element, see example table below).*

Example table reporting data elements

Data Element	***Collection Period***	***Collection Frequency***	***Spatial Granularity***	***Temporal Granularity***	***Comments***
Ignitions from contact with vegetation in non-enhanced vegetation areas	*2014 –2020+ (ongoing)*	*Per ignition*	*Lat/lon per ignition*	*Date, hour of ignition (estimated)*	–
Ignitions from contact with vegetation in enhanced vegetation areas	*2019 –2020+ (ongoing)*	*Per ignition*	*Lat/lon per ignition*	*Date, hour of ignition (estimated)*	–

4. ***Methodology*** *- Methodology for analysis, including list of analyses to perform; section shall include statistical models, equations, etc. behind analyses*

5. ***Timeline*** *- Project timeline and reporting frequency to WSD*

San Jose State University – Climatological Analysis

1. *Purpose of Research*

The purpose of the research is to better understand wildland fire behavior by studying fire-atmospheric interactions through partnership with the SJSU Fire Weather Research Lab. SJSU has established the largest academic Wildfire Interdisciplinary Research Center in the United States with five new tenure-track faculty members. SJSU will help PG&E analyze their 30-year 2 km x 2 km WRF model climatology to better understand the fire weather conditions associated with extreme wildfire and PSPSs. The analyses will be conducted by two tenure-track faculty, one post-doctoral scholar, and two graduate students.

2. *Relevant Terms*

WRF – Weather Research and Forecasting Model

3. *Data Elements*

TABLE PG&E-4.4-1: DATA ELEMENTS (SAN JOSE STATE UNIVERSITY – CLIMATOLOGICAL ANALYSIS)

Data Element	***Collection period***	***Collection frequency***	***Spatial granularity***	***Temporal granularity***	***Comments***
PG&E 30 year downscaled climatology	1990-2020 (modeled)	Modeled hourly weather data	2km x 2km grid	Hourly Data through the climatology	
PG&E Fire Occurrence Dataset	2003-2019	N/A	N/A	N/A	Dataset of fire ignitions in PG&E territory gathered from multiple sources

4. Methodology

a) Conduct analyses using PG&E's new 30-year climatology of 2 kilometer, hourly, WRF model output
   - This data shall allow for robust analyses on critical fire weather conditions using a combination of high spatiotemporal resolution and long duration data to investigate the following combined with fire occurrence datasets:
     - Climatology and decadal trends in fire weather and Diablo Wind events, or other Foehn wind events (type, intensity, duration, etc.).
     - A Diablo Wind metric shall be created and used to understand the climatology of events.
     - This metric shall be used to rank all Diablo Wind Events across the 30-year history based on strength, geographic extent, and duration.
     - Using PG&E's proprietary and public fire occurrence datasets to evaluate numerous fire weather indices to help determine which index is best correlated to daily fire growth.

b) Generation of grid point distributions, percentile data maps from the climatology data.
   - Map visualizations to be generated: 90th, 95th, 99th and Maximum (minimum) maps of:
     - Wind Speed
     - Wind Gust
     - Temperature
     - Relative humidity (minimum)
     - Dewpoint depression (minimum)
     - Precipitation
     - Diablo Fire Weather Index
   - Grid point specific distributions shall be used by PG&E to put the forecast in perspective with the historical data

c) Covariation of fire weather mesoscale circulation patterns with the synoptic patterns and known modes of climate variability

d) High-resolution trends in existing fire-weather indices and local fire season duration to help determine annual average start and end time of fire season.

e) SJSU will interact regularly with the PG&E Meteorological staff and will provide regular online meetings on research progress.

f) SJSU shall conduct the proposed analyses and publish the results in peer-reviewed journals.

5. Timeline

As the project is still in its initial planning stages, no timeline has been set at this time.

Wildfire Mitigation Open Innovation Challenge

1. ***Purpose of Research***

   PG&E has initiated an "Open Innovation Challenge" to identify novel technologies that could potentially reduce PG&E-caused wildfire risk. The search for innovations is global in reach and goes beyond the electric utility industry technology sector. PG&E hopes to identify one or more promising innovative technologies for use in a pilot project.

2. ***Relevant Terms***

   No terms used herein require additional definition.

3. ***Data Elements***

   No specific data elements for analysis are available at this time. See Methodology.

4. ***Methodology***

   The open innovation challenge process started with a definition of problem statements, instead of pre-supposing potential solutions. These problem statements were created following a series of interviews conducted with internal and external subject matter experts on areas where innovations could potentially provide the greatest ignition risk reduction. The set of problem statements described the problem areas that PG&E would like solved or improved upon, without specifying any technology or techniques to solve the problems. As a result of this process, PG&E narrowed its focus for this challenge to the following four areas:

   - Advancement of the state-of-the-art for "monitor & mitigate" technologies for real-time detection of faults and prevention of arcing, sparking, and other ignition events along transmission and distribution infrastructure
   - Alternatives to current undergrounding methods, including level-grounding
   - Reducing labor required for vegetation management
   - Innovative heat-resistant materials

   Using these problem statements, PG&E solicited innovators, entrepreneurs and startups to request that they apply if they have solutions for the defined problems. The solicitation was made through two methods: one being a research community network-driven effort and the other being an automated computer programmed Internet search method. For the research community network-driven method, PG&E reached out through known innovation networks, academic research partners, and other technology knowledge experts. For the second method, an automated computer programmed Internet search parsed technical journals, professional sites, startups sites, patent databases, and other publications across industries and disciplines to identify authors, institutes, and companies with relevant ideas or expertise. After compiling the potentially relevant resources, PG&E will create a ranked list of the top innovators in each challenge area for further solicitation including for referrals and submission of an application to this challenge. The resulting proposals will then be vetted, and winners selected with the desired result being technology pilots that lead to deployment.

5. ***Timeline***

In December 2020, PG&E announced this open innovation challenge, published the problem statements described in the Methodology section above, and set a submission deadline in January 2021. The solicitation and innovator communication phase are ongoing and scheduled to complete in February 2021. The ranking and final selection phase for each of the challenge areas is scheduled to conclude in March 2021. The final report will be completed by September 2021. Results are to be reported in the next annual update.

Cal Poly Wildland Urban Interface Fire Information Research and Education Institute

1. ***Purpose of Research***

The purpose of the newly formed Cal Poly Wildland Urban Interface Fire Information Research and Education Institute (FIRE Institute) is to make significant contributions to solving the WUI fire problem through integrated and applied research and education that innovates, informs policy, disseminates information, and educates students and professionals.

In 2021, PG&E is partnering with, and advising on the direction of research and associated activities by, the FIRE Institute as it embarks on the development of solutions for sustainable fire resilient communities and safer and more effective fire-preparedness and response operations through applied research and incorporation of technology.

2. ***Relevant Terms***

No terms used herein require additional definition.

3. ***Data Elements***

There are no specific data elements related to this effort at this time because PG&E's advisory role for the Institute's new research is in the beginning phase.

4. ***Methodology***

None currently as this research partnership is in its beginning phase.

5. ***Timeline***

Planned activities in 2021 include a symposium to engage stakeholders (private sector, utilities, government, regulatory bodies, academia), define research priorities, and identify policy recommendations. Specific PG&E-specific research workstreams are anticipated though not defined at this time.

We will report, in the next annual update, on our advisory role to the Institute, PG&E-relevant research direction and initiatives, as well as PG&E WMP-relevant results from this research collaboration.

Targeted Tree Species Study

1. ***Purpose of Research***

   The purpose of PG&E's Targeted Tree Species Study is to identify species that are more likely to fail near PG&E facilities, thereby creating potential wildfire ignitions. PG&E will use the information obtained through the study to evaluate the performance of the species risk rating component of its Tree Assessment Tool (TAT). The study will involve an analysis of tree mortality rates related to precipitation. PG&E will also use the information obtained through the study to evaluate its scheduling for patrol cycles as part of its vegetation management responsibilities.

2. ***Relevant Terms***

   Species Risk – What a particular tree species (in isolation of everything else) tells you about the likelihood of the tree failing or the likelihood of its failure relative to its frequency in the population.

   Tree Assessment Tool or TAT – Tool that evaluates an individual tree's likelihood of failing and supplies instruction of whether to abate or not abate the tree.

   Patrol Cycle – The span of time between inspections.

3. *Data Elements*

TABLE PG&E-4.4-2: DATA ELEMENTS (TARGETED TREE SPECIES STUDY)

Data Element	***Collection Period***	***Collection Frequency***	***Spatial Granularity***	***Temporal Granularity***	***Comments***
Ignitions from contact with vegetation	2008-2020+ (ongoing)	Per ignition	Circuit and/or Regional level	Date	–
Outages from contact with vegetation	2008-2020+ (ongoing)	Per outage	Circuit and/or Regional level	Date	
Trees assessed by TAT	March 2020+ (ongoing)	Per tree basis	Lat/Long per tree	Date	–
TBD					Per vendor input- vendor will extract and provide additional data

4. *Methodology*

- Vendor will identify the appropriate external data sources to study in conjunction with internal data provided by PG&E to develop and execute a targeted tree species study to quantify failure risk by species and region.
- Vendor will study tree mortality rates in conjunction with precipitation levels in order to evaluate patrol cycles within our service territory.
- Vendor will develop a working knowledge of the TAT and the species risk rating component currently in use.
- Vendor will evaluate the species risk component of the TAT currently in use for effectiveness, using available external data sources and data provided by PG&E.
- Vendor will evaluate the weighting of the risk component of the TAT using data provided by PG&E.
- Vendor will help set up a system for continuous monitoring of TAT for ongoing evaluation.

5. *Timeline*

The research is planned to be complete in Quarter 2 2022. PG&E plans to report on the status of this research in the next annual update.

4.4.2 Research Findings

Report findings from ongoing and completed studies relevant to wildfire and PSPS mitigation. Organize findings reports under the following structure:

1. ***Purpose of research** – Brief summary of context and goals of research;*

2. ***Relevant terms –*** *Definitions of relevant terms (e.g., defining "enhanced vegetation management" for research on EVM);*

3. ***Data elements –*** *Details of data elements used for analysis, including scope and granularity of data in time and location (i.e., date range, reporting frequency and spatial granularity for each data element, see example table above);*

4. ***Methodology*** *– Methodology for analysis, including list of analyses to perform; section shall include statistical models, equations, etc. behind analyses;*

5. ***Timeline –*** *Project timeline and reporting frequency to WSD. Include any changes to timeline since last update;*

6. ***Results and discussion*** *– Findings and discussion based on findings, highlighting new results and changes to conclusions since last update; and*

7. ***Follow-up planned*** *– Follow up research or action planned as a result of the research.*

PG&E engineers and technical staff perform analysis and review of concepts, tools, and technologies as a normal and consistent part of business operations; however, those analyses and reviews are not often characterized as "Research Studies" in the same formal approach as the kind of academic research that this section is set up to discuss. PG&E conducts research through the EPIC program and findings for EPIC projects are published as part of the closeout documentation. The relationship of the EPIC research program with this WMP is described in Section 7.1.D.2. There are a number of wildfire mitigation-related EPIC projects included as part of this WMP; they are listed in Section 7.1.D. In addition, PG&E documents "lessons learned" on projects, including numerous non-EPIC projects included in this WMP, in various sections, including, but not limited to, Section 7.1.D. The following are specific academic research findings for completed studies relevant to wildfire and PSPS mitigation:

Independent, External Review of the Proposed 2020-21 HFRA Map for PSPS Scoping by the B. John Garrick Institute for Risk Sciences at UCLA (GIRS-RT)

1. ***Purpose of Research***

   The GIRS-RT provided an independent, external review of the proposed 2020-21 PG&E HFRA Map for PSPS. The HFRA map builds on the the CPUC's HFTD Map developed in 2018. The HFRA map makes incremental changes to the HFTD map by adding regions where the risk of utility triggered catastrophic wildfire from an offshore wind event is high and removing regions where it is not.

   PG&E used this methodology review and polygon by polygon feedback to further inform the HFRA map development polygons.

2. *Relevant Terms*

High Fire Risk Area or HFRA - Mapping terminology that aligns with other California utilities use of maps supplemental to the HFTD Map. While the HFTD is a foundational tool to identify areas of elevated or extreme wildfire risk for utilities, it was not developed at the electric asset level and is not operationally informed for PSPS program scoping and execution. HFRA refinements may also serve to inform future adjustments or recommendations to improve the HFTD map.

Aspect - The direction the slope faces (north, east, south, west). The aspect determines the effect of solar heating, air temperature, and moisture. In the Northern Hemisphere, south facing slopes receive more solar heating which results in lower humidity, rapid moisture loss, and lighter fuels such as grasses. Seasonal directions of solar heating should be taken into consideration when analyzing a slope's aspect.

Slope - A ratio of rise over run. Another way to think of it is height over distance expressed as a percentage. Slopes can range from slight to steep but the influence on wildland fire is substantial. The steeper the slope the faster a fire moves uphill. Flames are closer to the fuel source, radiation heat increases the dehydration and preheats the vegetation, resulting in ignition sooner than on a slight slope or level ground.

Land Use – Evaluation of modification and maintenance activities to the natural wildland landscape. Land Use can change probability of fire ignition and fire behavior.

Fuel Loading – Fuel loading is reported in tons of fuel available per acre. The higher the fuel loading, the more heat that will be produced during a fire.

Fuel Position – Fuel position is based on relation to the ground. It can be defined by three types of fuels: subsurface fuels, surface fuels, and aerial fuels.

Fuel Continuity – The horizontal and vertical spacing of fuels. These are often referred to as continuous fuels or patchy fuels. The rate and direction of the fire is predictable with continuous fuels. Patchy fuels are difficult to calculate because the radiant heat may not be able to ignite the source.

3. *Data Elements*

TABLE PG&E-4.4-3: DATA ELEMENTS (INDEPENDENT, EXTERNAL REVIEW OF THE PROPOSED 2021-21 HFRA MAP FOR PSPS SCOPING BY THE B. JOHN GARRICK INSTITUTE FOR RISK SCIENCES AT UCLA (GIRS-RT)

Data Element	*Collection Period*	*Collection Frequency*	*Spatial Granularity*	*Temporal Granularity*	*Comments*
Aerial imagery	Varied	Varied	Varied	Varied	Utilization of readily available and current satellite imagery from Google Earth and ESRI to inform land use, fuels, and terrain at variable scale to inform wildfire ignition risks and potential fire behavior.
Topographic map layers	Varied	Varied	Varied	N/A	Utilized to evaluate the slope off the terrain in and adjacent to areas of the HFRA to inform potential for fire spread.
Fire perimeter history	Annual Ongoing MTBS and GeoMAC	Ongoing	Varied	Varied	Utilization of fire perimeter data to evaluate fire frequency/regimes, fire spread patterns and effectiveness of historical suppression efforts.
Fire spread modeling	N/A	Varied	N/A	Varied	The use of computational fire spread modeling to inform or support recommendations based on qualitative local knowledge and other analysis.
Qualitative historical local knowledge	N/A	N/A	N/A	N/A	Experience-based inputs and recommendations from PG&E Public Safety Specialists with fire response and experience in specific regions of PG&E service territory.
Field visits	N/A	N/A	N/A	N/A	As needed field verification for supplemental evaluation of actual current conditions.
Meteorology outputs	1989-2020 * modeled	N/A	2km x 2km grid	Hourly	Utilization of 30-year climatological re-analysis to inform anticipated exposures to electric assets and surrounding wildland fuels and terrain.

Data Element	Collection Period	Collection Frequency	Spatial Granularity	Temporal Granularity	Comments
Historical outage datasets	2009-2017	On-going	N/A	N/A	Datasets of outages that occurred during offshore wind events were used to inform polygon creation and by highlighting areas that typically experience outages during offshore wind events.

4. *Methodology*

After internal draft development of the HFRA Map, PG&E commissioned the GIRS-RT to review PG&E's HFRA Map development methodology and the polygons associated with the draft map. During this review, the GIRS-RT evaluated the criteria used to add or remove the areas to or from the HFTD Map. To supplement these criteria, the GIRS-RT accessed additional data sets to enable complementary, objective assessments for land use, fuel load and slope. The GIRS-RT also utilized fire history and perimeter data to check alignment of candidate regions with recent fires.

5. *Timeline*

This was a one-time review in 2020 of the proposed 2020-21 PG&E HFRA Map for scoping PSPS events and associated mitigation programs. PG&E may utilize the GIRS-RT for additional HFRA Map reviews going forward.

6. *Results and Discussion*

The GIRS-RT reviewed the polygons to the build the HFRA Map off of the existing HFTD map as well as the rationale used to make the case for each areas' addition or removal. The GIRS-ST agreed with PG&E's methodology and concurred with the majority of the polygons slated for the map. The GIRS-RT also recommended that some areas be expanded or shrunk based on their analysis. PG&E used this external analysis as a secondary check to confirm that the addition or removal rationale is correct and that the areas either pose or do not pose catastrophic wildfire risk.

7. *Follow-up Planned*

PG&E may further contract the GIRS-RT to review any additional areas slated for addition or removal to the HFRA Map that have not already been reviewed.

Continual Improvement within Enhanced Vegetation Management Program

1. *Purpose of Research*

The EVM program engaged with researchers at University of California Cooperative Extension and the University of California Berkeley to help evaluate the EVM procedural requirements for work execution that would help reduce wildfire risks. This research is part of continuous improvement efforts focused on long term analysis and strategy around the EVM program. PG&E worked with the engaged researchers to evaluate the methodology of targeting high risk tree species and trees exhibiting flawed branches for overhang zone clearing during EVM inspections. In addition, the parties evaluated potentially adjusting PG&E's minimum radial clearance requirements for trees whose trunks are within the defined minimum clearance zone.

2. Relevant Terms

EVM: Enhanced Vegetation Management; the PG&E program and effort to reduce vegetation-related risks to electric distribution facilities

3. Data Elements

TABLE PG&E-4.4-4: DATA ELEMENTS (CONTINUAL IMPROVEMENT WITHIN ENHANCED VEGETATION MANAGEMENT PROGRAMS)

Data Element	***Collection Period***	***Collection Frequency***	***Spatial Granularity***	***Temporal Granularity***	***Comments***
Outages from contact with vegetation	2008-2019	Per Outage	Regional	* From June-October/ Species-Redwood ** Species Redwood, Douglas Fir	This Data element was used for creating analysis reports regarding: – Fire risk ranking per region for targeting overhanging high risk species * Tree failure data for Redwoods ** Branch statistics for Redwoods and Douglas Fir to evaluate ignition ratings
Ignitions from contact with vegetation	All records up to 4/2019	Per Ignition	Regional	* From June-October/ Species-Redwood ** Species Redwood, Douglas Fir *** Month, Species-Redwoods	This Data element was used for creating analysis reports regarding: – Fire risk ranking per region for targeting overhanging high risk species * Tree failure data for Redwoods ** Branch statistics for Redwoods and Douglas Fir to evaluate ignition ratings *** Redwood ignitions based on acres burned
Species Composition	11/15/2016-11/15/2017	Per Tree	Regional/ and division	By project year	This Data element was used for creating analysis reports regarding:

Data Element	Collection Period	Collection Frequency	Spatial Granularity	Temporal Granularity	Comments
					– Fire risk ranking per region for targeting overhanging high risk species – Tree failure data for Redwoods – Branch statistics for Redwoods and Douglas Fir – Redwood ignitions based on acres burned to evaluate ignition ratings
Acres Burned	2008-2019	Per Ignition	N/A	Month	This Data element was used for creating analysis reports regarding: Redwood ignitions based on acres burned

4. *Methodology*

The above data elements were used to create the analysis reports used in this review. PG&E had the researchers review the analysis reports to evaluate our methodology for calculating the fire risk ranking for different types of trees per region, as set forth below.

PG&E bases the overall species fire risk ranking per region for targeting overhanging high-risk tree species on the following data:

- Overall species risk formula adds outage score to 1.5 times the ignition score. This is to account for the inherently greater wildfire risk associated with ignitions compared to outages alone.
  1.5 factor was evaluated and determined as part of this effort by both internal and external Subject Matter Experts.
- The Species list is limited to species that are related to >1 percent of a region's outages. This limit enables a focus on those species that are present and have had impacts in meaningful numbers in the region.

The parties also evaluated whether Redwoods and Douglas Fir should be excluded from target species lists based on the following data:

- Tree failure statistics from June to October
- Branch statistics to indicate low ignition ratings for both
- Ignitions based on acres burned and month of year

5. *Timeline*

This review was conducted in September and October 2020.

6. *Results and Discussion*

The research found that PG&E's fire risk ranking per species uses a sound methodology. The engaged researchers agreed that we should focus on tree species that have been observed to have a high(er) branch failure rate as part of our continuous improvement efforts. Redwoods and Douglas Firs were determined to not qualify as high risk tree species in any region based on this review. Lastly, the researchers also agreed that it may be appropriate to leave more healthy low risk tree species by adjusting PG&E's minimum radial clearance requirements for trees whose trunks are within the defined minimum clearance zone.

7. *Follow-up planned*

Results of this research may not result in any changes in 2021 but are part of long-term analysis for performing EVM in the most effective way possible.

Lab Testing to understand ignition behaviors associated with Electric and Magnetic field induction

1. *Purpose of Research*

To understand potential ignition risks associated with de-energized power lines with induced voltages and currents, a thorough literature search was performed both internally and with the help of a third party, the Electric Power Research Institute (EPRI), and no technical publications was found related to this scenario. To further explore this potential risk, lab testing was conducted to determine the fire ignition potential of induced voltages and currents at relatively low energy level associated with de-energized power lines in close proximity to other energized lines. Various scenarios were created in internal PG&E and external Powertech vendor labs in Canada to mimic the induction level currents and voltages and potential ignitions of a down conductor, with recognition of the varying factors in field conditions (i.e., ground resistivity).

2. *Relevant Terms*

GPR – Ground Potential Rise

3. *Data Elements*

TABLE PG&E-4.4-5: DATA ELEMENTS (LAB TESTING TO UNDERSTAND IGNITION BEHAVIORS ASSOCIATED WITH ELECTRIC AND MAGNETIC FIELD INDUCTION)

Data Element	*Collection period*	*Collection frequency*	*Spatial granularity*	*Temporal granularity*	*Comments*
Lab Testing to understand Induction driven Ignition	2020	N/A	N/A	August-Sept 2020	Lab data collected via testing

4. Methodology

Two types of current injection methodologies were used to perform the testing:

- Current injection via a ground rod.
- Current injection via a conductor resting on the surface of the ground.

Two types of fuel beds were used to represent flammable vegetation. The first type is a CAL FIRE-specified fuel bed per Section 9.1 of the Power Line Fire Prevention Field Guide used to qualify electrical equipment devices for exemption from Public Resource Code Section 4292. This fuel bed is an erosion control blanket, Excel S-22, manufactured by Western Excelsior Corporation, consisting of 12 mm (1/2 inch) thick layer of agriculture straw material. Four layers of the blanket were laid over the 44” x 44” area of compacted topsoil. The required moisture of the fuel bed is <5 percent, and this was achieved by using an environmental chamber to dry the blanket for at least 48 hours prior to testing. The temperature of the environmental chamber was kept at approximately 100 ^{O}F.

The second type of fuel bed consisted of sod purchased at the local hardware store and naturally dried outdoor for five days.

PG&E Internal Lab Test Circuit: For internal testing, energizing the ground rod/conductor using a high potential test unit with a max current output of 70mA, a current was injected through the fuel bed and soil to the ground plane, which created a ground potential rise (GPR) and voltage gradient around the electrode.

Powertech’s High Power Lab Test Circuit: For external testing, a high power lab set was used, which was connected to the BC Hydro’s largest substation via a 230 kV transmission line. A step-down transformer can provide voltages up to 44 kV. The lab capacitor bank had a selection of capacitors to adjust the current within the desired range of 0.1 – 5 A to match as closely as possible the large source impedance of the real system in an induced voltage scenario.

5. Timeline

The testing was conducted in August and September 2020.

6. Results and Discussion

Empirical data collected through a total of 150 tests provided us with better insight into ignition behaviors at low power levels, with different voltage and current combinations. However, the testing did not provide clear thresholds of ignition. The research found that the cases where the conductor was on the ground (representing a fallen conductor due to high wind or tree impact), the conditions of the ground and contact material were the most influential factors for ignition. We also witnessed reduced probability of ignition at lower voltage and current combinations, as well as increased ground impedance. Additionally, it was observed that current was less likely to be established and sustained in dry hay with lower voltages due to high impedance.

7. ***Follow-up Planned***

Based on the findings from the testing, it was determined that grounding and sectionalizing the de-energized lines, where feasible, to reduce induced voltages and currents may be the best way to minimize ignition risk. PG&E is working on determining the feasibility and PSPS procedural impact of this requirement and establishing revised guidance.

4.5 Model and Metric Calculation Methodologies

4.5.1 Additional Models for Ignition Probability, Wildfire and PSPS Risk

Report details on methodology used to calculate or model ignition probability, potential impact of ignitions and/or PSPS, including list of all input used in impact simulation; data selection *and treatment methodologies; assumptions, including Subject Matter Expert (SME) input; equation(s), functions, or other algorithms used to obtain output; output type(s), e.g., wind speed model; and comments.*

For each model, organize details under the following headings:

1. ***Purpose of model*** *– Brief summary of context and goals of model;*

2. ***Relevant terms –*** *Definitions of relevant terms (e.g., defining "enhanced vegetation management" for a model on vegetation-related ignitions);*

3. ***Data elements –*** *Details of data elements used for analysis, including scope and granularity of data in time and location (i.e., date range, reporting frequency and spatial granularity for each data element, see example table above);*

4. ***Methodology –*** *Methodology and assumptions for analysis, including Subject Matter Expert (SME) input; equation(s), functions, statistical models, or other algorithms used to obtain output;*

5. ***Timeline*** *– Model initiation and development progress over time. If updated in last WMP, provide update to changes since prior report; and*

6. ***Application and results*** *– Explain where the model has been applied, how it has informed decisions, and any metrics or information on model accuracy and effectiveness collected in the prior year.*

This section of the 2021 WMP addresses the information requested in the Guidelines, as well as the information requested in certain Action Items identified in WSD's evaluation of PG&E's Remedial Compliance Plan related to Class A Conditions and PG&E's First Quarterly Report related to Class B Conditions. The remainder of this section is organized as follows:

- Subsection (a): Introduction and summary table;
- Subsection (b): Overview of the 2021 Wildfire Distribution Risk Model and discussion of future models;
- Subsection (c): Developing a risk framework;
- Subsection (d): Modeling methodology for the 2021 Wildfire Distribution Risk Model;
- Subsection (e): Additional models developed and used for wildfire risk;
- Subsection (f): The Transmission Operability Assessment Model;
- Subsection (g): Validation of models and frequency of updates;
- Subsection (h): Models used for PSPS events; and,
- Subsection (i): Response to the following Action Items:
  - Class A: Action PGE-1, PGE-2, PGE-7, PGE-17, PGE-18, PGE-19, and PGE-20
  - Class B: Action PGE-31, PGE-37, PGE-38, PGE-39, PGE-40, PGE-41, PGE-42, PGE-52, PGE-53, and PGE-80.

(a) Introduction and Summary Table

PG&E's wildfire risk models produce a quantified risk value that is the product of two terms—the ignition probability and the wildfire consequence at each location. Consistent with this approach, this section discusses the probability and consequence portions of PG&E's wildfire risk models separately, as well as the resulting risk value. Table PG&E-4.5-1 below provides an overview of the wildfire risk models developed by PG&E, organized using the six headers requested by WSD, followed by a detailed narrative of the models and their uses and development.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
1	Enterprise Risk Model	To assess enterprise risks (including wildfire) using a common framework (i.e., risk bowtie and MAVF) and compare consequences using the MAVF scoring approach agreed to in the SMAP Settlement Agreement; and ultimately to develop RSEs at a portfolio/program level	Risk drivers, risk event, outcomes, consequence dimensions, MAVF	For wildfire: CPUC Reportable Ignitions, CalFire historical fire reports, Red Flag Warning days	Reference SMAP Settlement Agreement (D. 18-12-014)	RAMP Report filed every four years preceding the GRC submission by one year (i.e. 2020 RAMP and 2023 GRC – filed 2021)	For wildfire: results used to qualify pre and post mitigation risk score (for comparison to other enterprise risks).
2	2021 Wildfire Distribution Risk Model	Provide wildfire risk values for the distribution system to provide insights into the locations with high wildfire risk by risk driver to inform the development of mitigation programs	Vegetation Probability of Ignition Model (see row #3 below) Equipment Probability of Ignition Model (see row #4 below) Wildfire Consequence Model (see row #5 below)	Data elements listed below for the Vegetation POI, Equipment POI, and Wildfire Consequence Models. Definitions for circuit segments	Risk values are calculated for risk drivers (vegetation, equipment, etc.), at a 100-meter by 100-meter granularity and then aggregated up to circuit segments or circuits according to the need of the mitigation program. Risk is calculated as the product of ignition probability and wildfire consequence.	Initiated January 2020 and completed November 2020.	Used to provide insights for the System Hardening, EVM programs respectively.

PGE-DIXIE-NDCAL-000014054

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
3	Vegetation Probability of Ignition Model	Provide annual ignition probability due to vegetation failures	MaxEnt – Short for Maximum Entropy. The name given to a family of models that seek to maximize the information entropy[25] (i.e., instead of the likelihood or some other optimization criteria) of the probability distribution associated with a given set of conditions – in this case, ignition probability, given environmental and asset characteristics. It can also be interpreted as finding the least unique distribution that fits the underlying data.	Environmental, Meteorological, and Asset data	MaxEnt algorithm to provide 100-meter by 100-meter pixel values along the Tier 2 and Tier 3 distribution lines.	Initiated January 2020 and completed November 2020	Not directly used to inform workplans. Input to the 2021 Wildfire Distribution Risk Model

25 Information entropy is the average level of uncertainty inherent in an outcome derived from a set of variables or covariates.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
4	Equipment Probability of Ignition Model	Provide annual ignition probability due to conductor failures	MaxEnt – Short for Maximum Entropy. The name given to a family of models that seek to maximize the information entropy (i.e. instead of the likelihood or some other optimization criteria) of the probability distribution associated with a given set of conditions – in this case, ignition probability, given environmental and asset characteristics. It can also be interpreted as finding the least unique distribution that fits the underlying data.	Environmental, Meteorological, and Asset data as described below	MaxEnt algorithm to provide 100-meter by 100-meter pixel values along the Tier 2 and Tier 3 distribution lines.	Initiated January 2020 and completed November 2020	Not directly used to inform workplans. Input to the 2021 Wildfire Distribution Risk Model.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
5	Wildfire Consequence Model	Quantify the locational fire impacts in terms of the MAVF framework	Technosylva – Fire simulation software whose outcomes are based on available fuels, topography, and weather; and structure and population data. Technosylva simulation outputs are used as the source of spatially resolved fire severity data that is the primary input into the spatial consequence calculations. FBI – Technosylva's Fire Behavior Index. A scale of 1-5 that captures fire severity as a function of flame length (intensity of burn) and rate of spread. FBI of 3 or greater is expected to require aggressive suppression.	Input data: meteorology, satellite derived fuels (100-hour and 1000-hour) For each 8-hour simulation the following output data was used to develop the consequence data set: Number of structures, acres burned, and Fire Behavior Index (FBI) which is a combination of Flame Length and Rate of Spread (ROS)	Technosylva model output combined to develop a destructive fire probability that is then calibrated to the system level MAVF score.	Initiated January 2020 and completed November 2020	Used to prioritize the Distribution Tier 2 triennial inspections cycle (Tier 3 inspections are conducted every year), and other maintenance programs. Also input to the 2021 Wildfire Distribution Risk Model.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
6	Vegetation Risk Model	Quantify wildfire risk due to vegetation failures to prioritize vegetation wildfire mitigation programs	MAVF risk value for each 100-meter pixel Mean MAVF risk value for each circuit segment or circuit segment.	Output in 100-meter pixels that are aggregated to the circuit segment level	Risk is calculated as the product of the ignition probability and wildfire consequence for each 100-meter pixel. Circuit Segment level risk scores are the mean of the pixel risk scores in that segment.	Initiated January 2020 and completed November 2020	Used to provide insights to the prioritization for the EVM program to improve focus on highest risk segments.
7	Conductor Risk Model	Quantify wildfire risk due to conductor equipment failures to prioritize system hardening and equipment replacement wildfire mitigation programs	MAVF risk value for each 100-meter pixel Mean MAVF risk value for each circuit segment or circuit segment.	Output in 100-meter pixels that are aggregated to the circuit segment level	Risk is calculated as the product of the ignition probability and wildfire consequence for each 100-meter pixel. Circuit Segment level risk scores are the mean of the pixel risk scores in that segment.	Initiated January 2020 and completed November 2020	Used to provide insights to the prioritization for the System Hardening program to improve focus on highest risk segments.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
8	Large Fire Probability Model (Distribution) or LFP_d Model	Identify and quantify areas of the PG&E territory where there is concurrence in space and time of high potential for large fires to occur and increase outage probabilities.	The model is comprised of the Fire Potential Index and the Outage Producing wind model, which seek to quantify the probability of an outage event and the probability of large fire occurrence.	Data output every 2 x 2 km	Based on PG&E's high-resolution weather, outage and fuels models forecast and historical data.	First version in use in 2018, continued operations and enhancements through 2020.	Risk model utilized for distribution PSPS events.
9	Large Fire Probability Model (Transmission) or LFP_T Model	Identify and quantify areas of the PG&E territory where there is concurrence in space and time of high potential for large fires to occur and increase failure probabilities.	The model is comprised of the Fire Potential Index and the Transmission Operability Assessment model, which seek to quantify the probability of an outage event and the probability of large fire occurrence.	Data output for each transmission structure	Based on PG&E's high-resolution weather, outage and fuels models forecast and historical data.	First version in use in 2020, continued operations and enhancements through 2021.	Risk model utilized for transmission PSPS events.
10	Dead Fuel Moisture Model	Model and forecast the relative amount of moisture in dead vegetation	Fuel moisture is a measure of the amount of water in a potential fuel source for fire. It is expressed as a percentage of water in the dry weight of that fuel.	2 x 2 km output of four DFM fuel classes. Data available in forecast as well as across 30- year climatology	DFM is forecast by the Nelson Dead Fuel Moisture model, which utilized by federal agencies to model DFM.	Initially developed in 2015, enhanced in 2020 to run at 2 x 2 km.	Input to the Fire Potential Index Model

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
11	Live Fuel Moisture Model	Model and forecast the relative amount of moisture in live vegetation	Fuel moisture is a measure of the amount of water in a potential fuel source for fire. It is expressed as a percentage of water in the dry weight of that fuel. As opposed to dead fuels, live fuels are biologically active.	2 x 2 km output of LFM in Chamise and Manzanita species. Data available in forecast as well as across 30- year climatology	LFM is forecast by a machine-learning model that was trained on historical LFM observations and historical weather data.	Initially developed in 2015, enhanced in 2020 to run at 2 x 2 km.	Input to the Fire Potential Index Model
12	Transmission Operability Assessment Model or OA Model	Provides probability of failure of transmission line assets (at a structure level) in windy conditions	pf = probability of failure, Bayesian updating	Enhanced inspection condition scores, repair data, outage data, ETGIS data (age, environment), PLSCADD data (in progress), etc.	Probability is calculated based on an asset fragility curve that varies with windspeed. Asset failure curves are adjusted from “brand new” based on various factors such as inspection condition, age, environment and previous performance.	Initiated in 2019. Continually updated/enhanced with official version releases by May 31 of each fire season.	The OA Model is primarily used for PSPS events, but is also a factor incorporated into operational, maintenance, and investment decisions for the transmission system.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
13	Outage Producing Wind Model or OPW Model	Quantify and forecast the wind-related outage probability on the distribution system	The OPW model was built using historical weather compared sustained and momentary outages and is run at 2 x 2 km resolution. OPW is an input into the LFPd model.	2 x 2 km output of OPW in forecast and historical mode. Data available in forecast as well as across 30- year climatology	Wind speeds were first linked with over 400,000 historical sustained and distribution outages in space and time. The OPW model was then trained with this historical data for localized areas. OPW can be driven with forecasted wind speeds to determine areas that have an increased outage probability in the future.	Initially developed in 2019, enhanced in 2020 to run at 2 x 2 km. Future enhancements discussed in WMP.	OPW is a main input in the LFP_d Model. It is used to understand the probability of an outage event occurring hour-by-hour at 2 km resolution.

TABLE PG&E-4.5-1: OVERVIEW OF PG&E RISK AND OPERATIONAL MODELS (CONTINUED)

#	Model Name	Purpose of Model	Relevant Terms	Data Elements	Methodology	Timeline	Application and Results
14	Fire Potential Index Model or or FPI Model of Utility FPI Model	Quantify and forecast the probability of large fires based on environmental and vegetation factors	FPI describes the probability fires growing large (>1000 acres). It combines weather (wind, RH, temperature), DFM, LFM, and land-classification.	2 x 2 km output of FPI in forecast and historical mode. Data available in forecast as well as across 30- year climatology	Weather, fuel moisture, and other environmental data were linked to a historical fire occurrence in space and time. The goal was to determine which factors and combination of factors yield the most predictive skill of probability of large fires. Over 4,000 FPI models were constructed by combining multiple indices and factors to ultimately determine the most predictive and operable FPI. The FPI is run in forecast model out several days to determine the hour-by-hour risk of large fires.	Initially developed in 2018, model enhancements made in 2019, and enhanced to run at 2 x 2 km resolution in 2020. Future enhancements discussed in WMP.	FPI is a main input in the LFPd and LFPt models. It is used to understand the probability of a large fire occurring hour-by-hour at 2 km resolution.

(b) *Overview of 2021 Wildfire Distribution Risk Model And Future Models*

The 2021 Wildfire Distribution Risk Model supersedes the prior wildfire risk models used in the 2019 and 2020 WMPs, referred to as the 2019-2020 Wildfire Risk Model.[26] Key objectives for the 2021 Wildfire Distribution Risk Model are:

1. Provide situational awareness of risk;
2. Enable risk-informed decision making; and,
3. Enable PG&E to develop line-of-sight on risk reductions from wildfire risk mitigation initiatives.

Recognizing that risk-informed decision making is desired for both workplans developed on an annual basis and operational decisions, such as PSPS, PG&E has and is developing models specific to the temporal needs of each model. There are primarily two forms of models that can be used to address wildfire risk. First, planning models support annual workplans and are based on either worst case conditions such as weather and fuels or cumulative probabilities of failure or ignition. The 2021 Wildfire Distribution Risk Model described below is a planning model for the Electric Distribution system. Second, operational models, such as those used for PSPS events utilize real-time weather, fuels data, and asset conditions as reflected by maintenance tags or recently completed asset hardening. The Large Fire Probability Model (Distribution) or LFP_D Model, described in Section 4.2.A, is an example of an operational model. Given the respective application of planning and operational models, planning models are updated on an annual cadence while operational models are updated as frequently as weekly during fire season.

The 2021 Wildfire Distribution Risk Model seeks to quantify the risk of wildfire represented by the probability of ignitions associated with electric grid infrastructure combined with the consequences if that ignition propagates into a wildfire. The 2021 Wildfire Distribution Risk Model is a set of models that represents failure modes, or risk drivers, underlying ignitions and the consequences of wildfire. These models comprise the components of the wildfire risk formula:

Wildfire Risk = Ignition Probability x Wildfire Consequence

The "Ignition Probability" portion of the 2021 Wildfire Distribution Risk Model is modeled according to the risk drivers identified in PG&E's 2020 RAMP Report for wildfire risk. From among these risk drivers, the 2021 Wildfire Distribution Risk Model developed probabilities for vegetation and equipment failure caused ignitions as they represent 38 percent and 26 percent systemwide of the grid related ignitions respectively. Within equipment failures, the 2021 Wildfire Distribution Risk Model has developed probabilities for conductor failures. As described in Section 4.3, future modeling efforts

---

26 In the 2021 WMP, the naming convention used for models reflects the period of time the model was used to inform and prioritize planning. For example, the 2019-2020 Wildfire Risk Model was developed in 2018 but was used to inform planning in 2019 and 2020. The 2021 Wildfire Distribution Risk Model was developed in 2020 and is being used to inform planning in 2021.

will add failure models for other drivers such as 3rd party contact and for electric grid equipment such as poles and transformers. The modeling framework established with this model will accommodate the future addition of such models.

The “Wildfire Consequence” portion of the 2021 Wildfire Distribution Risk Model focuses on impact measures such as acres, number of structures, and variables describing the nature of the fire such as flame length and rate of spread. The key improvement for the 2021 Wildfire Distribution Risk Model is tied to the advanced modeling capabilities of the Technosylva fire simulation tools. In the 2019-2020 Wildfire Risk Model, REAX Engineering provided simulations that relied heavily on the concentration of fuels to determine the potential for an ignition to propagate to a wildfire. While informative, the Technosylva simulation tool improves on this capability by modeling what fire science refers to as ladder fuels whereby an ignition will propagate from low fuels such as grass and brush to increasingly denser fuels leading to treetop, as well as updated ground fuels, buildings and population data layers. The result is a more accurate representation of the potential consequences of wildfire in the wildland urban interface and the broader Tier 2 and Tier 3 HFTD areas modeled. Future model versions will model the entire PG&E distribution system.

Bringing the improvements to the both the Ignition Probability and Wildfire Consequence portions of the model together, the 2021 Wildfire Distribution Risk Model now provides an improved measure of wildfire risk. The 2019-2020 Wildfire Risk Model provided a relativistic measure that was instructive for prioritizing circuits and circuit segments, but it did not allow for measuring the degree of risk between those segments. The 2021 Wildfire Distribution Risk Model provides this capability as the risk scores are absolute scaled units. Furthermore, these wildfire risk scores are calibrated to the system and tranche risk scores for wildfire risk event as described and modeled in PG&E’s 2020 RAMP Report. As a result, risk values can now identify how much riskier a location is compared to another, risk can be more accurately compared across wildfire and PG&E’s other risk events, and the actual value of risk reduction is now more easily computed.

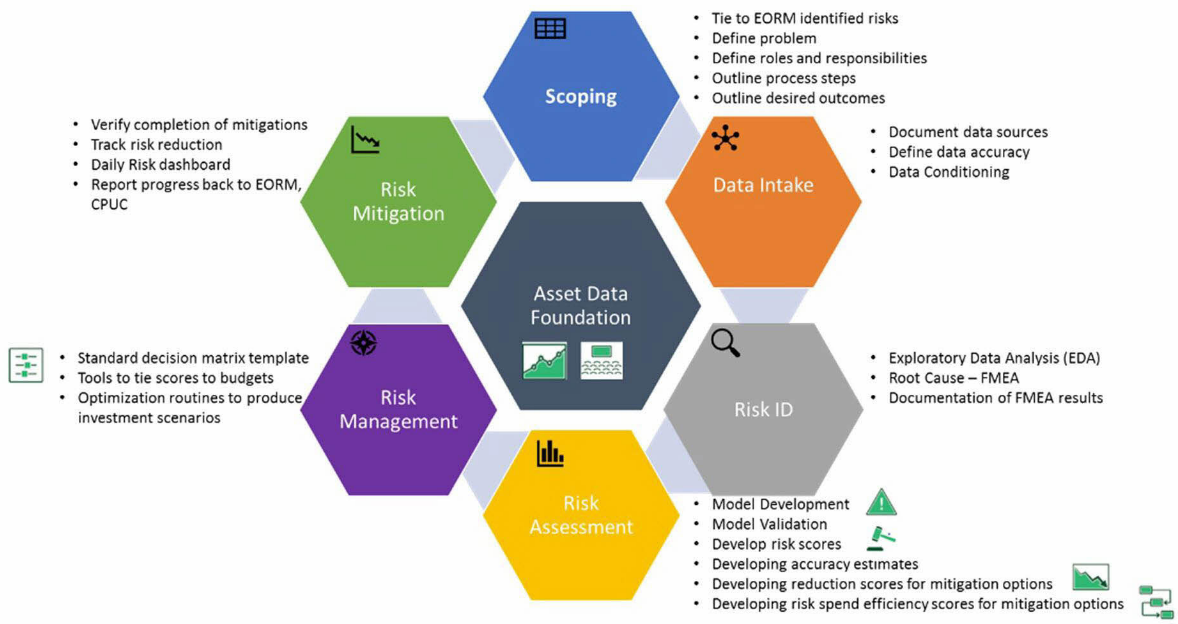
Even as the predictive power of the 2021 Wildfire Distribution Risk Model has been greatly improved as compared to the 2019-2020 Wildfire Risk Model, PG&E is continuing to develop and refine its risk modeling. The 2021 Wildfire Distribution Risk Model has several limitations; it does not include transmission facilities, does not have the ability to compare wildfire risks for additional risk drivers as well as measuring the risk reduction for specific mitigations, and for equipment probability of ignition only includes conductors.

In 2021, PG&E intends to develop the 2022 Wildfire Distribution Risk Model which will include certain upgrades to the 2021 model and will include data on additional electrical equipment (e.g., poles). In 2021, PG&E is also working to develop a 2022 Wildfire Transmission Risk Model for its transmission facilities that will be similar to the 2021 Wildfire Distribution Risk Model. Finally, PG&E is also working on a Pilot Probabilistic Risk Assessment or “PRA.” The PRA is still conceptual, but, if successfully developed, will integrate all models into a single electric system view of wildfire risk. PG&E is working to develop a reference model of the PRA in 2021 and potentially, depending on the effectiveness of the reference model, to use the PRA for planning in 2022.

(c) Developing a Risk Framework

To accomplish the improvements from the 2019-2020 Wildfire Risk Model to the 2021 Wildfire Distribution Risk Model, a systematic Risk Modeling Framework was used to develop the capabilities identified in the CPUC Utility Wildfire Mitigation Maturity Survey (Maturity Survey). This general framework is shown in Figure PG&E-4.5-1.

FIGURE PG&E-4.5-1: RISK MODELING FRAMEWORK



The specific risk model framework steps that resulted in the development of the 2021 Wildfire Distribution Risk Model include:

- **Scoping – defining the problem and desired outcomes.** Beginning with the Scoping step, the 2021 Wildfire Distribution Risk Model is tied to the wildfire risk bowtie and risk scores outlined by PG&E's Enterprise & Operational Risk Management (EORM) department in our 2020 RAMP Report. Examples include the development of risk scores calibrated to the system MAVF scores and modeling failure modes for the identified wildfire risk drivers. During the scoping step, key desired capabilities were identified tying to the Maturity Survey, such as the improved level of granularity, the ability to aggregate risk scores to different levels such as circuit segments, and the comparability of risk scores to facilitate the development of risk reduction and RSE values.

- **Data Intake – key data sets are identified and prepared for modeling**. For the 2021 Wildfire Distribution Risk Model, vegetation data, ignition data, and asset data were critical data sets that were identified and prepared in this step. As LiDAR data was not fully available at this stage, LiDAR informed satellite vegetation data was obtained by one of our project partners, Salo Sciences.

- **Risk ID – Failure Modes Effect Analysis (FMEA) and Exploratory Data Analysis (EDA) are employed to understand and identify the root cause**

and characteristics of the problem. From the identified risk drivers in the RAMP Wildfire Risk bowtie, vegetation and conductor equipment caused ignitions were investigated. Using a previously developed FMEA, EDA was conducted on the identified data sets in the Data Intake step. EDA begins the process of gaining insight from the data before the modeling begins. This includes understanding the accuracy of the data, patterns including outliers and anomalies, as well as interesting relationships between data sets.

- **Risk Assessment – development of the models and model features**. In this step, the model algorithm is selected and trained on the ignition data to provide spatial probabilities of ignition. The Wildfire Consequence Model data was also developed from the Technosylva simulation model. To quantify the predictive power of the model, precision assessments were developed. These metrics informed iterative adjustments that were subsequently made to improve predictive ability. The resulting MAVF risk scores were then calibrated, and validation exercises were held with the Vegetation Management and Distribution Asset Strategy teams that would use the models to inform their 2021 workplans. At this point the 2021 Wildfire Distribution Risk Model was reviewed and approved by the WRGSC which is lead by the Chief Risk Officer and made up a cross-functional officer team.

- **Risk Management – insights from models are used to develop work plans.** The modeling insights are combined with project factors and variables not incorporated in the models. For example, species data was not fully incorporated in to the EVM Risk model. As a result, the Vegetation Management team applied species data as an overlay to the Vegetation Risk Model to produce the 2021 EVM workplan. With the Distribution Asset Strategy team, model data is combined with information on terrain, customers locations, and customer counts to identify the preferred mitigation alternative. Similar to the risk models, the resulting workplans are also reviewed and approved, as part of this step, by the WRGSC.

- **Risk Mitigation – monitors and reports the drawdown of risk as work is performed.** This is accomplished with the model as well as validating the model against actual system performance metrics. For example, ignition probability models are validated against actual annual ignitions to capture insights into future improvements. As modeling capabilities improve monitoring the risk drawdown can become a key operational metric.

(d) Modeling Methodology for the 2021 Wildfire Distribution Risk Model

The 2021 Wildfire Distribution Risk Model formulates risk in probabilistic terms in a manner that is similar to and compatible with the MAVF risk framework established by the CPUC. The fundamental concept is that the risk associated with an event, such as a fire ignition, can be expressed as the product of the probability of the event happening and the consequences if it does happen. The MAVF framework calls these the likelihood of risk event (LoRE) and the CoRE, respectively. In the 2021 Wildfire Distribution Risk Model, the notation P(ignition) for ignition probability and C(ignition) for the consequences of an ignition, is used, as shown below:

$$Risk = P(ignition) \times C(ignition)$$

Below, PG&E describes in more detail how the 2021 Wildfire Distribution Risk Model addresses ignition probability and consequence.

Ignition Probabilities – Vegetation Probability of Ignition Model and Equipment Probability of Ignition Model. To answer the question of where ignition events are likely to occur, fire season ignition probabilities have been estimated using maximum entropy models (MaxEnt), which was pioneered in the modeling of ecological ranges of species. These models are trained on ignition (or outage) locations, gridded spatial environmental data, and asset attribute data. While the data can draw from a specific time period, the model itself is dedicated to spatial, not temporal, patterns. The MaxEnt model provides relative scores or, if properly calibrated, probabilities for fire-season ignitions per "pixel" of input data. MaxEnt models take the set of locations of ignitions under study and rasterized (i.e., pixelated) data on environmental conditions and asset attributes as explanatory covariates for all locations with grid infrastructure as inputs and output rasterized maps of ignition probabilities.

For the 2021 Wildfire Distribution Risk Model, the objective is to identify which environmental conditions and asset attributes (collectively called the model covariates) are more common among ignition locations than they are among all distribution grid locations. For example, tall trees are more common among vegetation caused ignition locations than they are among typical distribution grid locations. Metrics of vegetation dryness, HFTD tier assignments, conductor materials and size, and others, can all be checked for such patterns. The ratio of covariate value prevalence at ignition locations to their prevalence across all grid locations is called the relative occurrence rate. MaxEnt provides a way of estimating the relative occurrence rate given a fairly modest number of ignition locations. The way it does this is to fit a statistical distribution of covariate values for ignition locations that is consistent with the values at known ignition locations, but otherwise as similar as possible to the distribution of values found everywhere else along the distribution grid. The similarity criteria are enforced using a metric called the relative information entropy between the ignition locations and the distribution grid locations, where the larger that metric is, the more similar the two distributions are. For this reason, the overall approach is referred to as a maximum entropy or MaxEnt estimation of the relative occurrence rate. When multiplied by the fraction of all grid locations that experience ignitions annually, the relative occurrence rate is normalized into an estimate of the annual probability an ignition will occur for all values of the covariates. This can be used to forecast annual ignition probabilities based on the covariate values found at each distribution grid location.

MaxEnt models have been successfully applied in ecology to the problem of estimating a species' range (i.e., the physical extent of its suitable habitat), given a set of locations where members of that species have been observed and the corresponding environmental conditions at those locations and all candidate locations for the range. In that context, the model assigns a score to every location that captures how similar the conditions at that location are to the locations where the species was observed. There is a correspondence between MaxEnt applied to species observations and ranges and ignition locations and at-risk locations—looking for the "range" of grid-caused wildfires—the environmental conditions and asset attributes associated with elevated wildfire probabilities. PG&E has applied MaxEnt methods to event occurrences and their proximate asset and environmental conditions contrasted with the background conditions everywhere else along the distribution grid to identify the locations most likely to experience similar events in the future.

PG&E developed two models regarding the probability of ignition related to specific risk drivers—the Vegetation Probability of Risk Model (Model #3 in Table PG&E-4.5-1 above) and the Equipment Probability of Ignition Model (Model #4 in Table PG&E-4.5-1 above). These models are further described in Section 4.3.

Ignition Consequences – Wildfire Consequence Model. PG&E uses MAVF to calculate the consequence of an event. The consequence attributes and their respective weights are:

1. Safety (50%)
2. Financial (25%)
3. Electric Reliability (20%)

Each outcome in the Wildfire Consequence Model (Model #5 in Table PG&E-4.5-1 above) is assigned a score for these three categories which is then aggregated to calculate the consequence score. The consequence values assigned to each simulated fire comes from these existing MAVF consequence scores. MAVF divides wildfire risk events into severity categories, modeling each category as a separate set of inputs (think tabulations/counts of historical ignitions that fit into each severity category) and consequence outcomes.

Historically, risk assessments using MAVF scoring have been performed at the enterprise-level without spatially explicit data or models. In other words, the risks are computed in terms of the expected count and severity of “risk events” but not at their specific locations. The purpose of the 2021 Wildfire Distribution Risk Model is to model the spatial variation in risk so that wildfire mitigation efforts can prioritize higher risk assets and locations for mitigation. This approach required new spatially explicit MAVF CoRE consequence metrics that are consistent with the enterprise-wide risk numbers. The development of spatial MAVF CoRE consequence metrics required mapping the characteristics of every “grid pixel” in the HFTD areas to the categories used to assign ignitions to tranches of consequence already in use in the MAVF framework. These categories include HFTD areas, red flag warning conditions, and fire severity. Technosylva fire simulations under extreme fire weather conditions were used to estimate the likelihood of ignitions growing into fires of Small, Large, Destructive, or Catastrophic extent. These characteristics were then used to lookup existing MAVF CoRE values for corresponding tranches and used to compute probability weighted averages of the consequence values for every grid location in the HFTDs areas.

(e) Additional Models Used for Wildfire Risk

In addition to the models described above, there are two additional models that PG&E developed to address wildfire risk. These are submodels that include components of the 2021 Wildfire Distribution Risk Model.

- **Vegetation Risk Model.** All vegetation-caused CPUC reportable fire season ignitions from 2015 to 2018 within the HFTD areas were used to model the risk addressed by the EVM program. PG&E did not use 2019 ignition data initially because this data is being used to test and validate the predictive power of the model. A MaxEnt model was used to estimate spatial ignition probabilities based on those ignitions. This work was informed by data on vegetation, weather and other environmental conditions. The ignition probabilities were combined with the MAVF CoRE values from the spatial ignition consequence data set to produce 100m x 100m grid-pixel-level risk scores. The pixelated risks were aggregated within each circuit segment (also called Circuit Protection Zone or CPZ) in the HFTD areas to produce the risk summaries provided as inputs used to inform EVM planning and prioritization. The Vegetation Risk Model is Model #6 in Table PG&E-4.5-1 above.

- **Conductor Risk Model.** All conductor-involved CPUC reportable fire season ignitions from 2015 to 2018 (2019 was held back for testing predictive power) within the HFTDs were used to model the risk addressed by the System Hardening program.[27] A MaxEnt model was used to estimate spatial ignition probabilities based on those ignitions. The ignition probabilities were combined with the MAVF CoRE values from the spatial ignition consequence data set to produce 100m x 100m grid-pixel-level risk scores. This work was informed by data on conductor materials and size, proximity to the coast, and the location of splices. Prior work within PG&E informed our interest in these data fields. The pixelated risks were aggregated within each circuit segment in the HFTD areas to produce the risk summaries provided as inputs used to inform system hardening planning and prioritization. The Conductor Risk Model is Model #7 in Table PG&E-4.5-1 above.

(f) Transmission Operability Assessment Model

While the 2021 Wildfire Distribution Risk Model is focused on PG&E's electric distribution system, the Transmission Operability Assessment Model or OA Model works to mitigate the risk of wind-induced failures of transmission equipment that may result in an unintentional ignition. The OA Model is primarily used for PSPS events, but is also a factor incorporated into operational, maintenance, and investment decisions for the transmission system.

In 2019, PG&E developed the OA Model to assess the physical condition of overhead electrical transmission line assets. The OA Model provides for a data-driven, risk-based framework to inform both asset management and operability assessment decisions by incorporating elements of probabilistic-based engineering analyses commonly used in other risk-driven industries such as nuclear power generation. The OA Model computes an asset-based fragility (probability of failure due to wind gust speed) by quantitatively assessing the condition (or health) of transmission structures and components and accounting for known degradation mechanisms. This fragility, in turn, contributes to the quantification of risk due to environmental conditions associated with PSPS. When used in conjunction with Transmission Asset Management, the OA Model also provides

---

27 Note that vegetation-caused conductor-involved ignitions were also modeled by the Vegetation Risk Model.

probabilistic-driven insight into the operation, maintenance, and investment strategy of transmission infrastructure.

PG&E is engaged with two ongoing modeling efforts regarding the data-driven, risk-informed decision making for management of PG&E's transmission system:

(1) Operation of the OA Model, which includes maintenance of existing data supplies to ensure daily relevance of the Model's outputs, and

(2) Use of Bayesian Updating (a data-driven, probability-based methodology) for in-flight improvement of wind-based asset strength estimation.

Both of these modeling efforts are described briefly below.

Operation of the OA Model: The key to understanding the OA Model is the concept of fragility. In short, fragility refers to the increasing probability of failure for increasing applied load. In the context of the OA Model, fragility is the conditional probability that an asset (tower, pole, conductor, anchor, etc.) will fail at a given wind speed. While wind speed is the intensity measure used to define fragility, the OA Model considers many damage mechanisms such as corrosion, fatigue, wear and decay that can lower the capacity of the asset to resist wind loads.

The OA Model is based on assigning a fragility curve to each asset to reflect its current health relative to a newly designed and constructed, but otherwise identical, asset. This is done by first presuming a fragility associated with a new, healthy asset, and then adjusting both the strength and uncertainty to reflect the observed condition, age, environment, and historical performance of the circuit in whole. Specifically, the median strength is adjusted based on asset inspection results, test and treat inspection findings (for wood poles only), and structural engineering analysis of the towers/poles, insulators, guys, foundations, anchors and conductors. The uncertainty is adjusted based on the asset age versus a notional design life, the aggressiveness of the asset environment with respect to corrosion and windiness, and the past performance of the circuit.

Fragility can be used to predict the risk that an asset (or set of assets) will underperform at a forecast wind speed. Alternately, if a risk tolerance is defined, the corresponding wind speed at which that tolerance is exceeded can be determined directly from the fragility as described earlier. The risk tolerance is an input to the OA Model, and is a function of many concerns outside the scope of the OA Model.

Bayesian Updating: Bayesian Updating is a methodology by which the wind-based asset strength estimation provided by the OA Model is continuously improved as additional outage data is received. In this manner, the OA Model works to maintain up-to-date relevancy by incorporating new data in the form of newly-reported failures and survivals of transmission assets subjected to windy conditions. Ongoing efforts to improve on the Bayesian Updating methodology have included:

- Vetting of historical outage data to identify, where missing, the cause category and location;

- Identifying the expected wind speed at the date, time, and location of the historical outage;

- Examining post-PSPS patrol data to identify transmission-specific damage, if any, that may have resulted in an outage if the transmission line were energized; and

- Working to establish a unified dataset from which all historical outage data can be referenced.

PG&E has learned a number of key lessons from nearly two years of operating the OA Model, including:

- Identifying and mitigating missing data: This most notably has occurred with the operation of Bayesian Updating. When outage data was missing or sparse (for example, location data was missing), it led to earlier indications that the outputs from Bayesian Updating may be disproportionately penalizing transmission assets due to limited data. Transmission OA subsequently engaged in an extensive effort to research, vet, and document historical outage data to improve the quality of this dataset for Bayesian Updating usage.

- Data visualization: As more data continues to be available, the computational demands on the OA Model have stressed earlier tools. To this end, the Transmission OA team built out and validated data processing, analysis, and visualization tools to provide a robust, reliable, and repeatable framework for operating, visualizing, and distributing OA Model data.

These lessons have been incorporated into the OA Model enhancements that are either in progress or under investigation, as described in the following paragraphs.

Enhancements to the OA Model that are in progress include:

- Incorporation of quantitative outputs for Tier 2 and Tier 3 HFTD transmission assets into the fragility calculations; and

- Integration of a refined corrosion data that incorporates additional variables (such as an asset's distance from a known pollution source) in the corrosion score computation.

PG&E is also looking into the following enhancements for the OA Model that include:

- Integrating the probability of a flashover into the existing OA Model framework;

- Conductor-specific refinements to the fragility computations of this asset class;

- Aggregation and incorporation of wood pole test and treat data; and

- Incorporation of component test data collected by PG&E as part of a larger testing program that PG&E with which PG&E has engaged to better define fragility curves for specific components.

(g) Validation and Frequency of Updates

As part of the Risk Assessment step in the Risk Modeling Framework, models are reviewed and validated. Validation is conducted on a number of Quality Assurance (QA) and Quality Control (QC) levels. Two QA methods are employed for validation. First, following good data science and software development practice, data scientists conduct code reviews on each other's work. Second, model runs include test automation code that checks model outputs to catch erroneous values. A number of QC steps are also employed both internal and external to PG&E. Within PG&E, the EORM team reviews the modeling methodology and results to provide feedback and signal their acceptance of the models for use in measuring risk. Next, PG&E groups that use the risk models to develop mitigation work plans test the model with their subject matter expertise. The PG&E Internal Audit group also has conducted in depth reviews of model methods, results and the application in developing mitigation workplans. Finally, PG&E uses outside expertise to review and validate model methods, code and model results. PG&E is currently contracted Energy and Environmental Economics, Inc. to perform a review and validation of the modeling methodology, code, model results and application to be completed in the spring 2021.

For transmission, the OA Model methodology is derived from the performance-based engineering framework supported by the Pacific Earthquake Engineering Research (PEER) program, which is a consortium of research and industry experts who have extensively published peer-reviewed technical papers related to this topic. PG&E subject matter experts reviewed the OA Model methodology in numerous meetings and workshops, where the nature, purpose, and preliminary outcomes of the model were discussed. An independent, external review was also performed by experts in probabilistic engineering analysis with the B. John Garrick Institute for Risk Sciences at UCLA.

Best practices from data science and software development were employed to integrate the OA Model methodology into Python and Power BI. These best practices included code peer review, automated scripts that compare the model outputs from two independent systems, and automated unit tests of the code for repeatable validation.

Updates and enhancements to the OA Model go through the same review and validation processes, with the additional step of PG&E's Transmission consultant preparing a delta study that identifies the impact of these updates or enhancements on the model outputs. OA Model documentation, including the technical basis of the methodology, is maintained by the Transmission OA team.

As we explained above in Section 4.5.1(b), planning models support annual workplans and are based on either worst case conditions such as weather and fuels or cumulative probabilities of failure or ignition. An example of a planning model is the 2021 Wildfire Distribution Risk Model. Operational models, such as those used for PSPS events utilize real-time weather, fuels data, and asset conditions as reflected by maintenance tags or recently completed asset hardening. An example of operational models are the Large Fire Probability Model (Distribution) and the Large Fire Probability Model (Transmission).

Given the respective application and use of planning and operational models, planning models are updated on an annual cadence while operational models are updated as frequently as weekly during fire season. While operational models benefit from the latest meteorology and asset data to inform event based decisions (e,g., PSPS), investment and planning models require less frequent updates. Planning models are used for annual planning decisions. However, as risk mitigations are completed through the year, planning models can be updated to measure the resulting risk reduction. The frequency of updates in planning models to reflect the completion of risk mitigations will occur on a quarterly basis beginning in 2021.

(h) Modeling for PSPS Events

The operational modeling used by PG&E to determine whether to initiate a PSPS event includes the Large Probability Fire Model (Distribution) and (Transmission), that includes the Utility FPI and OPW Models, as well as the OA Model described above in Section 4.5.1(f). The Large Probability Fire Model (Distribution) and (Transmission), Utility FPI, and OPW Models are also discussed in Sections 4.2.A.

PG&E has also modeled PSPS consequences to customers at a program level in terms of MAVF as discussed in Section 4.1(e); and is currently developing a more granular, circuit level model, to assess the impacts of PSPS denenergizations. PG&E currently plans to complete this analysis in collaboration with the WSD and the other California utilities in 2021 ahead of its 2022 WMP and/or 2023 GRC submission.

(i) Response to RCP Actions

ACTION PGE-1 (Class A)

In its 2021 WMP update, PG&E shall elaborate on its risk modeling plans to explain:

a. *how it plans to use risk modeling to evaluate benefits for each individual initiative in its WMP;*
b. *PG&E shall also detail current capabilities, future capabilities, and how it intends to use future capabilities; and*
c. *the frequency of model updates.*

Response:

a. In Section 4.5.1(b) above, PG&E describes how the models that it has developed, including the 2021 Wildfire Distribution Risk Model, are used for distribution planning purposes generally. This information will assist in PG&E's general planning for initiatives. In Section 4.5.1(e), PG&E describes specifically how the Vegetation Risk Model and Conductor Risk Model inform its EVM and system hardening initiatives. In Section 4.5.1(f), PG&E describes how the Transmission OA Model helps inform transmission planning. With regards to other initiatives, in Section 4.5.1(b), PG&E describes its plans to develop additional modeling capabilities in 2021. These additional capabilities will help evaluate the benefits of additional WMP initiatives. Finally, PG&E addresses incorporating each initiative into its risk modeling in its response to Action PGE-6 (Class A) in Section 4.2 above.

b. The current and future capabilities of PG&E's models are described in Sections 4.5.1(b)-(g) above. Section 4.5.1(h) references other sections in the 2021 WMP that specifically describe the capabilities and future capabilities of models used for PSPS events.

c. The frequency of model updates is described in Section 4.5.1(g).

ACTION PGE-2 (Class A)

In its 2021 WMP update, regarding its vegetation probability model, PG&E shall:

1) *include fall-ins and other vegetation-related instances within its probabilistic outputs,*
2) *describe how non-vegetation related outputs are excluded, and*
3) *describe the frequency and manner in which updates are performed.*

Response:

1) and 2) For the Vegetation Probability of Ignition Model, only ignition events are predicted or *produced* as a probabilistic output. PG&E assumes that the term "output" in this Action Item refers to the ignition events used to train the model. In Section 4.3(c), PG&E outlines that all vegetation related ignition events were used to train the model. Ignition events without the mention of vegetation in the cause code were not included in the training set.

3) As a planning model used for the development of annual workplans, this model is updated annually. This update trains the model with an expanded set of event data that *includes* the addition of the latest year. As additional data sets are identified and made available and algorithm improvements are identified, they are also included in the annual update.

ACTION PGE-7 (Class A)

In its 2021 WMP update, PG&E shall specify intended benchmarks for risk modeling and provide clearer detail on who has peer validated the models and how the review has been incorporated, including, but not limited to, (a) qualifications and job titles of the "peers" who provided feedback in the Utility Analytics Institute Conference, (b) the input and validation provided by such peers, and (c) a description of how PG&E plans to or has incorporated such external peer review into its modeling efforts.

Response:

In Section 4.5.1(g), PG&E provides details on the QA and QC validation steps that are part of our risk model development. While PG&E did present the 2021 Wildfire Distribution Risk Model at the November 2020 Utility Analytics Institute Conference, due to the pandemic the conference was remote and the presentations were pre-recorded. As such, no significant feedback was received and PG&E did not consider this presentation as part of the model validation process. As mentioned in Section 4.5.1(g), PG&E is contracting with Energy and Environmental Economics, Inc. to perform a review and validation of the modeling methodology, code, model results and application to be completed in the Spring of 2021.

ACTION PGE-17 (Class A)

In its 2021 WMP update, PG&E shall discuss whether it intends to update its asset risk model daily outside of a PSPS event, giving reasons. PG&E shall also discuss when it intends to implement more frequent than annual updates for distribution asset risk models and the frequency of such updates.

Response:As we explained above in Section 4.5.1(b), planning models support annual workplans and are based on either worst case conditions such as weather and fuels or cumulative probabilities of failure or ignition based on historical analysis and asset attributes. An example of a planning model is the 2021 Wildfire Distribution Risk Model. On the other hand, operational models, such as those used for PSPS events utilize real-time weather, fuels data, and asset conditions as reflected by maintenance tags or recently completed asset hardening. Examples of operational models are the Large Fire Probability Model (Distribution) and the Large Fire Probability Model (Transmission).

Given the respective application and use of planning and operational models, planning models are updated on an annual cadence while operational models are updated as frequently as weekly during fire season. While operational models benefit from the latest meteorology and asset data to inform event based decisions (e,g., PSPS), investment and planning models require less frequent updates. Planning models are used for annual planning decisions. However, as risk mitigations are completed through the year, planning models can be updated to measure the resulting risk reduction. The frequency of updates in planning models to reflect the completion of risk mitigation work will occur on a quarterly basis beginning in 2021.

ACTION PGE-18 (Class A)

In its 2021 WMP update, PG&E shall: (1) discuss why it does not plan on using a similar methodology for its distribution asset risk model as compared to its transmission risk model, and (2) explain why it does not plan on updating the distribution model weekly, similar to the frequency used for updating its transmission model.

Response:

1) As outlined in Sections 4.5.1(b) – (e), the 2021 Wildfire Distribution Risk Model employs a machine learning approach to develop an ignition probability. In Section 4.5.1(f), PG&E explains that the OA Model employs a fragility approach where the relationship between ignition probability and force (primarily via wind speed) is characterized by a curve. Given the scope, design and function of the transmission system, the fragility approach is an effective methodology. Specifically, for steel structures the characteristic strength curve is informative as the age, location, and load on the steel structure are available and the variation

in steel characteristics are more narrow than wood. Alternatively, the scarcity of transmission ignition events (at approximately 10 per year for transmission versus approximately 100 for distribution) makes a machine learning approach for transmission more challenging. Due to the much wider scope, design, and function of the distribution system, ignition event counts are higher which provides more data for the development of machine learning models. As data collection improves, machine learning models could become more effective for the development of transmission risk models and with improved distribution system data, the fragility approach could prove instructive for the development of distribution risk models

2) In Section 4.5.1(g), PG&E outlines the update frequency for planning models used for annual work plans and for operational models used for events such as PSPS. As discussed in that section, the OA Model is primarily used to inform PSPS decisions and thus is updated more frequently, often weekly during PSPS events. The OA Model is used as an input to annual planning, but this is not the primary purpose of the model. The Distribution Planning models, such as the 2021 Wildfire Distribution Risk Model, are not used for PSPS decisions but instead are used to target mitigations and estimate risk reduction for work planning such as system hardening and EVM. Since work planning is done primarily on an annual cycle, these models do not need to be updated as frequently. However, as PG&E explained in Section 4.5.1(g), it will updating its planning models quarterly in 2021 to reflect completed risk mitigation work.

ACTION PGE-19 (Class A)

In its 2021 WMP update, PG&E shall provide an interim solution for more frequent than annual updates of distribution asset conditions in its risk model

Response:

In Section 4.5.1(g), PG&E outlines the update frequency for planning models used for annual work plans such as the 2021 Wildfire Distribution Risk Model and for operational models such as the Transmission Operating Assessment Model used for events such as PSPS. For planning models specifically, PG&E indicated that as risk mitigations are completed through the year, planning models can be updated to measure the resulting risk reduction. The frequency of updates in planning models to reflect the completion of risk mitigation work will occur on a quarterly basis beginning in 2021.

ACTION PGE-20 (Class A)

In its 2021 WMP update, PG&E shall: (1) provide sufficient reasoning for the current lack of distribution asset health updates within its risk modeling, (2) explain why more frequent distribution asset health updates are not possible at this time, (3) provide a concrete timeline outlining each step in PG&E's process to updating each risk model, and (4) define the frequency of risk model updates in the interim before the 2022/2023 standardization with an explanation as to if and why PG&E finds that frequency sufficient.

Response:

1) The 2021 Wildfire Distribution Risk Model currently includes updated asset data as compared to prior risk models discussed in the 2019 and 2020 WMPs. PG&E plans to update the 2021 Wildfire Distribution Risk Model on a quarterly basis as mitigation field work is completed, as described in Section 4.5.1(g). The OA Model is updated weekly with the status of maintenance tags and this cadence switches to daily during PSPS events. PG&E also summarizes these points in its responses to Action PGE-17 (Class A) and Action PGE-18 (Class A). In addition, asset health updates from inspections and maintenance tags will also be part of the updates that will be incorporated into the 2022 Wildfire Distribution Risk Model.

2) In Section 4.5.1(g), PG&E explains the basis for the update frequency for planning models used for annual work plans and for operational models used for events such as PSPS. PG&E also summarizes these points in its responses to Action PGE-17 (Class A) and Action PGE-18 (Class A).

3) In Q1 of 2021, the asset health data from maintenance inspections will be integrated into the 2021 Wildfire Distribution Risk Model. In Q2 2021, the 2021 Wildfire Distribution Risk Model will then augment the OPW Model in determining the Large Fire Probability for use in deenergization decisions during PSPS events. With these two steps, distribution asset health is scheduled to be integrated into the OPW Model for the 2021 fire season and to follow a similar update cadence to the Transmission asset health data.

4) PG&E's objective is to update planning models on an annual basis for the development of workplans, and on a quarterly basis for tracking risk reduction following mitigation work completed in the field. Operational models are generally updated on a weekly basis switching to daily updates during PSPS events.

ACTION PGE-31 (Class B)

1) *Describe how it has calculated overall wildfire risk in a similar manner as the 5,500 miles for system hardening to identify the most high-risk circuits,*

2) *Provide the locations via GIS files on such high-risk circuits,*

3) *Provide the percentage of the 5,500 miles fall under the total identified high-risk circuits,*

4) *Describe how the determination of high-risk circuits was used to prioritize WMP initiatives, and*

5) *Explain how PG&E's risk modeling considers a range of potential mitigation types, rather than assuming system hardening is the appropriate mitigation.*

Response:

1) In a recognition of the continually changing effects of climate, PG&E is no longer setting an end point to the System Hardening Program. For more detail concerning

the 5,500 miles of system hardening, see the response to Action PGE-3 (Class B) in Section 7.3.3.17.1.

2) PG&E has provided a map of wildfire risk by circuit segment in Section 7.3.7.4.

3) In a recognition of the continually changing effects of climate, PG&E is no longer setting an end point to the System Hardening Program. For more detail concerning the 5,500 miles of system hardening, see the response to Action PGE-3 (Class B) in Section 7.3.3.17.1.

4) The development of the system hardening WMP initiative looked to the ignition probability and wildfire risk values of circuit segments using the 2021 Wildfire Distribution Risk Model for insights which are combined with additional information not included in the model to determine if the proposed mitigation will be effective in reducing risk in that location.

5) At this time the 2021 Wildfire Distribution Risk Model does not provide risk reduction values that are specific by mitigation type. As described in Section 7.3.3.17.1, the System Hardening Program considers a range of alternatives such as undergrounding, installing covered conductor, and even remote grid to customize the improvements to the circuit segment. The capability to provide risk reduction scores for each mitigation type will be added as part of the 2022 Wildfire Distribution Risk Model..

ACTION PGE-37 (Class B)

1) Provide the age score used for each conductor installation year, and

2) Explain how it calculates the age score input for Sub-Model #1 when it has not provided complete conductor age information to the WSD in its GIS data submissions to date.

Response:

The estimated conductor age (the “estimated-age”) was calculated as the number of years since the *installation* year, as listed in EDGIS. If the installation date was missing or invalid, then the estimated age in the STAR model dataset was used (as extracted from the primary conductor dataset in the Foundry platform). The installation date was determined to be invalid if:

1. It fell within the 1986 to 1990 time period, an unreliable default value in the dataset,

2. It was greater than the current date, or

3. It was less than 1901.

The STAR model estimated the conductor age using the average age of the poles associated with *the* conductor or, if pole age could not be calculated, the average age of the conductors in the service territory (PG&E Digital Catalyst, 2019).

ACTION PGE-38 (Class B)

1) Provide an update to the status of integrating any new inputs into its risk modeling, and

2) Describe how such new inputs have been integrated into its risk modeling.

Response:

Please see Sections 4.3(b) and 4.3(c) for a description of new risk model inputs, as well as Section 4.5.1 which provides an overview of updates to our risk modeling.

ACTION PGE-39 (Class B)

1) *Provide the timeline in detail for when it plans to include all outstanding inputs, broken down by each input.*

Response:

The timeline for the planned inclusion of data set or inputs are outlined in the Table PG&E-4.5-2 below:

TABLE PG&E-4.5-2: TIMELINE FOR RISK MODELING INPUTS

Input Data Set	Anticipated Benefit	Need for Inclusion	Inclusion Challenge Preventing Inclusion Already	Timeline
LiDAR tree species data	Specific tree species detail in risk scores	VM mitigations can be customized to tree species.	LiDAR collection completion and data processing were completed by the end of 2020.	Q2 2021
LiDAR asset data	Improved accuracy of asset locations	LiDAR data provides a more accurate lat/long of assets.	LiDAR collection completion and data processing were completed by the end of 2020.	Q2 2021
Maintenance Tags	Improved data asset condition	Improved ability to prioritize tags	Connecting asset level data to model whose granularity is not yet at the asset level.	Q2 2021
Inspection Results	Improved data asset condition	Improved ability to prioritize tags	Connecting asset level data to model whose granularity is not yet at the asset level.	Q2 2021
Pole loading	Support development of pole failure model	Need to add pole failures to the conductor risk model to better model distribution equipment modeling	O-calc data base project is still in progress	Q2 2022

ACTION PGE-40 (Class B)

1) Describe in detail how each of the currently outstanding inputs will contribute to PG&E's modeling efforts;

2) Describe how PG&E determined the need to include each of these inputs; and

3) Further explain why each of these inputs were not already included within modeling efforts.

Response:

Please see the Table PG&E-4.5-2 above.

ACTION PGE-41 (Class B)

1) Explain how egress *is weighted against other factors during risk modeling and selection of initiatives.*

Response:

A general egress model was included in previous wildfire risk models used in the 2019 and 2020 WMP. In 2020, PG&E worked with Santa Cruz County to complete a detailed egress study for Santa Cruz County. The results for the individual Census Defined Places in Santa Cruz County were compared to the evacuation times from the general egress model. As a result of inconsistency between the detailed study results with the general egress model, PG&E is undertaking the development of a new egress model with expected completion in 2022. In the interim, egress is not part of the 2021 Wildfire Distribution Risk Model.

ACTION PGE-42 (Class B)

1) Provide a quantitative description of how egress score is calculated and incorporated into its prioritization calculations, particularly in comparison to the other factors;

2) Explain how it factors in identification of wooden poles near evacuation routes. If such information is not currently factored in, explain why, and ensure that wooden poles are included as a factor for calculating egress in its 2021 WMP Update; and

3) Provide an example showing the calculation of egress assessment.

Response:

As discussed in the response to Action PGE-41 (Class B), egress is not part of the 2021 Wildfire Distribution Risk Model.

ACTION PGE-52 (Class B):
1) explain how the models in Table 7 assess the potential between risk levels on safety and reliability for the purposes of classifying priority levels in accordance with Rule 18.

Response:

Table 7 in the First Quarterly Report provided a timeline for asset management and inspections maturity. Table 7 did not include any models but only referred to moving “towards risk informed inspection protocols. The models described in the 2021 WMP can be used for mitigations such as the System Harding Program and priority of inspections. The classification of priority levels for conditions identified in inspections, as described in GO 95 Rule 18, are solely determined by the field assessment of the inspection team, in accordance with their safety severity and location within the HFTD tiers, not by risk models.

ACTION PGE-53 (Class B)

1) Create a framework for the maturation of risk modeling outlining each step, including a timeline for completion and progress updates; and

2) Expand on the details of each step.

Response:

PG&E’s risk modeling objectives are to develop models that: (1) provide situational awareness of risk; (2) enable risk-informed decision making; and (3) enable PG&E to develop line-of-sight on risk reductions from wildfire risk mitigation initiatives. Following the risk framework outlined in Section 4.5.1(c) and shown in Figure PG&E-4.5-2, as modeling capabilities are improved from relative risk models at the circuit level with system level risk reduction and RSE capabilities, to automated quantitative risk models that include risk reduction and RSE evaluations all at the asset level, these improvements will register across the capabilities and categories of the Maturity Survey.

Figure PG&E-4.5-2 below outlines PG&E risk modeling capabilities across the Maturity Survey categories today and Figure PG&E-4.5-3 shows the planned progress over the next three years from 2021 to 2023.

FIGURE PG&E-4.5-2: PG&E RISK MODELING CAPABILITIES IN THE MATURITY SURVEY (CURRENT STATE)

	2. Ignition risk estimation	3. Estimation of wildfire consequences on communities	4. Estimation of wildfire and PSPS risk-reduction impact of initiatives	14. Risk-based grid hardening and cost efficiency	41. Portfolio-wide initiative allocation methodology
Typical characteristics	2- Based on two categories	2- Binary (low, high)	1 - None	1- None	1 - None
Typical data validation and granularity	3 – Circuit level	3- Circuit level	1- System level	3- Circuit level	1 – Average RSE by category
Level of systematization and automation	1- None	1 - None	1 - None	1- None	1- None
Typical approach to learning and updates	2- Historical data	1 – acreage, no structures or fatalities	1 - None	1- None	1- None

Scoring philosophy

- 5* - Improvement over best practices
- 4 - Consistent with best practice
- 3 - Beyond minimum expectations
- 2- Meets minimum expectations
- 1 - Below expectations

* - in some categories the scoring extended to only 3 or 4

The planned improvement for each of the five risk modeling categories shown above are discussed in more detail here:

Ignition Risk Estimation – As detailed in Section 4.5.1, ignition probability capabilities have improved to produce a quantitative value based on individual failure modes within each risk driver. Currently, vegetation and conductor equipment failures are modeled at a 100 meter x 100 meter granularity. From this base level output, circuit segment and circuit level outputs are produced. Our next model iterations will add failure models for poles and transformers followed by third party and animal risk drivers. As more risk drivers and failure modes are added to the ignition models the model output will approach an asset level of granularity. At the same time, model code will stabilize to the point where automated, productionalized code will be updated with refreshed data.

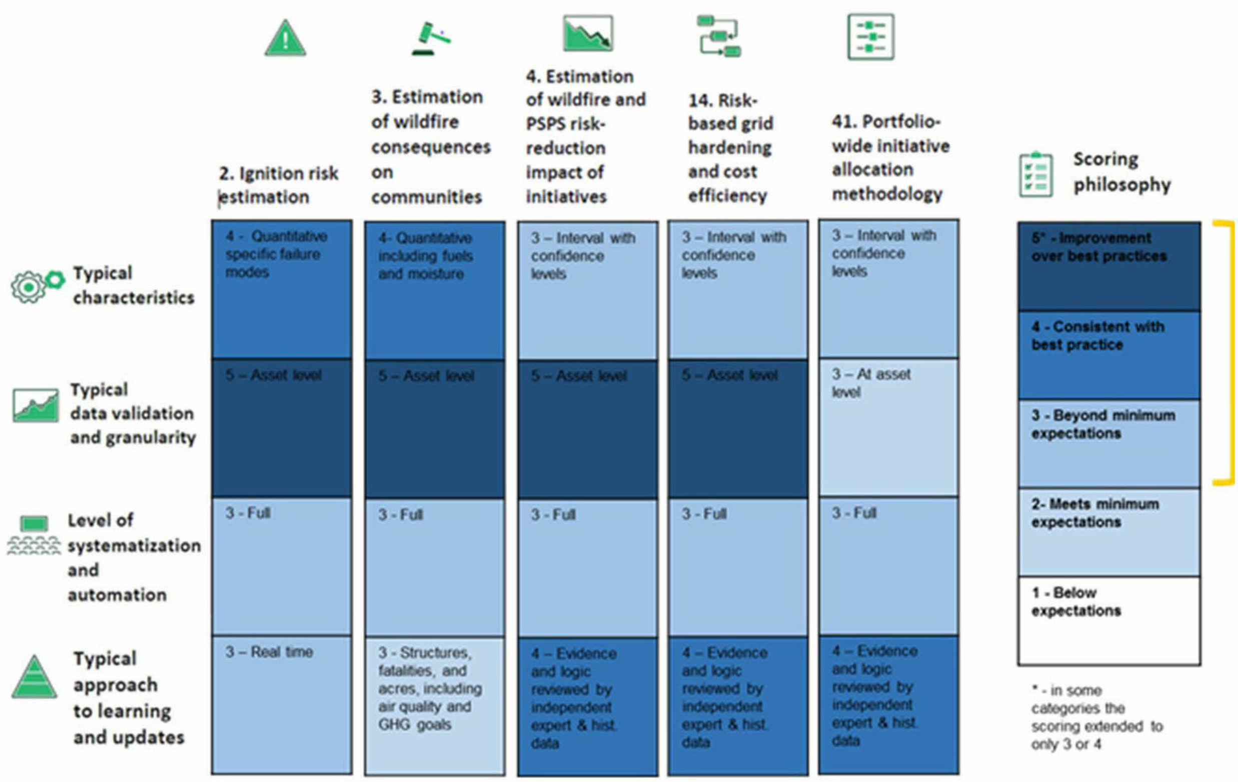
Estimation of Wildfire Consequences on Communities – Wildfire consequence capabilities have improved with the use of the Technosylva wildfire spread modeling. Current wildfire consequence data is now based on a range of fire science and meteorological data to produce community impacts data such as acres burned and impacted structures. These are produced at a 200 meter granularity along electrical lines and area aggregated up to the circuit segment, circuit level and higher levels for use with the ignition probability models. As our ignition models improve to the asset level, the consequence data PG&E is working closely with Technosylva to improve the accuracy of the wildfire consequence modeling by comparing model capabilities to match actual fires as they occur. Future improvements include the further automated integration of Technosylva model features with ignition probability models to product wildfire risk values.

Estimation of Wildfire and PSPS Risk-Reduction Impact of Initiatives – Currently, risk reduction values for mitigations are estimated at the system level. With the development of the 2022 Wildfire Distribution Risk Model, the risk model output will include risk scores for circuit segments as they do in the 2021 Wildfire Distribution Risk Model, and risk reduction estimates for mitigation alternatives. This feature will next be automated in to the model code to enable the development of portfolio scenarios. The first set of risk reduction values for mitigations will be based on subject matter expertise until sufficient operational data from mitigation technologies are obtained that statistical models can be developed.

Risk-based Grid Hardening and Cost Efficiency – With the addition of risk reduction values for mitigations the development of more granular risk spend efficiency values will follow.

Portfolio-wide Initiative Allocation Methodology – As mentioned, automating the model code with the risk reduction feature will enable the development of portfolio scenarios.

FIGURE PG&E-4.5-3 PG&E: RISK MODELING CAPABILITIES IN THE MATURITY SURVEY (FUTURE STATE ~2023)



ACTION PGE-80 (Class B)

1) Provide a framework or outline of the modeling efforts underway to integrate system hardening and VM, and

2) Describe the initiatives it is taking in order to integrate the two moving forward.

Response:

The 2022 Wildfire Distribution Risk Model aims to add two new features that will improve the maturity of PG&E risk modeling (as described in Action PGE-53 (Class B)) which will improve the coordination of mitigation efforts such as system hardening and VM. The 2022 Wildfire Distribution Risk Model will allow for the development of a composite ignition probability and risk value at each point along the grid. From this composite value the portion of the ignition probability and risk due to different risk drivers such as vegetation or equipment will be available. Building on these features, the development of reduction scores for mitigation alternatives will then allow for the estimation of risk reduction along a circuit by mitigation. These features will allow for work plan develop that can identify a balanced mix of mitigations to address the risk profile of the circuit location.

4.5.2 Calculation of Key Metrics

Report details on the calculation of the metrics below. For each metric, a standard definition is provided with statute cited where relevant. The utility must follow the definition provided and detail the procedure they used to calculate the metric values aligned with these definitions. Utilities must cite all data sources used in calculating the metrics below.

1. ***Red Flag Warning overhead circuit mile days –*** *Detail the steps to calculate the annual number of red flag warning (RFW) overhead (OH) circuit mile days. Calculated as the number of overhead circuit miles that were under an RFW multiplied by the number of days those miles were under said RFW. Refer to Red Flag Warnings as issued by the National Weather Service (NWS). For historical NWS data, refer to the Iowa State University Iowa archive of NWS watch/warnings. Detail the steps used to determine if a circuit mile was under a Red Flag Warning, providing an example of how the RFW OH circuit mile days were calculated for a Red Flag Warning that occurred within utility territory over the last five years.*

   RFWs are issued by the NWS in defined fire zones (https://www.weather.gov/gis/FireZones). These zones are different from the typical NWS public forecast zones. Because the fire zones are used by the NWS for issuing RFWs, the PG&E overhead circuit miles were calculated by the PG&E GIS team for each of the NWS fire zone polygons that intersect and are within the PG&E territory. Then, RFW days for each year and/or quarter were calculated for each fire zone. A RFW day is defined as the number of days that a RFW was valid from issue date to expiration date. For example, if a RFW lasted for 12 hours before expiring, then it will be equal to 0.5 RFW days. Finally, the RFW overhead circuit mile days were calculated by multiplying the RFW days and the overhead miles for each NWS fire zone. All RFW overhead circuit mile days were summed up across the NWS fire zones to give the total RFW overhead circuit mile days. RFW archived data shapefiles were downloaded from the Iowa State University's public archived NWS Watch/Warning website (https://mesonet.agron.iastate.edu/request/gis/watchwarn.phtml).

2. ***High Wind Warning overhead circuit mile days*** – *Detail the steps used to calculate the annual number of High Wind Warning (HWW) overhead circuit mile days. Calculated as the number of overhead circuit miles that were under an HWW multiplied by the number of days those miles were under said HWW. Refer to High Wind Warnings as issued by the National Weather Service (NWS). For historical NWS data, refer to the Iowa State University Iowa archive of NWS watch/warnings.7 Detail the steps used to determine if an overhead circuit mile was under a High Wind Warning, providing an example of how the OH HWW circuit mile days were calculated for a High Wind Warning that occurred within utility territory over the last five years.*

   HWWs are issued by the NWS in defined NWS public forecast zones (https://www.weather.gov/gis/PublicZones), which are different from the NWS fire zones. The PG&E GIS team calculated the overhead circuit miles for all NWS public forecast zones that are within and intersect the PG&E territory. Then, HWW days were calculated for all the same NWS public forecast zones. A High Wind Warning Day is defined as the number of days that a High Wind Warning was valid from issue date to expiration date within an NWS public zone. For example, if a HWW was valid for six hours within a public zone, then the number of HWW days for that zone is equal to 0.25 days. Finally, the HWW overhead circuit mile days were calculated by multiplying the RFW days and overhead miles for each NWS public zone. All HWW overhead circuit mile days were summed up across the NWS public zones to give the total HWW overhead circuit mile days. HWW archived data shapefiles were downloaded from the Iowa State University's public archived NWS Watch/Warning website (https://mesonet.agron.iastate.edu/request/gis/watchwarn.phtml).

3. ***Access and Functional Needs population*** – *Detail the steps to calculate the annual number of customers that are considered part of the Access and Functional Needs (AFN) population. Defined in Government Code § 8593.3 and D.19-05-042 as individuals who have developmental or intellectual disabilities, physical disabilities, chronic conditions, injuries, limited English proficiency or who are non-English speaking,*[28] *older adults, children, people living in institutionalized settings, or those who are low income, homeless, or transportation disadvantaged, including, but not limited to, those who are dependent on public transit or those who are pregnant*

   PG&E follows the four step process as delineated below to calculate the annual number of customers that are considered part of the AFN population.

---

28 Guidance on calculating number of households with limited or no English proficiency can be found in D.20-04-003.

Step 1: Collect data from the following categories that apply to the CPUC's AFN definition for which data is available in PG&E databases:

1) Customers enrolled in the Medical Baseline program;
   - Data source: Medical baseline enrollment data
2) Customers enrolled in California Alternative Rates for Energy (CARE) program or Family Electric Rate Assistance (FERA) program;
   - Data source: CARE or FERA enrollment data
3) Customers that self-identify to receive an in-person visit before disconnection for non-payment (e.g., vulnerable);[29]
   - Data source: self-identification to receive in-person visit before disconnection for non-payment enrollment data
4) Customers that self-identify as having a person with a disability in the household (e.g., "disabled");[30]
   - Data source: self-identification as having a person with a disability in the household enrollment data
5) Customers who self-select to receive utility communications in non-standard format (e.g., in braille or large print)
   - Data source: self-selection to receive utility communications in non-standard data enrollment data
6) Customers who indicate a non-English language preference.
   - Data source: Non-English language preference enrollment data

Step 2: Calculate the number of customers in each of the six categories above and add them together.

---

29 In accordance with D.12-03-054, customers that are not enrolled or qualify for the Medical Baseline Program can "certify that they have a serious illness or condition that could become life threatening if service is disconnected." PG&E uses this designation to make an in-person visit prior to disconnection. This designation remains on their account temporarily for 90 days, and can be extended to 12 months if the customers submits an application. The customer characteristic, vulnerable senior, is no longer included in the Disconnect OIR based on D.20-06-003, p. 14, and therefore not included in this metric.

30 Customers can self-identify with PG&E that they have a person in the household with a disability. This customer designation currently has no end date. In accordance with D.12-03-054, customers who have previously been identified as disabled and who have identified a preferred form of communication, the utility shall provide all information concerning the risk of disconnection in the customer's preferred format (e.g. phone, text, email, TDD/TTY).

Step 3: Calculate the number of customers appearing in more than one of the above six categories.

Step 4: Subtract the result of Step 3 from the result of Step 2 to arrive at the total annual number of customers that are considered part of the AFN populations.

4. ***Wildlife Urban Interface*** *– Detail the steps to calculate the annual number of circuit miles and customers in Wildland Urban Interface (WUI) territory. WUI is defined as the area where houses exist at more than one housing unit per 40 acres and (1) wildland vegetation covers more than 50 percent of the land area (intermix WUI) or (2) wildland vegetation covers less than 50 percent of the land area, but a large area (over 1,235 acres) covered with more than 75 percent wildland vegetation is within 1.5 mi (interface WUI) (Radeloff et al., 2005).*

   PG&E identifies WUI areas within our service territory based upon data provided by the University of Wisconsin-Madison SILVIS Lab, available here: http://silvis.forest.wisc.edu/data/wui-change/, which shows the WUI areas within California as of 2010.

5. ***Urban, rural and highly rural*** *– Detail the steps for calculating the number of customers and circuit miles in utility territory that are in highly rural, rural, and urban regions for each year. Use the following definitions for classifying an area highly rural/rural/urban (also referenced in glossary):*

   - *Highly rural – In accordance with 38 CFR 17.701, "highly rural" shall be defined as those areas with a population of less than 7 persons per square mile as determined by the United States Bureau of the Census. For the purposes of the WMP, "area" shall be defined as census tracts.*

   - *Rural – In accordance with GO 165, "rural" shall be defined as those areas with a population of less than 1,000 persons per square mile as determined by the United States Bureau of the Census. For the purposes of the WMP, "area" shall be defined as census tracts.*

   - *Urban – In accordance with GO 165, "urban" shall be defined as those areas with a population of more than 1,000 persons per square mile as determined by the United States Bureau of the Census. For the purposes of the WMP, "area" shall be defined as census tracts.*

   Population density numbers are calculated using the American Community Survey (ACS) 1-year estimates on population density by census tract for each corresponding year (2016 ACS 1-year estimate for 2016 metrics, 2017 ACS 1-year estimate for 2017 metrics, etc.). For years with no ACS 1-year estimate available, we use the 1-year estimate immediately before the missing year (e.g., use 2019 estimate if 2020 estimate is not yet published).

4.6 Progress Reporting on Past Deficiencies

Report progress on all deficiencies provided in the 2020 WMP relevant to the utility. This includes deficiencies in Resolution WSD-002.

Summarize how the utility has responded and addressed the conditions in the table below. Reference documents that serve as part of the utility's response (e.g., submitted in the utility's Remedial Compliance Plan, location in 2021 WMP update, etc.). Note action taken by the WSD for Class A and B deficiencies (e.g. response found sufficient, response found insufficient and further action required, etc.).

In this section, PG&E lists the deficiencies identified by WSD for its 2020 WMP. For ease of reference, PG&E is providing separate tables for the Class A, Class B and Class C deficiencies identified in Resolutions WSD-002 and WSD-003. For referenced documents, PG&E is using the following terminology:

- **RCP** – The Remedial Compliance Plan submitted by PG&E on July 27, 2020.
- **First Quarterly Report** – the Quarterly Report submitted by PG&E on September 9, 2020 for the period May to July 2020.
- **Second Quarterly Report** – the Quarterly Report submitted by PG&E on December 9, 2020 for the period July to September 2020.
- **Third Quarterly Report** – the Quarterly Report submitted by PG&E on February 5, 2021, concurrent with the filing of the 2021 WMP, for the period October to December 2020.

On December 30, 2020, WSD provided a Notice of Non-Compliance regarding PG&E's RCP and additional action items for the Class A deficiencies addressed in the RCP. On January 8, 2021, WSD provided a Notice of Non-Compliance regarding PG&E's First Quarterly Report and additional action items for certain of the Class B conditions addressed in that report.

Below, in Table PG&E-4.6-1 for Class A action items and Table PG&E-4.6.2 for Class B action items, we have made each action item a separate row. In some cases, there are multiple action items for a single Class A or Class B deficiency, so this deficiency is repeated in each row with the separate action item.

Table PG&E-4.6-3 includes the Class C deficiencies identified by WSD.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing a discussion concerning its risk modeling approach, addressing each of the subparts of Action PGE-1	RCP, pp. 1-12 2021 WMP, Section 4.5.1	**Insufficient** **Action PGE-1 (Class A):** In its 2021 WMP update, PG&E shall elaborate on its risk modeling plans to explain: a. How it plans to use risk modeling to evaluate benefits for each individual initiative in its WMP; b. PG&E shall also detail current capabilities, future capabilities, and how it intends to use future capabilities; and c. The frequency of model updates.
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing a discussion concerning its vegetation probability model modeling approach, addressing each of the subparts of Action PGE-2	RCP, pp. 1-12 2021 WMP, Section 4.5.1	**Insufficient** **ACTION PGE-2 (Class A):** In its 2021 WMP update, regarding its vegetation probability model, PG&E shall: 1) include fall-ins and other vegetation-related instances within its probabilistic outputs; 2) describe how non-vegetation related outputs are excluded; and 3) describe the frequency and manner in which updates are performed.
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing a discussion concerning the weighting of financial consequence and spend in its MAVF.	RCP, pp. 1-12 2021 WMP, Section 4.2	**Insufficient** **ACTION PGE-3 (Class A):** In its 2021 WMP update, PG&E shall describe how financial consequence and spend is weighted within the MAVF.
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing a table describing its risk assessment techniques in the format used by SCE.	RCP, pp. 1-12 2021 WMP, Section 4.2	**Insufficient** **ACTION PGE-4 (Class A):** In its 2021 WMP update, PG&E shall submit a table describing its risk assessment techniques used for each initiative in the format used by Southern California Edison (SCE). [See SCE RCP at 9].

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing its updated OPW and wind data analysis and information concerning verification and granularity.	RCP, pp. 1-12 2021 WMP, Section 4.2.A	**Insufficient** **ACTION PGE-5 (Class A):** In its 2021 WMP update, PG&E shall: 1) refile the updated OPW and wind analysis data, 2) provide detail on how it has verified the accuracy of its OPW model and 3) how it accounts for less granularity in historic weather data due to fewer deployed weather stations.
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing a timeline of when it expects each initiative will be incorporated into its risk modeling.	RCP, pp. 1-12 2021 WMP, Section 4.2	**Insufficient** **ACTION PGE-6 (Class A):** In its 2021 WMP update, PG&E shall provide a timeline that shows when it expects each individual initiative in its WMP to be incorporated into its risk modeling.
Guidance-3	Lack of risk modeling to inform decision-making	PG&E is providing a discussion of benchmarks and peer validation for risk modeling.	RCP, pp. 1-12 2021 WMP, Section 4.5.1	**Insufficient** **ACTION PGE-7 (Class A):** In its 2021 WMP update, PG&E shall specify intended benchmarks for risk modeling and provide clearer detail on who has peer validated the models and how the review has been incorporated, including, but not limited to, a) qualifications and job titles of the "peers" who provided feedback in the Utility Analytics Institute Conference, b) the input and validation provided by such peers, and c) a description of how PG&E plans to or has incorporated such external peer review into its modeling efforts.
PGE-1	PG&E groups initiatives into programs and does not provide granular initiative detail	PG&E has addressed this action item in Section 4.6.2, Table 12 in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx, and Attachment 2021WMP_Class A_Action-PGE-8_Atch01.	RCP, pp. 13-19 First Quarterly Report, pp. 90-96 2021 WMP, Section 4.6.1 2021 WMP, Table 12 in Attachment 1 –	**Insufficient** **ACTION PGE-8 (Class A):** In its 2021 WMP update, PG&E shall: 1) update Tables 21-30 to reflect a quantitative value to accurately reflect risk reduction effectiveness instead of the current qualitative descriptions 2) provide a column describing the program under which initiative falls, and 3) provide the difference between the actual and forecasted amounts in comparison to the 2020 WMP Section 5.3 tables.

			All Data Tables Required by 2021 WMP Guidelines.xlsx. Attachment 2021WMP_Class A_Action-PGE-8_Atch01	

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-1	PG&E groups initiatives into programs and does not provide granular initiative detail	PG&E is providing the information requested regarding the Inspect App.	RCP, pp. 13-19 First Quarterly Report, pp. 90-96 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-9 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) provide the month for implementation of the Inspect App broken down between all patrol and inspection programs, as well as between distribution and transmission programs if such differ, 2) provide an explanation for any delays in implementing the Inspect App for certain programs, and 3) explain what qualifies the process to be "stabilized" for utilization on inspection type identification.
PGE-3	High incidence of conductor failure	PG&E is providing an analysis of its internal reports regarding it investigation of primary wire down events.	RCP, pp. 20-27 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-10 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) provide its analysis and any internal report(s) completed in regards to PG&E's internal investigation(s) on primary wire down events from conductor or splice failure, [As stated in Footnote 1 of PGE RCP on p. 21, PG&E can provide the substantial amount of data collected to run analysis, but WSD is more interested in the numerical conclusions drawn from the analysis (such as calculated failure rates for all conductor materials analyzed, failure rate by material per overhead circuit mile, failure rate of ASCR inside corrosion zones vs. outside, etc.) and any internal reports completed based on the analysis. The full data set is not necessary at this time]. 2) provide a summary of any conclusions or findings drawn relating to splice failure. 3) report on its evaluation of historical meteorology data versus distribution wires-down outage data.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-3	High incidence of conductor failure	PG&E is providing a discussion regarding Major Event Days and the information requested in the subparts of Action PGE-11.	RCP, pp. 20-27 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-11 (CLASS):** In its 2021 WMP update, PG&E shall elaborate on its MEDs by: 1) describing what PG&E uses as its Major Event Day identification threshold value (TMED), 2) providing the percentage of data not included in analysis due to MED data exclusion, both in terms of number of days and number of wire-down instances, and 3) explaining how PG&E intends to improve and expand MED reporting and why current circumstances allow for expanded MED reporting when the past did not.
PGE-3	High incidence of conductor failure	PG&E is providing a graph similar to Figure 10 for all weather metrics and sub-categories	RCP, pp. 20-27 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-12 (CLASS A):** In its 2021 WMP update, PG&E shall provide a graph similar to Figure 10 (PG&E RCP @ 25) which includes all weather metrics and sub-categories described in Section (3) (PG&E RCP @ 24) (e.g., Gray Sky, Storm Day, Northeast Wind).
PGE-3	High incidence of conductor failure	PG&E is providing a discussion regarding performing an analysis of the correlation between wind speeds and wire down events.	RCP, pp. 20-27 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-13 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) describe when it intends to perform an analysis on the correlation between wind speed and wire down events; 2) explain why it has not performed such an analysis yet; and 3) upon completion of this analysis, provide the percentage of outages and wire down events caused by conductor failure due to wind.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-3	High incidence of conductor failure	PG&E is providing a description of its prioritization for aluminum conductor replacements	RCP, pp. 20-27 2021 WMP, Section 7.3.3.3	**Insufficient** **ACTION PGE-14 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) provide an explanation as to how it is prioritizing replacing aluminum conductors in areas that overlap both corrosion zones and the HFTD, 2) if PG&E is not prioritizing aluminum conductors located in overlapping corrosion zones and HFTDs, explain why, and 3) explain whether any higher priority is given to aluminum conductor within corrosion zones outside of HFTDs.
PGE-3	High incidence of conductor failure	PG&E is re-submitting Attachments 3 and 4 in Excel format with the additional requested columns	RCP, pp. 20-27 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-15 (CLASS A):** In its 2021 WMP update, PG&E shall resubmit its RCP Attachments 3 and 4 in Excel format with the following additional columns: 1) region number 1-4 (as outlined in the National Electric Energy Testing, Research and Applications Center (NEETRAC) report); 2) corrosion area ranking (e.g., moderate, severe); 3) conductor material; and 4) number of splices along replaced portion. PG&E shall also provide similar tables for 2021 and 2022.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-3	High incidence of conductor failure	PG&E is providing a discussion of how hardened circuits will be reflected in future PSPS events	RCP, pp. 20-27 2021 WMP, Section 8.1	**Insufficient** **ACTION PGE-16 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) provide the timeline for which it expects "hardened" circuits to be "reflected" in future PSPS events; 2) define what "hardened" circuits consists of; 3) explain how "hardened" circuits will be "reflected" in future PSPS events (i.e., scope, location, thresholds for initiating); 4) explain how long it takes to perform the analysis to determine the impact of "hardened" circuits on PSPS; and 5) explain the factors that PG&E is monitoring and analyzing to determine the impact of "hardened" circuits on PSPS.
PGE-8	Annual risk ranking is quickly out of date	PG&E is providing a discussion of risk model updating, including the frequency of updates	RCP, pp. 28-32 2021 WMP, Section 4.5.1	**Insufficient** **ACTION PGE-17 (CLASS A):** In its 2021 WMP update, PG&E shall discuss whether it intends to update its asset risk model daily outside of a PSPS event, giving reasons. PG&E shall also discuss when it intends to implement more frequent than annual updates for distribution asset risk models and the frequency of such updates.
PGE-8	Annual risk ranking is quickly out of date	PG&E is providing a discussion of its distribution and transmission modeling, and the frequency of updating	RCP, pp. 28-32 2021 WMP, Section 4.5.1	**Insufficient** **ACTION PGE-18 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) discuss why it does not plan on using a similar methodology for its distribution asset risk model as compared to its transmission risk model, and 2) explain why it does not plan on updating the distribution model weekly, similar to the frequency used for updating its transmission model.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-8	Annual risk ranking is quickly out of date	PG&E is addressing the frequency of updating the condition of its distribution assets in its risk model	RCP, pp. 28-32 2021 WMP, Section 4.5.1	**Insufficient** **ACTION PGE-19 (CLASS A):** In its 2021 WMP update, PG&E shall provide an interim solution for more frequent than annual updates of distribution asset conditions in its risk model
PGE-8	Annual risk ranking is quickly out of date	PG&E is providing a discussion of its distribution asset health updates in its risk model	RCP, pp. 28-32 2021 WMP, Section 4.5.1	**Insufficient** **ACTION PGE-20 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) provide sufficient reasoning for the current lack of distribution asset health updates within its risk modeling, 2) explain why more frequent distribution asset health updates are not possible at this time, 3) provide a concrete timeline outlining each step in PG&E's process to updating each risk model, and 4) define the frequency of risk model updates in the interim before the 2022/2023 standardization with an explanation as to if and why PG&E finds that frequency sufficient.
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing the percentage of tag reprioritization information requested	RCP, pp. 33-42 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-21 (CLASS A):** In its 2021 WMP update, PG&E shall provide the percentage of priority "E" and "F" findings that were reprioritized to "A" or "B" from the 2019 to the 2020 inspection cycles within HFTDs.
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing an explanation regarding the use of 2013-2018 ignition data	RCP, pp. 33-42 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-22 (CLASS A):** In its 2021 WMP update, PG&E shall explain why it uses 2013-2018 ignition frequency for transmission and 2014-2019 for distribution when determining prioritization. [From page 35 of our RCP.]

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing a description of RSE calculations and the tables requested in Action PGE-23	RCP, pp. 33-42 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-23 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) explain how it determined the Risk Reduction and RSE values provided in Table 5 and provide an explanation of all inputs, relative weight of inputs, and list all algorithms used; 2) reproduce Table 5 with each column normalized per overhead circuit mile; and 3) submit an additional table for numbers in HFTD only and per circuit mile within HFTD.
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing a description of its preselected priority options	RCP, pp. 33-42 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-24 (CLASS A):** In its 2021 WMP update, PG&E shall provide all preselected priority options available within its inspections mobile application or any references available to properly classify field conditions.
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing a breakdown of enhanced inspection costs	RCP, pp. 33-42 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-25 (CLASS A):** In its 2021 WMP update, PG&E shall break down the additional costs of enhanced inspections compared to routine inspections.
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing a discussion of how its enhanced inspection and routine inspection programs are being addressed	RCP, pp. 33-42 2021 WMP, Section 7.3.4	**Insufficient** **ACTION PGE-26 (CLASS A):** In its 2021 WMP update, PG&E shall explain whether and where enhanced inspections have replaced or been merged with routine inspections. PG&E shall also describe the areas outside of the HFTD that have had routine inspections replaced by enhanced inspections.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-15	It is unclear how PG&E classifies findings as the appropriate level	PG&E is providing an update of Tables 6 and 7	RCP, pp. 33-42 2021 WMP, Table 1 (Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx) – metrics with "grid conditions findings from inspection"	**Insufficient** **ACTION PGE-27 (CLASS A):** In its 2021 WMP update, PG&E shall update Tables 6 and 7 to include Tag Find Rate per circuit mile inspected instead of per pole/structure inspected.
PGE-25	Lack of details to address personnel shortages	PG&E is providing a discussion of how it identifies effective contract employees	RCP, pp. 43-48 2021 WMP, Section 5.4.2	**Insufficient** **ACTION PGE-28 (CLASS A):** In its 2021 WMP update, PG&E shall describe its process for identifying the most effective contract employees.
PGE-25	Lack of details to address personnel shortages	PG&E is providing a discussion of how it is working with other utilities on resources	RCP, pp. 43-48 2021 WMP, Section 5.4.2	**Insufficient** **ACTION PGE-29 (CLASS A):** In its 2021 WMP update, PG&E shall provide further explanation on how it is working with other utilities to ensure that it is not limiting other utilities' resources.
PGE-25	Lack of details to address personnel shortages	PG&E is providing a discussion of the increase in its external VM workforce	RCP, pp. 43-48 2021 WMP, Section 5.4.2	**Insufficient** **ACTION PGE-30 (CLASS A):** In its 2021 WMP update, PG&E shall describe the increase in external VM workforce from 2018 to 2020.
PGE-25	Lack of details to address personnel shortages	PG&E is providing a discussion of the VM information requested in Action PGE-31	RCP, pp. 43-48 2021 WMP, Section 5.4.1	**Insufficient** **ACTION PGE-31 (CLASS A):** In its 2021 WMP update, PG&E shall: 1) describe how long it takes to complete tree crew training, 2) describe the type of certification earned upon the completion of pre-inspector training, 3) elaborate on how PG&E supports obtaining an International Society of Arboriculture (ISA) certification, 4) provide the number and percentage of contracted versus internal pre-inspectors and describe

				whether contracted pre-inspectors undergo the same training as internal pre-inspectors, 5) describe how PG&E ensures proper certification of contracted pre-inspectors, and 6) explain how it ensures proper training is completed by subcontractors.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-25	Lack of details to address personnel shortages	PG&E is providing a discussion of how it prioritizes work based on labor constraints.	RCP, pp. 43-48 2021 WMP, Section 5.4.2	**Insufficient** **ACTION PGE-32 (CLASS A):** In its 2021 WMP update, PG&E shall describe how it prioritizes work based on labor constraints. Specifically, PG&E shall discuss whether it has reduced the scope of VM work due to labor constraints and, if so, explain the analysis to support that decision-making, including risk assessment and prioritization.
PGE-26	Effectiveness of increased vegetation clearances	PG&E is providing a description of how it intends to analyze and use vegetation clearance data and analyze data regarding EVM effectiveness.	RCP, pp. 49-53 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-33 (CLASS A):** In its 2021 WMP update, PG&E shall 1) provide a detailed plan for how it intends to analyze and use extended vegetation clearance data specifically, including specific statistical methods it intends to use and how it will control for environmental variables (e.g., wind, soil, elevation, species), and 2) provide a plan on how PG&E will continue analyzing and collecting data relating to measuring EVM effectiveness.
PGE-26	Effectiveness of increased vegetation clearances	PG&E is providing an explanation of how it calculated effectiveness for certain sub-drivers.	RCP, pp. 49-53 2021 WMP, Section 4.6.1	**Insufficient** **ACTION PGE-34 (CLASS A):** In its 2021 WMP update, PG&E shall explain how it calculated the effectiveness for each sub-driver shown in Table 8 and include all inputs and algorithm(s) used.
PGE-26	Effectiveness of increased vegetation clearances	PG&E is working with SCE and SDG&E to develop a plan for the items requested in Action PGE-35. This information will be provided in the 2/26 filing.	RCP, pp. 49-53 2/26 submission	**Insufficient** **ACTION PGE-35 (CLASS A):** In its 2021 WMP update, PG&E along with SCE and SDG&E shall submit a joint, unified plan that reflects collaborative efforts and contains uniform definitions, methodology, timeline, data standards, and assumptions.

TABLE PG&E-4.6-1: LIST OF CLASS A DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-27	Public safety partner coordination	PG&E is providing a description of how it chooses PSPS Advisory Committee representatives.	RCP, pp. 54-64 2021 WMP, Section 7.3.10.1	**Insufficient** **ACTION PGE-36 (CLASS A):** In its 2021 WMP update, PG&E shall describe how it vets and chooses PSPS Advisory Committee representatives.
PGE-27	Public safety partner coordination	PG&E is providing a discussion of how it intends to communicate with the counties identified.	RCP, pp. 54-64 2021 WMP, Section 7.3.10.1	**Insufficient** **ACTION PGE-37 (CLASS A):** In its 2021 WMP update, PG&E shall explain how it intends to remedy the lack of communication with the three counties that declined to meet for the Wildfire Safety Working Sessions.
PGE-27	Public safety partner coordination	PG&E is providing the requested list of contacts.	RCP, pp. 54-64 2021 WMP, Section 7.3.10.1 2021WMP_Section-7.3.10.1_Atch01	**Insufficient** **ACTION PGE-38 CLASS A):** In its 2021 WMP update, PG&E shall provide a list of every PG&E contact and their counterparts and the cities, counties, tribal governments, and first responder entities and description of their interaction.
PGE-27	Public safety partner coordination	PG&E is providing a discussion of how it intends to approach PSPS meetings to provide adequate communication.	RCP, pp. 54-64 2021 WMP, Section 5.3.10.1	**Insufficient** **ACTION PGE-39 (CLASS A):** In its 2021 WMP update, PG&E shall explain how it intends to remedy any planned meetings that were not completed and ensure adequate communication is maintained when meetings are not held.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-1	Lack of risk RSE Information	PG&E provides a description of how both ignition risk and wildfire consequence risk are used in calculation	First Quarterly Report, pp. 1-14 Subpart 1 – 2021 WMP Section 4.2 Subpart 2 - 2/26 submission	**Insufficient** **ACTION PGE-1 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) further describe why either ignition risk and wildfire consequence risk is calculated instead of calculating both, and 2) provide an explanation for each initiative as to why it either reduces ignition risk or wildfire consequence risk, but not both.
Guidance-1	Lack of risk RSE Information	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 1-14 2/26 submission	**Insufficient** **ACTION PGE-2 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide an RSE calculation for fuel and slash management, and 2) provide a description of how this value was calculated.
Guidance-1	Lack of risk RSE Information	PG&E clarified the scope of the System Hardening project and provided more details and updates related to the project. PG&E also attached data tables to clarify the assumptions and figures.	First Quarterly Report, pp. 1-14 2021 WMP Section 7.3.3	Insufficient **ACTION PGE-3 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain why only hardening efforts are identified within a higher risk tranche as a solution for the 7,100 miles scoped for system hardening, and no other initiatives are viable as a solution, 2) define what hardening consists of in regards to the 7,100 miles identified to be hardened, 3) provide the supporting materials and calculations showing that assets in the 7,100 is 2.75 more likely to fail, including all conclusions as to the reason why the failure rate is higher, 4) the location of the 7,100 miles, and 5) the explanation of the overlap and increase for these 7,100 and the 5,500 discussed in PGE-5 identified for hardening.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-1	Lack of risk RSE Information	PG&E has provided definitions and data around large catastrophic fires greater than 300 acres, including those during RFW conditions	First Quarterly Report, pp. 1-14 2021 WMP Section 4.2	**Insufficient** **ACTION PGE-4 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) clarify what is meant by "the likelihood of a large 300-acre fire of exponentially spreading and becoming catastrophic or destructive is closer to 70 percent,"13 2) provide the percentage of ignitions that lead to fires greater than 300-acres, 3) explain why PG&E finds 300-acres to be of significant value, 4) define what PG&E's understanding of "catastrophic" fire is in the context of less than 1 percent of ignitions leading to a catastrophic fire, 5) provide the percent of ignitions that lead to catastrophic fires during Red Flag Warning (RFW) conditions.
Guidance-1	Lack of risk RSE Information	PG&E has explained how the failure rates for various tags have been calculated along with power-line failure rate. PG&E has also provided details of the team of SMEs responsible to determine such failure rates. Finally PG&E has explained how collaboration between various IOUs are being used to fine tune the model.	First Quarterly Report, pp. 1-14 2021 WMP Section 4.2	**Insufficient** **ACTION PGE-5 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide in-depth explanations as to how a failure rate of 70 percent for Priority A tags, 50 percent for Priority B tags, and 1 percent for Priority E and F tags was calculated, 2) provide an in-depth explanation as to how a power-line failure rate from vegetation of 70 percent was calculated, 3) describe the SMEs used to determine such failure rates, and 4) implement industry standard and best practices into determining such failure rates, or describe how such have been implemented..
Guidance-2	Lack of alternatives analysis for chosen initiatives	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 15-24 2/26 submission	**Insufficient** **ACTION PGE-6 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide an explanation of what "limited alternatives considered" consists of for all initiatives in which PG&E provided such explanation in Table 1, 2) use the terminology of "no alternatives considered" if "limited" does not include anything substantive, and 3) reevaluate all initiatives with "limited" or no alternatives considered to include actual alternatives analysis.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-2	Lack of alternatives analysis for chosen initiatives	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 15-24 2/26 submission	**Insufficient** **ACTION PGE-7 (CLASS B):** In its 2021 WMP Update, PG&E shall provide a table similar to Table 1 evaluating how initiatives interact with one another as alternatives when deciding implementation.
Guidance-2	Lack of alternatives analysis for chosen initiatives	PG&E explains the pilot of the use of fire retardant	First Quarterly Report, pp. 15-24 2021 WMP Section 7.3.3.5	**Insufficient** **ACTION PGE-8 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) discuss how PG&E is piloting the use of fire retardant, including how PG&E is choosing areas to undergo the pilot, 2) discuss how long it takes to deploy fire retardant, including when such a decision would be made, 3) describe the environmental permitting process needed for deployment of fire retardant, and 4) explain what continuing "to explore the potential of this 'fail safe' alternative"14 consists of.
Guidance-2	Lack of alternatives analysis for chosen initiatives	PG&E clarifies that the System Hardening Hybrid Program was being considered as an alternative program in 2020 and is not implemented	First Quarterly Report, pp. 15-24 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-9 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide details on the System Hardening Hybrid Program, particularly when comparing it to covered conductor and the standard system hardening projects discussed within the WMP, 2) when comparing the system hardening hybrid to standard hardening, provide the risk reduction per mile implemented, 3) provide the locations in which the system hardening hybrid has been deployed and piloted, including an explanation of the rationale and any supporting calculations to determine the use of the hybrid over standard hardening approach in those areas, and 4) provide the locations in which the system hardening hybrid is planned to be deployed, including an explanation of the rationale and any supporting calculations to determine the use of the hybrid over standard hardening approach in those areas.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-2	Lack of alternatives analysis for chosen initiatives	PG&E clarifies that the Wildfire Targeted Syetm Upgrades was being considered as an alternative program in 2020 and is not implemented	First Quarterly Report, pp. 15-24 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-10 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide details on the Wildfire Targeted System Upgrades, particularly when comparing it to covered conductor and other system hardening projects discussed within the WMP, 2) when comparing the Wildfire Targeted System Upgrades to covered conductor, provide the risk reduction per mile implemented; 3) provide the locations in which Wildfire Targeted System Upgrades have been deployed and piloted, including an explanation as to the reasoning and any supporting calculations to determine the use of upgrades in those areas, and 4) provide the locations in which the upgrades are planned to be deployed, including an explanation as to the reasoning and any supporting calculations to determine the use of upgrades in those areas.
Guidance-4	Lack of discussion of PSPS impacts	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 25-27 2/26 submission	**Insufficient** **ACTION PGE-11 (CLASS B):** In its 2021 WMP Update, PG&E shall provide quantitative values for all initiatives for all subparts included in Condition Guidance-4.
Guidance-4	Lack of discussion of PSPS impacts	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 25-27 2/26 submission	**Insufficient** **ACTION PGE-12 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) analyze how initiatives will impact subparts (i), (ii), and (iii) based on “protection zone,” and 2) define what PSPS area was used for such analysis.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-4	Lack of discussion of PSPS impacts	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 25-27 2/26 submission	**Insufficient** **ACTION PGE-13 (CLASS B):** In its 2021 WMP Update, PG&E shall reevaluate all initiatives for reduction in PSPS duration, including any indirect impacts.
Guidance-4	Lack of discussion of PSPS impacts	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 25-27 2/26 submission	**Insufficient** **ACTION PGE-14 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) reevaluate all initiatives and state if they directly support the "Evolution of the PSPS Program" (as outlined on p. 4-24 of the 2020 WMP), and 2) if so, expand on how the initiative directly supports the "Evolution of the PSPS Program."
Guidance-5	Aggregation of initiatives into programs	PG&E explains that the linear relationship is assumed based on conservative estimates and includes the Technosylva Fire Probability Dataset	First Quarterly Report, pp. 28-31 2021 WMP Section 4.2	**Sufficient** **ACTION PGE-15 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) describe why it used a linear relationship between probability of fire type and time passed, and 2) provide supporting materials showing a linear relationship.
Guidance-5	Aggregation of initiatives into programs	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 28-31 2/26 submission	**Sufficient** **ACTION PGE-16 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) list all initiatives in which it is developing a quantitative threshold, 2) provide a timeline and status update for when it intends to develop such quantitative evaluations for each initiative, and 3) explain what sort of SME expertise is being used for the development of each quantitative value.
Guidance-6	Failure to disaggregate WMP initiatives from standard operations	Not Applicable	First Quarterly Report, pp. 32-35	**Sufficient**

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-7	Lack of detail of effectiveness of enhanced inspection programs	PG&E defines what is meant by Asset Improvement Opportunities and explains how enhanced inspections allow for "building for the future" and system trending for these opportunities	First Quarterly Report, pp. 36-39 2021 WMP Section 7.3.4.2	**Insufficient** **ACTION PGE-17 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) define "asset investment opportunities" and, 2) explain how these opportunities benefit from enhanced inspections.
Guidance-9	Insufficient discussion of pilot programs	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 40-43 Second Quarterly Report, pp. 1-6 2/26 submission	**Insufficient** **ACTION PGE-18 (CLASS B):** In its 2021 WMP Update, PG&E shall provide a refiling of Attachment 1 from its QR filing that includes a column with quantitative values for both performance and risk reduction.
Guidance-10	Data issues - general	Not Applicable	First Quarterly Report, pp. 44-48 Second Quarterly Report, pp. 7-15	WSD has indicated that this deficiency is being addressed separately.
Guidance-11	Lack of detail on plans to address personnel shortage	PG&E explains that Qualified Electrical Worker Journeyman Lineman can be either promoted from within or hired from outside, in each of which cases there are minimum qualifications and/ or apprenticeship requirements to be fulfilled	First Quarterly Report, pp. 49-58 2021 WMP Section 5.4.3	**Insufficient** **ACTION PGE-19 (CLASS B):** In its 2021 WMP Update, PG&E shall differentiate and describe the differences between the hiring and training process of an outside hire compared to an internal promotion or reassignment.
Guidance-11	Lack of detail on plans to address personnel shortage	PG&E explains the details of training related to the System Instpections Program QCR position and further describes additional training/ ceritifications for contracted positions as well	First Quarterly Report, pp. 49-58 2021 WMP Section 5.4.3	**Insufficient** **ACTION PGE-20 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the details regarding the internal training course required in order to qualify for a System Inspections Program QCR position, including: a) a description of the materials it covers, b) components of the course (such as WBT, OJT,22 etc.), and c) the length of time it takes to complete each component of the course.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-11	Lack of detail on plans to address personnel shortage	PG&E explains contractual terms that expect the contracted QEWs to be trained by the vendor	First Quarterly Report, pp. 49-58 2021 WMP Section 5.4.3	**Insufficient** **ACTION PGE-21 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain why Journeyman Lineman trainings are not provided to contracted QCR inspectors, and 2) describe any assessment taken to demonstrate qualifications of Journeyman Lineman regarding "routine job knowledge," or explain why PG&E does not find it necessary, if one is not required.
Guidance-11	Lack of detail on plans to address personnel shortage		First Quarterly Report, pp. 49-58 Attachment 2021WMP_Class B_Action-PGE-22_Atch01	**Insufficient** **ACTION PGE-22 (CLASS B):** In its 2021 WMP Update, PG&E shall develop and present a performance scorecard for vegetation management contractors similar to the scorecard used to evaluate the performance of construction contractors.
Guidance-11	Lack of detail on plans to address personnel shortage	PG&E explains current multi-day program orientation traininf and plans to improve worker qualification	First Quarterly Report, pp. 49-58 2021 WMP Section 5.4.3	**Insufficient** **ACTION PGE-23 (CLASS B):** In its 2021 WMP Update, PG&E shall implement an assessment for all external recruits in order to ensure proper training levels are met.
Guidance-12	Lack of detail on long-term planning	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 59-89 2/26 submission	**Sufficient** **ACTION PGE-24 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) define what "continue" or "increase" means for each instance it is used from Tables 4 to 13, and 2) either a) implement quantitative benchmarks that are reasonable and achievable for each such instance, or b) explain how it intends to track progress of each instance if a quantitative benchmark is not provided.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-12	Lack of detail on long-term planning	PG&E has included a section on long term planning under each initiative (after 5) Future Improvements to Initiative)	First Quarterly Report, pp. 59-89 2021 WMP Section 7 under each initiative	**Sufficient** **ACTION PGE-25 (CLASS B):** In its 2021 WMP Update, PG&E shall integrate discussion on long-term planning within the respective section of each individual initiative.
PGE-2	Equipment failure	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 97-107 2/26 submission	**Insufficient** **ACTION PGE-26 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain why equipment failure is used as the current default for ignition cause, 2) provide the percentage of ignitions from 2016 to 2020 that are inaccurately characterized as equipment failure causes, 3) describe how PG&E checks for accuracy of ignition cause determinations currently, including any supporting documentation and procedures, 4) explain how PG&E plans to change the inaccurately documented ignition cause of "equipment failure" moving forward, including changes in procedures, training of first responders, and QA/QC checks for accuracy, 5) explain how PG&E plans on remedying inaccurately documented past ignition causes (include all relevant plans, if they differ from the plan for more accurate documentation in the future), and 6) provide a timeline for when PG&E intends to complete these improvements.
PGE-2	Equipment failure		First Quarterly Report, pp. 97-107 2021 WMP Section 7.3.3.3	**Insufficient** **ACTION PGE-27 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the percentage and overhead circuit mileage of small copper conductor replacement projects that fall within HFTD areas, 2) explain how PG&E is prioritizing small copper replacement projects, and 3) explain any parallel upgrades (pole replacements, crossarm repairs, etc.) PG&E is performing that are compatible with small copper conductor replacements, including how such are prioritized.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-2	Equipment failure	PG&E explains how data from a consortium of utilities are used to benchmark across a variety of topics and metrics	First Quarterly Report, pp. 97-107 2021 WMP Section or 4.6.2	**Insufficient** **ACTION PGE-28 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide a list of the electrical corporations PG&E has worked with so far regarding identification of high equipment failure rates, and 2) explain how PG&E is working with each of the other utilities regarding data comparisons.
PGE-2	Equipment failure	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 97-107 2/26 submission	**Insufficient** **ACTION PGE-29 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) indicate which subset of outages in Table 17 it considers to be near-miss ignition events, 2) explain what each subcategory of "Unknown" or "Other" consists of in Tables 16 and 17 of PG&E's QR, and 3) explain in more detail all "Unknown" and "Other" values, including what is included within those values.
PGE-5	Use of relative risk scoring method	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 108-112 2/26 submission	**Insufficient** **ACTION PGE-30 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide a list of all changes to equipment as described in PG&E's QR response that would cause GIS data to no longer accurately reflect the original location of the 600 miles missing from the GIS data, 2) describe why the "start and end point" of circuit segments would no longer exist within the GIS data, broken down by percentage of cause (e.g., conductor replacement, full equipment replacements, facility removals), and 3) explain whether PG&E has completely replaced or hardened these 600 miles of its distribution system and thus no longer considers them part of the highest priority circuit segments, or if not, explain the cause of the missing information.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-5	Use of relative risk scoring method	PG&E has provided rationale and data supporting the questions in this action	First Quarterly Report, pp. 108-112 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-31 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) describe how it has calculated overall wildfire risk in a similar manner as the 5,500 miles for system hardening to identify the most high-risk circuits, 2) provide the locations via GIS files on such high-risk circuits, 3) provide the percentage of the 5,500 miles fall under the total identified high-risk circuits, 4) describe how the determination of high-risk circuits was used to prioritize WMP initiatives, and 5) explain how PG&E's risk modeling considers a range of potential mitigation types, rather than assuming system hardening is the appropriate mitigation.
PGE-5	Use of relative risk scoring method	PG&E explains how the system hardening initiatves will be prioritized in the future	First Quarterly Report, pp. 108-112 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-32 (CLASS B):** In its 2021 WMP Update, PG&E shall explain how the system hardening initiatives provided in this response are prioritized in comparison to one another.
PGE-5	Use of relative risk scoring method	PG&E clarifies that it is no longer targeting a specific set of miles for system hardening	First Quarterly Report, pp. 108-112 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-33 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the number of circuit miles and percentage of the 5,500 identified miles each of the targeted approaches consist of, and 2) provide the GIS file for the locations of each targeted approach.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-5	Use of relative risk scoring method	PG&E described how certain information and risk scores were used to prioritize initiatives.	First Quarterly Report, pp. 108-112 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-34 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the number and percentage of circuit miles out of the 5,500 miles in which EVM work is being completed, 2) provide the location of such miles via GIS, 3) provide the number and miles in which the high risk circuits identified with the Distribution EVM model overlap with the 5,500 miles, and 4) provide the location of the circuit miles in GIS and in accordance with data attributes and metadata specified in the WSD's GIS data reporting requirements.
PGE-5	Use of relative risk scoring method	PG&E explains the assumptions around the RSE increase	First Quarterly Report, pp. 108-112 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-35 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) describe the reason behind the increase in RSE for system hardening between 2020-2022 and 2023-2026, and 2) provide the calculations used to determine the RSEs for both date ranges.
PGE-5	Use of relative risk scoring method	PG&E explains the prioritization of the System Hardening Program's goal	First Quarterly Report, pp. 108-112 2021 WMP Section 7.3.3.17.1	**Insufficient** **ACTION PGE-36 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain how and why the 1,060 miles were prioritized, and 2) provide the location of the 1,060 circuit miles via GIS.
PGE-6	Discrepancy between ignition reduction projections	N/A	First Quarterly Report, pp. 113-117	**Sufficient**

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-7	Line risk scoring sufficiently incorporates all risks that cause ignition and PSPS	PG&E explains the definition of conductor age/ estimated age used in the EDGIS	First Quarterly Report, pp. 118-122 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-37 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the age score used for each conductor installation year, and 2) explain how it calculates the age score input for Sub-Model #1 when it has not provided complete conductor age information to the WSD in its GIS data submissions to date.
PGE-7	Line risk scoring sufficiently incorporates all risks that cause ignition and PSPS	PG&E explains the integration of new inputs into its risk modeling	First Quarterly Report, pp. 118-122 2021 WMP Section 4.5.1 Section 4.3 (b) Section 4.3 (c)	**Insufficient** **ACTION PGE-38 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide an update to the status of integrating any new inputs into its risk modeling, and 2) describe how such new inputs have been integrated into its risk modeling.
PGE-7	Line risk scoring sufficiently incorporates all risks that cause ignition and PSPS	PG&E provides a timeline and rationale of including new data inputs into the risk modeling	First Quarterly Report, pp. 118-122 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-39 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the timeline in detail for when it plans to include all outstanding inputs, broken down by each input.
PGE-7	Line risk scoring sufficiently incorporates all risks that cause ignition and PSPS	Same as above (Action PGE-39 Class B)	First Quarterly Report, pp. 118-122 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-40 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) describe in detail how each of the currently outstanding inputs will contribute to PG&E's modeling efforts, 2) describe how PG&E determined the need to include each of these inputs, and 3) further explain why each of these inputs were not already included within modeling efforts.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-9	Weighing egress as a risk factor	PG&E explains how egress is no longer factors into the risk modeling	First Quarterly Report, pp. 123-124 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-41 (CLASS B):** In its 2021 WMP Update, PG&E shall explain how egress is weighted against other factors during risk modeling and selection of initiatives.
PGE-9	Weighing egress as a risk factor	Same as above (Action 41 Class B)	First Quarterly Report, pp. 123-124 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-42 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide a quantitative description of how egress score is calculated and incorporated into its prioritization calculations, particularly in comparison to the other factors, 2) explain how it factors in identification of wooden poles near evacuation routes. If such information is not currently factored in, explain why, and ensure that wooden poles are included as a factor for calculating egress in its 2021 WMP Update, and 3) provide an example showing the calculation of egress assessment.
PGE-10	Sufficient weather station coverage	PG&E provided an updated description of its weather station coverage.	First Quarterly Report, pp. 125-127 2021 WMP Section 7.3.2.1.3	**Insufficient** **ACTION PGE-43:** In its 2021 WMP Update, PG&E shall: 1) provide the locations via GIS of the 111 stations awaiting installation, and 2) explain how PG&E chose these 111 locations.
PGE-10	Sufficient weather station coverage	PG&E provided an updated description of its weather station coverage including benefits of weather stations far from PG&E assets	First Quarterly Report, pp. 125-127 2021 WMP Section 7.3.2.1.3	**Insufficient** **ACTION PGE-44 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain why it finds installation of weather stations far from PG&E electrical assets to be necessary, and 2) explain how installation of such weather stations will augment its situational awareness.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-10	Sufficient weather station coverage	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 125-127 2/26 submission	**Insufficient** **ACTION PGE-45 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the internal cost/benefit analysis being conducted in the interim while a program is being developed.
PGE-11	Additional relevant reports	PG&E provided the reports and documents requested by this deficiency.	First Quarterly Report, pp. 128-135 Second Quarterly Report, pp. 16-18	**Sufficient**
PGE-12	Fuse replacement program planned to take 7 years	PG&E further clarified the scope of the fuse replacement program in 2021	First Quarterly Report, pp. 136-138 2021 WMP Section 7.3.37	**Insufficient** **ACTION PGE-46 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain whether it is increasing the scope of fuse replacements and, if so, why, 2) explain whether the replacement of the originally identified fuses (i.e., 625 per year) are being prioritized before replacement of those in the increased scope (i.e., 1,200 per year), and 3) describe how prioritization has changed since the initial scope in 2019.
PGE-12	Fuse replacement program planned to take 7 years	Attachment provided with GIS locations	First Quarterly Report, pp. 136-138 See attachment: 2021WMP_Class B_Action-PGE-47_Atch01	**Insufficient** **ACTION PGE-47 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the locations via GIS of the fuses that have already been replaced.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-12	Fuse replacement program planned to take 7 years	PG&E provides a cost benefit analysis of fuse replacements	First Quarterly Report, pp. 136-138 2021 WMP Section 7.3.3.7	**Insufficient** **ACTION PGE-48 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the cost/benefit analysis performed regarding fuse replacements, including the calculation of reduction of VM costs per fuse replaced.
PGE-13	Factors limiting microgrid deployment	PG&E details the use of microgrid sites/ backup sites during 2020 PSPS event	First Quarterly Report, pp. 139-145 2021 WMP Section 7.3.3.11.1	**Insufficient** **ACTION PGE-49 (CLASS B):** In its 2021 WMP Update, PG&E shall provide additional information about its specific backup generation sites, including a) the number of times used and b) challenges faced with the completion of this project and its operation.
PGE-13	Factors limiting microgrid deployment	PG&E describes the rationale for deploying microgrid sites	First Quarterly Report, pp. 139-145 2021 WMP Section 7.3.3.11.1	**Insufficient** **ACTION PGE-50 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the cost/benefit analysis completed for microgrids as a mitigation, and 2) define what is meant by a "bridge" solution and "other solutions" and 3) include a timeline for how long an interim "bridge" solution would be in place.
PGE-13	Factors limiting microgrid deployment	PG&E describes the microgrip initiative in detail	First Quarterly Report, pp. 139-145 2021 WMP Section 7.3.3.17.5	**Insufficient** **ACTION PGE-51 (CLASS B):** In its 2021 WMP Update, PG&E shall expand on the remote grid initiative in detail and explain the feasibility of it.
PGE-14	Level 3 findings	PG&E *explains how the models in Table 7 assess the potential between risk levels on safety and reliability*	First Quarterly Report, pp. 146-151 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-52 (CLASS B):** In its 2021 WMP Update, PG&E shall explain how the models in Table 7 assess the potential between risk levels on safety and reliability for the purposes of classifying priority levels in accordance with Rule 18.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-14	Level 3 findings	PG&E outlines risk modeling capabilities across the Maturity Survey categories today and shows the planned progress over the next three years from 2021 to 2023	First Quarterly Report, pp. 146-151 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-53 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) create a framework for the maturation of risk modeling outlining each step, including a timeline for completion and progress updates, and 2) Expand on the details of each step.
PGE-17	Inspections using infrared technology	PG&E provides clarification on the IR findings	First Quarterly Report, pp. 152-154 2021 WMP Section 7.3.4.4	**Insufficient** **ACTION PGE-54 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the source that states 70 percent of IR findings are not identified visually, and 2) provide the percentage of PG&E findings via IR that were not identified during prior visual inspections.
PGE-17	Inspections using infrared technology	PG&E provides a discussion on risk reduction and cost savings of its infrared inspections	First Quarterly Report, pp. 152-154 2021 WMP Section 7.3.4.4	**Insufficient** **ACTION PGE-55 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the expected risk reduction for using IR inspections, as well as all inputs and algorithms used for the calculation, and 2) provide the estimated cost savings, both overall and per Overhead (OH) circuit mile, that IR inspections provide.
PGE-17	Inspections using infrared technology	PG&E provides clarification the splice count using infrared inspections	First Quarterly Report, pp. 152-154 2021 WMP Section 7.3.4.4	**Insufficient** **ACTION PGE-56 (CLASS B):** In its 2021 WMP Update, PG&E shall explain why IR inspections are used to determine splice count, and why it does not currently retain that information otherwise.
PGE-18	Hazard tree analysis focus on at-risk trees	PG&E provides a clarification on prioritization in the hazard tree program	First Quarterly Report, pp. 155-161 2021 WMP Section 7.3.5.15	**Insufficient** **ACTION PGE-57 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain the prioritization of hazard tree work in relation to the highest risk areas, and 2) prioritization of work relative to TAT scoring.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-18	Hazard tree analysis focus on at-risk trees	PG&E clarifies that while it does not hve a top 10 list for at-risk species, it maintains a list of highest estimated overall EVM risk per region	First Quarterly Report, pp. 155-161 2021 WMP Section 7.3.5.15	**Insufficient** **ACTION PGE-58 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the top 10 at-risk EVM species categorized by geographical area,31 and 2) provide a list of vegetation work prescribed based on specific tree species, if such exists and differs from at-risk identification.
PGE-18	Hazard tree analysis focus on at-risk trees	PG&E provides data on the green hazard tree program.	First Quarterly Report, pp. 155-161 2021 WMP Section 7.3.5.15	**Insufficient** **ACTION PGE-59 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the percentage of trees within PG&E's inventory that are classified as a "Green Hazard Tree," and 2) provide the percentage of both "Green Hazard Trees" worked and removed in relation to a) identified "Green Hazard Trees," b) total tree inventory, c) work performed on tree inventory, and d) total tree removals.
PGE-19	Low pass rate on EVM QA	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 162-167 2/26 submission	**Insufficient** **ACTION PGE-60 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) describe what WV consists of when comparing the 2019 audit to the 2020 audit, and 2) provide all criteria for both the 2019 and 2020 pass rates.
PGE-19	Low pass rate on EVM QA	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 162-167 2/26 submission	**Insufficient** **ACTION PGE-61 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) define what "Pass w/Observations" consists of, including all supporting procedures and criteria, and 2) provide a list of the observations made that "Pass w/ Observations" consists of from Table 21.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-19	Low pass rate on EVM QA	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 162-167 2/26 submission	**Insufficient** **ACTION PGE-62 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide details on specific capabilities being implemented to improve inspection pass rates, 2) the cost increase or savings of each capability, and 3) the timeline for implementation of each capability, including past dates for any already implemented.
PGE-19	Low pass rate on EVM QA	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 162-167 2/26 submission	**Insufficient** **ACTION PGE-63 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the 2019 and 2020 monthly passing rate both in miles and percent, including the breakdown between "Pass" and "Pass w/Observation," 2) explain whether criteria for pass rate changed, along with the month in which new criteria was utilized, and 3) continue providing monthly results in PG&E's future WMP and QR filings.
PGE-20	Redistributing resources to focus on transmission clearances	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 168-170 2/26 submission	**Insufficient** **ACTION PGE-64 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain where the numbers in Table 22 originated and why they differ from Table 11-2, 2) provide a revision of Table 22 showing only transmission-related ignitions caused by vegetation contact, and 3) include an additional row showing transmission-related ignitions caused by vegetation contact that led to fires greater than 500-acres.
PGE-20	Redistributing resources to focus on transmission clearances	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 168-170 2/26 submission	**Insufficient** **ACTION PGE-65 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) include an estimated change from 2019 to 2020 in personnel hours for a) distribution EVM work and b) TVM work, and 2) provide the targeted miles for 2019 and 2020 of TVM.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-21	Describe why additional programs for transmission clearances are necessary	PG&E provides further clarification and data associated with TVM	First Quarterly Report, pp. 171-174 2021 WMP Section 8.2.2	**Insufficient** **ACTION PGE-66 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the percent reduction to transmission de-energization during PSPS events associated with TVM, including a description and supporting data of how such was calculated, 2) describe how PG&E factors in areas that have not undergone TVM when determining transmission de-energization during PSPS events, including all supporting procedures and models used, and 3) describe all instances in which a transmission line stayed energized due to TVM being completed, where it otherwise would have been subject to PSPS.
PGE-21	Describe why additional programs for transmission clearances are necessary	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 171-174 2/26 submission	**Insufficient** **ACTION PGE-67 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the number of OH circuit miles tested in the transmission ROW Expansion Program, 2) break down the number of vegetation-caused outages per year for the ten years prior to the 2017 ROW expansion pilot, 3) provide the number of vegetation-caused outages along the circuit miles demonstrating the ROW Expansion Program pilot in the ten years prior to the pilot, and 4) provide data on any ignition(s) that have occurred in areas that have undergone TVM outside of the pilot.
PGE-21	Describe why additional programs for transmission clearances are necessary	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 171-174 2/26 submission	**Insufficient** **ACTION PGE-68 (CLASS B):** In its 2021 WMP Update, PG&E shall explain the resource shift from distribution EVM to TVM with the support of quantitative data and figures demonstrating increased effectiveness for decreasing catastrophic wildfire risk.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-21	Describe why additional programs for transmission clearances are necessary	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 171-174 2/26 submission	**Insufficient** **ACTION PGE-69 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the percentage of all VM resources (labor, costs, etc.) being allocated to TVM.
PGE-21	Describe why additional programs for transmission clearances are necessary	PG&E provides clarity on resource allocation and circuit miles related to transmission ROW	First Quarterly Report, pp. 171-174 2021 WMP Section 7.3.5.3	**Insufficient** **ACTION PGE-70 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the resource allocation in terms of percentage between transmission ROW expansion and PSPS risk tree work, and 2) provide the number of circuit miles completed in 2020 for transmission ROW expansion and PSPS risk-tree work, respectively.
PGE-21	Describe why additional programs for transmission clearances are necessary	PG&E provides clarification and calculation around “veg point”	First Quarterly Report, pp. 171-174 2021 WMP Section 4.6.2	**Insufficient** **ACTION PGE-71 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) define what a “veg point” is, and 2) discuss how 3.82 “veg points” was calculated for use when determining distribution EVM reallocation.
PGE-22	Vegetation Management inspectors lacking proper certification	PG&E provides the score to pass pre-inspector assessment	First Quarterly Report, pp. 175-178 Second Quarterly Report, pp. 19-22 2021 WMP Section 7.3.5.14	**Insufficient** **ACTION PGE-72 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the pass-rate and identify the score required to pass the Pre-Inspector assessment.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-22	Vegetation Management inspectors lacking proper certification	PG&E provides the processes around ensuring professionals having ISA certification carry out the work	First Quarterly Report, pp. 175-178 Second Quarterly Report, pp. 19-22 2021 WMP Section 7.3.5.14	**Insufficient** **ACTION PGE-73 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain whether and how it ensures that pre-inspection work not completed by an ISA certified pre-inspector is verified by an ISA certified arborist during the WV process, 2) furnish any supporting procedures and documents demonstrating that VM work is checked by an ISA certified arborist at some point in the process, and 3) clarify if PG&E's understanding of "vast majority" of work professionals having ISA certification correlates to the "50 percent" of the WV Team being ISA Certified Arborists, mentioned earlier within its response to the "Work Verification" explanation of this section.
PGE-22	Vegetation Management inspectors lacking proper certification	PG&E further clarifies verification and improvement of TAT	First Quarterly Report, pp. 175-178 Second Quarterly Report, pp. 19-22 2021 WMP Section 7.3.5.15	**Insufficient** **ACTION PGE-74 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain how it verifies and improves the TAT, 2) provide the timeline/frequency of verification and improvements, and 3) provide a list of SMEs that contributed to and "endorsed"40 the TAT.
PGE-22	Vegetation Management inspectors lacking proper certification	PG&E provides explanation on certification for pre-inspectors	First Quarterly Report, pp. 175-178 Second Quarterly Report, pp. 19-22 2021 WMP Section 7.3.5.14	**Insufficient** **ACTION PGE-75 (CLASS B):** In its 2021 WMP Update, PG&E shall explain the resources and processes it provides to employees to support ISA certification of its pre-inspectors.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP
(CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-22	Vegetation Management inspectors lacking proper certification	PG&E provides clarification on the Work Verification process	First Quarterly Report, pp. 175-178 Second Quarterly Report, pp. 19-22 2021 WMP Section 7.3.5.13	**Insufficient** **ACTION PGE-76 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain what the verification process entails for the 100 percent of EVM work being checked, including the length of time it takes the WV process to be completed per circuit mile, and 2) explain why it finds it necessary to increase the WV process for Routine Maintenance from 10 percent to 25 percent.
PGE-23	Vegetation waste and fuel management process	PG&E provides more information on the USD pilot program	First Quarterly Report, pp. 179-189 Second Quarterly Report, pp. 23-33 2021 WMP Section 7.3.5.3	**Insufficient** **ACTION PGE-77 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide the percentage and number of OH circuit miles that underwent the Transmission UDS pilot program, including the Transmission UDS and ROW Expansion overlap, for both completed and scheduled work, and 2) explain how it determines UDS is beneficial on top of TVM, and how the benefits between the two differ.
PGE-23	Vegetation waste and fuel management process	PG&E provides more information on the USD pilot program	First Quarterly Report, pp. 179-189 Second Quarterly Report, pp. 23-33 2021 WMP Section 7.3.5.2	**Insufficient** **ACTION PGE-78 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) describe whether it has evaluated implementing UDS for distribution ROW, and either a) provide locations where UDS for distribution ROW is being implemented or planned to be implemented, or b) explain why PG&E is not utilizing UDS for distribution ROW vegetation maintenance.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-23	Vegetation waste and fuel management process	PG&E explains that the effectiveness assessment will be dependent on the pilot UDS program	First Quarterly Report, pp. 179-189 Second Quarterly Report, pp. 23-33 2021 WMP Section 7.3.5.15	**Insufficient** **ACTION PGE-79 (CLASS B):** In its 2021 WMP Update, PG&E shall provide quantitative determinations of effectiveness for its fuel management efforts broken down by geographical area,42 demonstrating how PG&E tracks effectiveness when optimizing its processes based on geography.
PGE-24	Improving prioritization	PG&E explains the plan to integrate system hardening and VM effforts	First Quarterly Report, pp. 190-196 2021 WMP Section 4.5.1	**Insufficient** **ACTION PGE-80 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) provide a framework or outline of the modeling efforts underway to integrate system hardening and VM, and 2) describe the initiatives it is taking in order to integrate the two moving forward.
PGE-24	Improving prioritization	PG&E explains that the new startegies outlined in First Quarterly Report will allow for retroactive data integration	First Quarterly Report, pp. 190-196 2021 WMP Section 7.3.7.1	**Insufficient** **ACTION PGE-81 (CLASS B):** In its 2021 WMP Update, PG&E shall: 1) explain whether these developments are solely for newly collected data or if these developments allow retroactive data integration for previously collected data, and 2) if they do not allow for previous data usage, explain a) why PG&E does not have such capability and b) why PG&E deems its plan to be sufficient.
PGE-24	Improving prioritization	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 190-196 2/26 submission	**Insufficient** **ACTION PGE-82 (CLASS B):** In its 2021 WMP Update, PG&E shall provide an update and explanation as to how its hardening initiatives have directly impacted its threshold values for initiating de-energization events, giving a) particular locations and b) quantitative data showing such changes.

TABLE PG&E-4.6-2: LIST OF CLASS B DEFICIENCIES FOR 2020 WMP (CONTINUED)

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
PGE-24	Improving prioritization	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 190-196 2/26 submission	**Insufficient** **ACTION PGE-83 (CLASS B):** In its 2021 WMP Update, PG&E shall provide the calculations used to determine the percent outage reduction of the five categories (all, high, medium, low, and none) presented on page 194 of PG&E's QR.
PGE-28	Justification and detail for PG&E's self-assessed stakeholder engagement capabilities	PG&E provided a description of its approaches for coordinating and collaborating with communities for wildfire mitigation and PSPS.	First Quarterly Report, pp. 197-215 Second Quarterly Report, pp. 34-64	**Sufficient**
PGE-29	Cooperation and sharing of best practices	This information will be provided in the 2/26 filing	First Quarterly Report, pp. 216-219 2/26 submission	**Sufficient** **ACTION PGE-84:** In its 2021 WMP Update, PG&E shall incorporate lessons learned from the 2020 WMP filing into its discussion of each initiatives.

TABLE PG&E-4.6-3: LIST OF CLASS C DEFICIENCIES FOR 2020 WMP

Deficiency Number	Deficiency Title	Utility Response (Brief Summary)	Referenced Documents	WSD Action
Guidance-8	Equivocating language and failure to commit	PG&E was mindful to not include ambiguous, diluting or equivocating language in the 2021 WMP and sought to include specific objectives, details and commitments throughout the 2021 WMP, where possible. However, as PG&E has noted in several portions of our WMP, our understanding of the effects of climate change, wildfire risks and the best mitigation approaches are evolving fields with new information and learnings every year. Therefore, some of the words noted in this deficiency, like "assess," "evaluate" and "evolve" are included in some portions of the 2021 WMP as these words properly articulate a planned action and/or stage of development or maturity for some of PG&E's efforts. Particularly as it relates to long-term planning, PG&E believes that we would be imprudent if we were not continually assessing, evaluating and evolving our wildfire mitigation efforts to make improvements. These descriptions are provided only where they are applicable to fully communicate the plans we currently have and how they may change as we learn more.	2021 WMP (throughout)	WSD has not yet acted on this deficiency.
PGE-4	Capacitor bank failure	PG&E is providing a description of the mitigation measures being undertaken to reduce capacitor bank failures. Those measures are described in more detail in Section 7.3.3.1.	2021 WMP, Section 7.3.3.1	WSD has not yet acted on this deficiency.
PGE-16	PG&E's recordkeeping	PG&E describes the challenges and limitations of working with paper records. PG&E also notes areas where it has shifted to electronic records.	2021 WMP, Section 7.3.7.1	WSD has not yet acted on this deficiency.

4.6.1 Responses to WSD Actions for Class A RCP Conditions

As referenced in the Table PG&E-4.6-1 above, PG&E has included responses to the WSD Actions for the Class A RCP conditions in various sections within the 2021 WMP that are related to that Action. For Actions in which the response does not fit in with a specific WMP section, PG&E is providing the response below.

ACTION PGE-8 (Class A)

In its 2021 WMP update, PG&E shall:

1) *Update Tables 21-30 to reflect a quantitative value to accurately reflect risk reduction effectivenss instead of the current qualitative descriptions*

2) *Provide a column describing the program under which each initiative falls, and*

3) *Provide the difference between the actual and forecasted amounts in comparison to the 2020 WMP Section 5.3 tables.*

Response:

1) PG&E has provided the risk reduction effectiveness for each initiative in Table 12 in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. Due to scope changes from 2020 WMP to 2021 WMP (for example, PG&E has added/removed sub-initiatives for the 2021 WMP), the risk reduction evaluation assumptions are based on the 2021 WMP scope for each initiative.

2) PG&E has provided a column describing the program under which each initiative falls in Table 12 in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. Due to scope changes from 2020 WMP to 2021 WMP (for example, PG&E has added/removed sub-initiatives for the 2021 WMP), the program listed is based on the 2021 WMP scope for each initiative.

3) PG&E has provided the difference between the actual and forecasted amount for 2020 in Attachment 2021WMP_ClassA_Action-PGE-8.xlsx. The numbers in this attachment are based on the scope and financial assumptions used for the PG&E's First Quarterly Report (submitted September 9, 2020).

   The 2020 numbers in Attachment 2021WMP_ClassA_Action-PGE-8.xlsx will be different from the 2020 numbers provided in Section 3.1 (Tables 3-1 and 3-2) and Table 12 (Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx) due to scope changes from 2020 WMP to 2021 WMP (for example, PG&E has added/removed sub-initiatives for the 2021 WMP or as per the 2021 WSD guidelines, we are now including Non-HFTD spend).

ACTION PGE-9 (Class A)

In its 2021 WMP update, PG&E shall:

1) *Provide the month for implementation of the Inspect App broken down between all patrol and inspection programs, as well as between distribution and transmission programs if such differ,*

2) *Provide an explanation for any delays in implementing the Inspect App for certain programs, and*

3) *Explain what qualifies the process to be "stabilized" for utilization on inspection type identification*

Response:

1) Inspect App implementation:

    a. Distribution Detailed OH Inspections pilot deployed in January 2020

    b. Transmission Detailed OH Inspections pilot deployed in March 2020

    c. Inspect App for documentation of Transmission and Distribution Patrols has not yet been developed or deployed

2) In August of 2016, a custom-developed, native iOS mobile application, *Asset Inspection* was deployed to the electric compliance organization. The features in the application were part of a minimum viable product that was used in conjunction with a paper process to facilitate the documentation of any minor work or corrective issues found during a detailed inspection process. The initiative was a multi-year effort to create an enterprise mobile solution and align the preventative maintenance processes between gas and electric operations. The electric patrol and inspection process during this timeframe only required documentation and photos if an issue was identified and follow-on work was required.

    In March 2018, the *Asset Inspection* application was updated to incorporate a new, more robust mapping interface with improved functionality that included Gas Distribution, Gas Transmission, Electric Distribution and Electric Transmission assets. *Asset Inspection* was re-branded as *Inspect* and was deployed to the Gas Leak Survey organization. In August 2018, the new electric version of *Inspect* was completed and deployed to Electric Compliance, replacing the previous *Asset Inspection* version. The functionality was still limited to access to maps, documentation and photos of corrective issues and integration to our system of record, SAP. The next iteration of the application was going to incorporate patrol documentation until the change was made in November 2018 to collect an inspection checklist for every detailed inspection as directed by the Wildfire Safety Inspection Program.

    In 2019, the majority of the year was spent revising, refining and aligning the checklist questions for distribution, transmission and substation. Due to the revisions being made throughout the year to align with the System Inspection Program regulatory oversight, the decision was made not to incorporate the checklist into the *Inspect* application yet, instead a separate low code/no code forms application called Pronto Forms was developed to facilitate frequent changes. The inspection questions were moved into the *Inspect* application in 2020 which eliminated the use of Pronto Forms for detailed OH inspection documentation

3) A “stabilized” process is defined as the ability to accomplish the end to end process for detailed overhead inspections, using technology to document the details and collect photos of an overhead inspection digitally with an integrated submission directly into our system of record and associated compliance reporting.

ACTION PGE-10 (Class A)

In its 2021 WMP *update, PG&E shall:*

1) *provide its analysis and any internal report(s) completed in regards to PG&E's internal* investigation*(s) on primary wire down events from conductor or splice failure, [As stated in Footnote 1 of PGE RCP on p. 21, PG&E can provide the substantial amount of data collected to run analysis, but WSD is more interested in the numerical conclusions drawn from the analysis (such as calculated failure rates for all conductor materials analyzed, failure rate by material per overhead circuit mile, failure rate of ASCR inside corrosion zones vs. outside, etc.) and any internal reports completed based on the analysis. The full data set is not necessary at this time.]*

2) *provide a summary of any conclusions or findings drawn relating to splice failure*

3) *report on its evaluation of historical meteorology data versus distribution wires-down outage data.*

Response:

1) PG&E's internal investigation on wires down events resulting from conductor or splice failure focuses on Basic Cause, main equipment involved, and the equipment condition. The Engineer Investigation Wires Down Database focuses on equipment failure caused wire down outages on non-Major Event Day (MED) where the equipment involved is either the overhead conductor or Splice/Connector. From here, the database tracks asset information such as involved conductor size/type, exact fault location (lat/long), known splices, and environmental information such as corrosion zone, snow loading, and HFTD. These attributes and factors are used to determine conductor replacement project justification and priority, as well as to determine failure trends of types of conductors and environmental factors that may increase asset health deterioration.

   Our numerical conclusions are based on the fact that PG&E has done analysis on conductor rates by size/type normalized by quantity in the PG&E system. Figures PG&E-4.6-1 and 4.6-2 below, which were previously provided in PG&E's RCP, were developed from the Engineer Investigation Wires Down Database collected data indicating that small copper wire has a higher rate of failure system wide, in addition to 4 Aluminum Conductor Steel-Reinforced (ACSR) conductor. In an effort to reduce outages due to conductor failure, PG&E standards were updated in 2015 to reduce conductor size options on new construction, using larger more resilient conductor as well as reduce inventory requirements for multiple conductor sizes.

FIGURE PG&E-4.6-1: CONDUCTOR ANNUAL WIRE-DOWN RATE

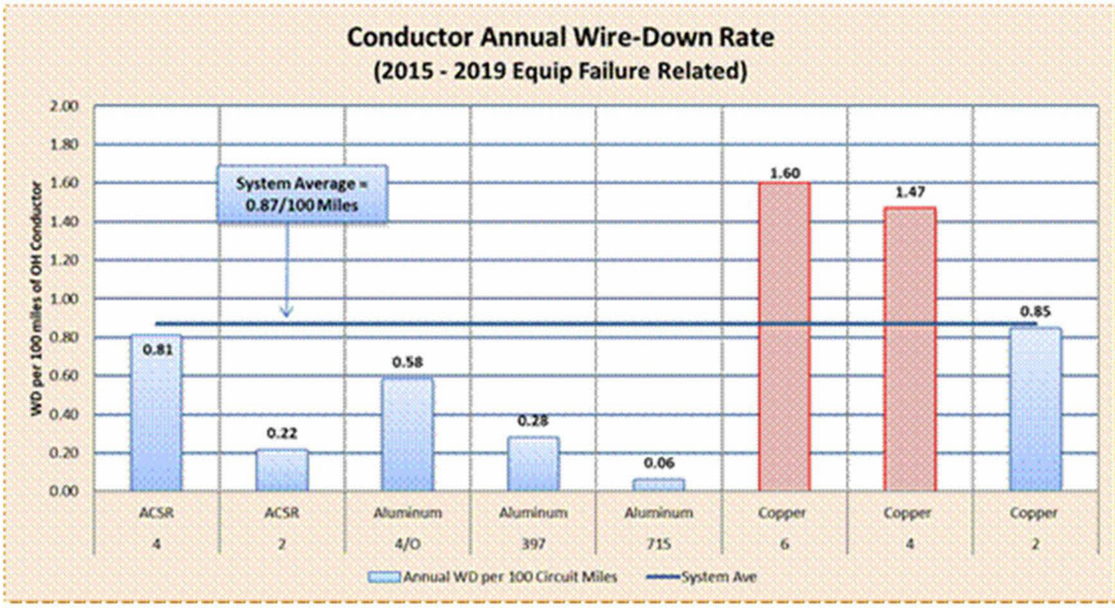
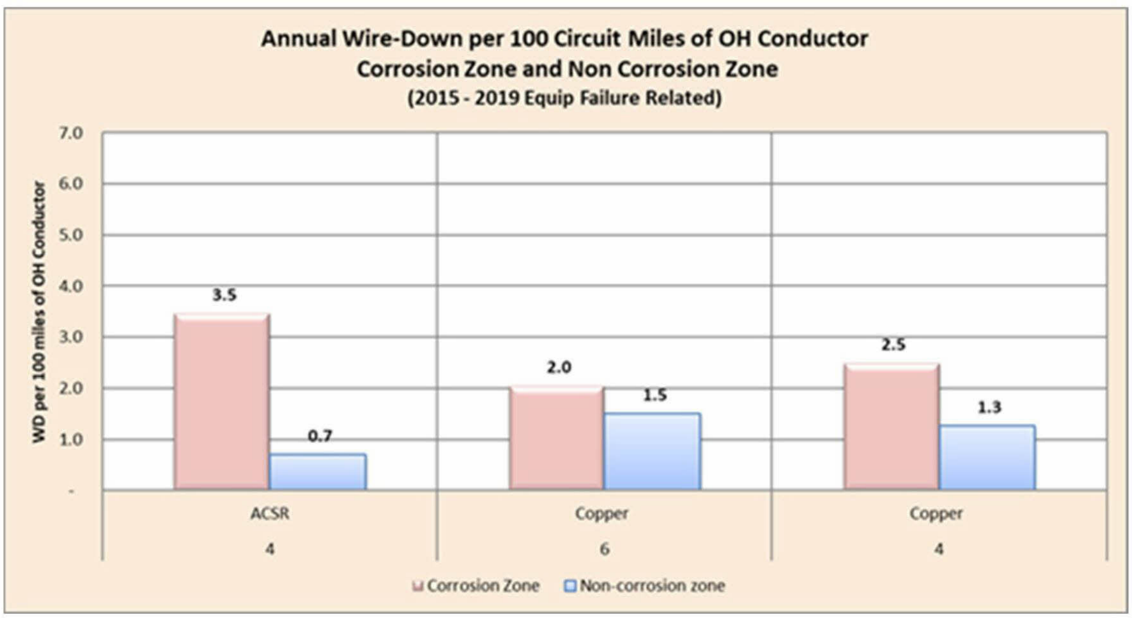


FIGURE PG&E-4.6-2: ANNUAL WIRE-DOWN RATE PER CIRCUIT MILE



2) Splice quantity within a span was identified as the highest impact variable to predict future wires down. Starting in 2021, PG&E is initiating efforts to collect more information from the field in order to develop more insights regarding asset failures. One effort will pilot extracting sections of span(s) that have failed to do testing on the conductor and the splices involved.

3) The below graph shows the equipment (Overhead Conductor and Splice) failure wires down rates on Blue Sky Days vs Grey Sky/Storm day (specifically with

Northeast Wind, Northwest Wind, and Winter Storm influence) vs Major Event Days. The Blue Sky wire down trend is showing a steady/decreasing rate.

TABLE PG&E-4.6-3: DISTRIBUTION WIRES DOWN EVENTS DUE TO EQUIPMENT (OVERHEAD CONDUCTOR AND SPLICE FAILURES

	Distribution Wires Down Events				Days Per Year				Wires Down/Day			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
Blue Sky Day	488	499	385	422	262	304	247	279	1.9	1.6	1.6	1.5
*Grey Sky/Storm	152	148	130	76	35	34	35	23	4.3	4.4	3.7	3.3
Major Event Days	514	17	231	23	26	2	11	1	19.8	8.5	21.0	23.0

*Northeast Wind, Northwest Wind, and Winter Storm only

ACTION PGE-11 (Class A)

In its 2021 WMP update, PG&E shall elaborate on its MEDs by:

1) describing what PG&E uses as its Major Event Day identification threshold value (TMED)13,
2) providing the percentage of data not included in analysis due to MED data exclusion, both in terms of number of days and number of wire-down instances, and
3) explaining how PG&E intends to improve and expand MED reporting and why current circumstances allow for expanded MED reporting when the past did not

Response:

1) The MED threshold is calculated each year using the methodology prescribed in the IEEE 1366-2012 Standard titled "IEEE Guide for Electric Power Distribution Reliability Indices." This threshold represents a daily System Average Interruption Duration Index (SAIDI) value and any day with outages that exceed this daily threshold is classified as an MED. The historical MED threshold values from 2015 to 2020 vary by year and are provided in the table below:

TABLE PG&E-4.6-4: HISTORICAL MED THRESHOLD VALUES

Year	2015	2016	2017	2018	2019	2020
TMed	2.186	1.879	1.463	1.847	1.935	2.941

2) The referenced analysis consisted of distribution wire down events caused by equipment (overhead conductor and splice) failures. Days not classified as MEDs are referred to Non-MEDs and PG&E also classifies the Non-MEDs into Blue Sky, Gray Sky, and Storms days. The table below shows and compares the corresponding wire down events that occur on MEDs versus those that occurred on Non-MEDs.

TABLE PG&E-4.6-5: DISTRIBUTION WIRE DOWN EVENTS ON MEDs VERSUS NON-MEDs

All Days	2015	2016	2017	2018	2019	2020
Number of Distribution Wire Down Events						
Contribution on Non-MEDs	633	714	739	695	662	615
Contribution on MEDs	126	69	533	37	354	84
MED Contribution as a Percent of Total	16.6%	8.8%	41.9%	5.1%	34.8%	12.0%
Number of Days						
Contribution of Non-MEDs	355	363	335	358	334	352
Contribution of MEDs	10	3	30	7	31	14
MED Contribution as a Percent of Total	2.7%	0.8%	8.2%	1.9%	8.5%	3.8%

3) Although PG&E recognizes that external factors such as weather and wind will tend to stress the electric system and increase the number of wire down events experienced, PG&E's analysis of wire down events that occur on Blue Sky (non-weather related events) is intended to provide a base line of the system health with no external factors. PG&E's focus on Non-MEDs was driven not by circumstances but rather by choice to help gauge the historical trends and to prioritize/optimize the benefits of future reconstruction projects. Although the impacts to PG&E's system varies significantly based on the weather and winds experienced across its very large service territory, we do see value in better understanding how the system responds to wind events during Major Event Days. As such, PG&E has improved and expanded its analysis and reporting to include the impacts during wind-related Major Event Days, which is covered in Action Item PGE-12 (Class A).

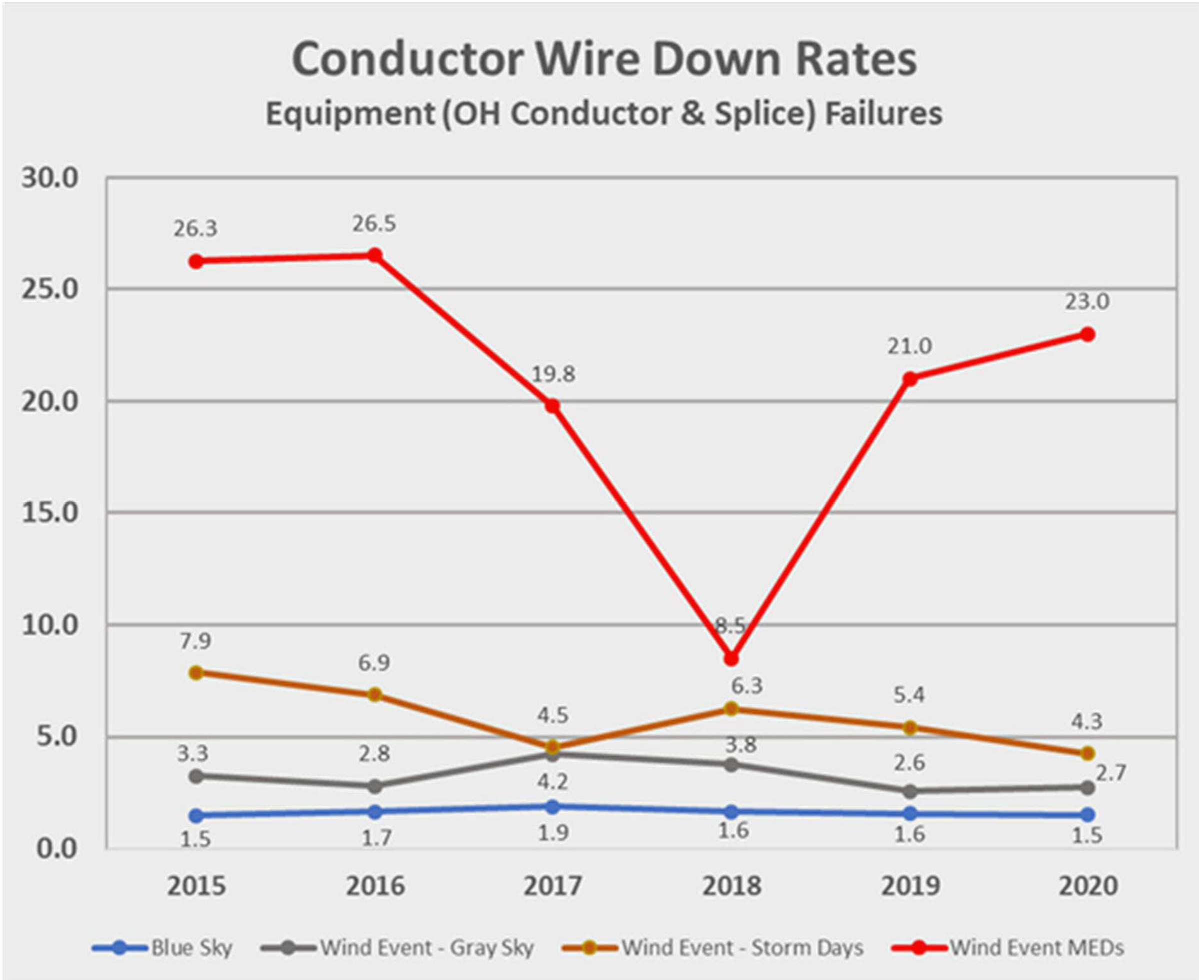
ACTION PGE-12 (Class A)

In its 2021 WMP update, PG&E shall provide a graph similar to Figure 10 (PG&E RCP @ 25) which includes all weather *metrics and sub-categories described in Section (3) (PG&E RCP @ 24) (e.g. Gray Sky, Storm Day, Northeast Wind)*

Response:

Figure PG&E-4.6-3 below provides updated distribution wire down information from 2015 to 2020 similar to the information previously contained in Figure 10 of PG&E's RCP. For further comparison purposes, the Gray Sky and Storm Days have been separated in this graph and the graph includes the corresponding average number of wire-down events per day experienced on MEDs resulting from the same three wind related events (*i.e.*, Winter Storm, Northeast Wind, and Northwest Wind).

FIGURE PG&E-4.6-3 CONDUCTOR WIRE DOWN RATES FROM 2015-2020



ACTION PGE-13 (Class A)

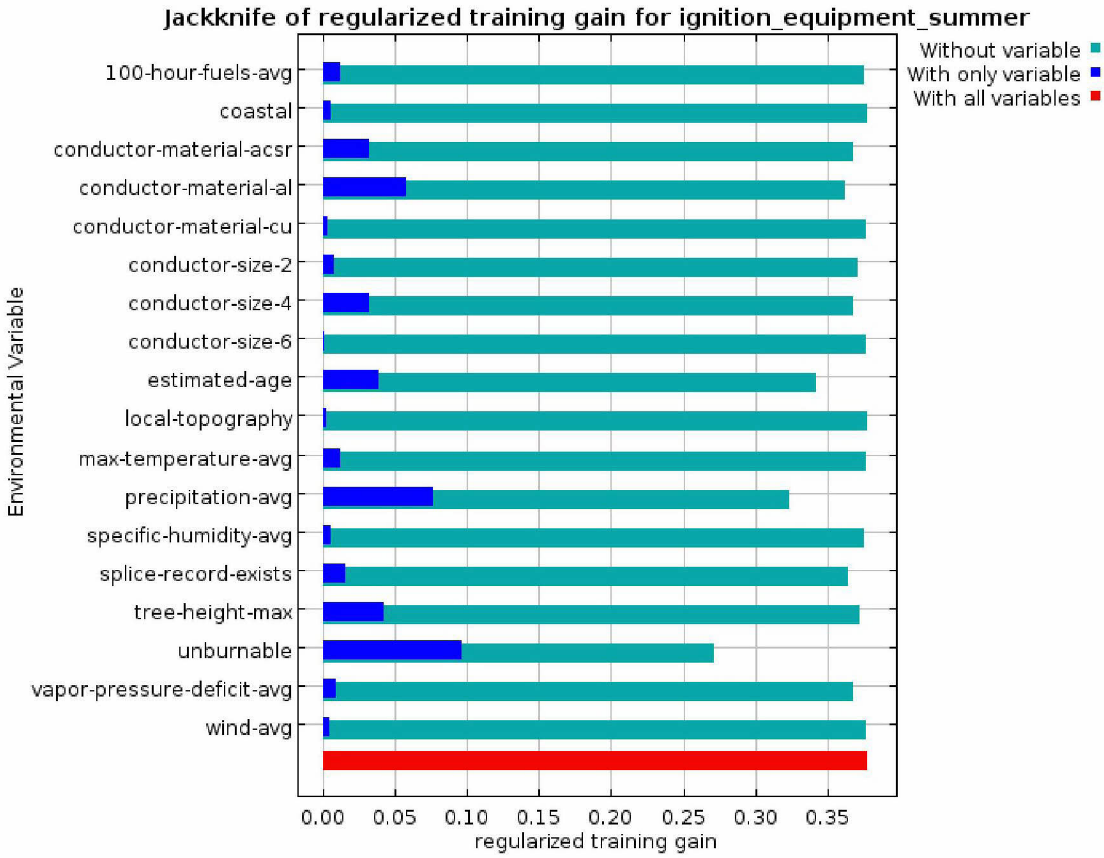
In its 2021 WMP update, PG&E shall:

1) describe when it intends to perform an analysis on the correlation between wind speed and wire down events,
2) explain why it has not performed such an analysis yet, and
3) upon completion of this analysis, provide the percentage of outages and wire down events caused by conductor failure due to wind.

Response:

Wind speed is one of many variables that influences failures and wire down events. However, wind speed alone is not the only factor that needs to be considered in wire down events. When developing the 2021 Wildfire Distribution Risk Model, wind speed was considered as a variable impacting ignition, and it was determined, as can be seen in the output below, average wind speed has a marginal effect on the probability of ignition.

FIGURE PG&E-4.6-4: Jackknife Analysis of Regularized Training Gain for Ignition Equipment



Given these results, PG&E decided to use an ignition model as it is better equipped and more relevant for decision making rather than developing an analysis that attempts to solely correlate wind speed to wires down. Moreover, there is not a single relation between average wind speeds and wire down events, as the wind speed required for an outage varies across PG&E's system based on differences in topology, vegetation and climatological weather exposure.

ACTION PGE-15 (Class A)

In its 2021 WMP update, PG&E shall resubmit its RCP Attachments 3 and 4 in Excel format with the following additional columns

1) region number 1-4 (as outlined in the National Electric Energy Testing, Research and Applications Center (NEETRAC) report),
2) corrosion area ranking (e.g., moderate, severe),
3) conductor material, and
4) number of splices along replaced portion. PG&E shall also provide similar tables for 2021 and 2022.

Response:

2021WMP_ClassA_Action-PGE-15_Atch01
2021WMP_ClassA_Action-PGE-15_Atch02

ACTION PGE-21 (Class A)

In its 2021 WMP update, PG&E shall provide the percentage of priority "E" and "F" findings that were reprioritized to "A" or "B" from the 2019 to the 2020 inspection cycles within HFTDs.

Response:

There was a small percentage of open "E" and "F" priority corrective notifications (e.g., EC or LC "tags") that have changed to an "A" or "B" priority rating during the performance of Field Safety Reassessments (FSR) in 2020. The following table summarizes the change in Tags that has occurred:

TABLE PG&E-4.6-6: PERCENTAGE OF TAGS ESCALATED TO PRIORITY A AND B

EC/LC	Total FSRs completed YTD	Total Escalated to Priority A	% Escalated to Priority A	Total Escalated to Priority B	% Escalated to Priority B
EC - Distribution	182,764	103	0.056%	3,991	2%
LC - Transmission	11,906	12	0.10%	168	1%

ACTION PGE-22 (Class A)

In its 2021 WMP update, PG&E shall explain why it uses 2013-2018 ignition frequency for transmission and 2014-2019 for distribution when determining prioritization.

Response:

This historical asset ignition frequency data referenced on pages 35-36 of PG&E's RCP was used to determine tag prioritization and was based on PG&E's Wildfire Safety Inspection Program (WSIP) Compliance Plan and Interim Controls (Interim Controls) drafted in August 2019 [see Attachment _]. For Tag Risk Scoring, PG&E considered five components: asset failure ignition risk, historical asset ignition frequency, likelihood of wildfire spread and consequence score, egress score and time-dependent. As noted, historical asset ignition frequency was different between Distribution and Transmission. Because the Interim Controls were drafted in mid-2019, and given to the infrequency and lack of data points for Transmission for the partial year, we did not include partial 2019 data into our scoring for Transmission at the time. For Distribution, because there was more data to consider, the partial year was included.

ACTION PGE-23 (Class A)

In its 2021 WMP update, *PG&E shall:*

1) explain how it determined the Risk Reduction and RSE values provided in Table 5 and provide an explanation of all inputs, relative weight of inputs, and list all algorithms used,
2) reproduce Table 5 with each column normalized per overhead circuit mile, and
3) submit an additional table for numbers in HFTD only and per circuit mile within HFTD.

Response:

1. Risk Reduction and RSE values are calculated using the SMAP conforming Enterprise Risk Model. Details of the methodologies and algorithms on how this is calculated are provided in the 2020 RAMP Report Chapter 3, attached as 'RAMP_2020_Report…'and 'PGE Enterprise Risk Model Documentation'. In addition, PG&E includes 2 additional files that include the calculation and inputs to this calculation of RSE, listed as 'WF_Enhanced Inspections_v4' and 'RiskInputs_v1.1.1_EO_WF_20200615RAMP_EnhancedInspections_v4. [provide attachment]

2. Below is Table-5 normalized per overhead circuit mile. Circuit miles for routine inspection were based on a 5 year cycle of ~80,710 distribution and ~18,125 transmission miles, divided evenly across the 5 years. Circuit miles files for WSIP inspection are based on the entire ~25,410 distribution and ~5,525 transmission HFTD miles. Normalization of Overhead Circuit Mile was performed by dividing the Ignitions Prevented, Risk Reduction, and Cost by the number of overhead circuit miles. RSE is agnostic to circuit miles, as it is already a ratio of risk reduction divided by cost. Incremental benefit is not normalized per overhead circuit mile, as the number of miles performed is different between routine and WSIP inspections.

Original Table-5

Inspection Type	Ignitions Prevented	Risk Reduction	Cost ($000)	RSE
2018 Routine Inspection – Dist.	21.7	1,095	[redacted]	~90.7
2019 WSIP – Dist.	91	15,825		~106.0
Incremental Benefit – Dist	**69.3**	**14,452**		**~105.3**
2018 Routine Inspection – Trans	8.3	945		~110.7
2019 WSIP – Trans.	102	18,116		~268.0
Incremental Benefit – Trans	**93.7**	**17,171**		**~290.7**

Table-5 Normalized Per Overhead Circuit Mile

Inspection Type	Circuit Miles	Ignitions Prevented	Risk Reduction	Cost ($000)	RSE
2018 Routine Inspection – Dist.	16,142	0.0013	0.0678	[redacted]	~90.7
2019 WSIP – Dist.	25,410	0.0036	0.6228		~106.0
Incremental Benefit – Dist		**N/A**	**N/A**		**N/A**
2018 Routine Inspection – Trans	3,625	0.0023	0.2607		~110.7
2019 WSIP – Trans.	5,525	0.0185	3.2789		~268.0
Incremental Benefit – Trans		**N/A**	**N/A**		**N/A**

3. Below is the Table-5 with HFTD miles only. Please note WSIP figures did not change, as WSIP was meant to be performed in HFTD only in 2019.

Table-5 HFTD Only

Inspection Type	Ignitions Prevented	Risk Reduction	Cost ($000)	RSE
2018 Routine Inspection – Dist.	6.3	1,051	[redacted]	~276.7
2019 WSIP – Dist.	91	15,825	[redacted]	~106.0
Incremental Benefit – Dist	**84.7**	**14,774**	[redacted]	**~117.8**
2018 Routine Inspection – Trans	5.3	913	[redacted]	~351.1
2019 WSIP – Trans.	102	18,116	[redacted]	~268.0
Incremental Benefit – Trans	96.7	17,203	[redacted]	~264.7

Inspection Type	Circuit Miles	Ignitions Prevented	Risk Reduction	Cost ($000)	RSE
2018 Routine Inspection – Dist.	5,082	0.0012	0.2068	[redacted]	~276.7
2019 WSIP – Dist.	25,410	0.0036	0.6228	[redacted]	~106.0
Incremental Benefit – Dist		**N/A**	**N/A**	[redacted]	**N/A**
2018 Routine Inspection – Trans	1,105	0.0048	0.8262	[redacted]	~351.1
2019 WSIP – Trans.	5,525	0.0185	3.2789	[redacted]	~268.0
Incremental Benefit – Trans		**N/A**	**N/A**	[redacted]	**N/A**

ACTION PGE-24 (Class A)

In its 2021 WMP update, *PG&E shall provide all preselected priority options available within its inspections mobile application or any references available to properly classify field conditions.*

Response:

Please see the responses below and documents included as Attachment [x] [Appendix PGE-24].

(1) Screen shots of Inspect App showing the condition assessment codes and notification priority codes (T&D)

These are summary condition assessment codes related to the inspector evaluation of the item being inspected on the structure and documented against the completed inspection record for the asset. These codes are coupled with any corrective notifications also documented at the structure being inspected.

FIGURE PG&E-4.6-5: EXAMPLE - INSPECT APP

These are the corrective notification priority codes for distribution and transmission. A recommended priority is pre-selected in the mobile application, based on the selections made in “Facility,” “Damage” and “Action” sections. This priority can be over-ridden if the priority is “higher” than recommended based on the opinion of the inspector or as determined by field conditions. This priority may also be over-ridden during review of the field finding by the Central Inspection Review Team (CIRT).

FIGURE PG&E-4.6-6: EXAMPLE - TRANSMISSION INSPECT APP

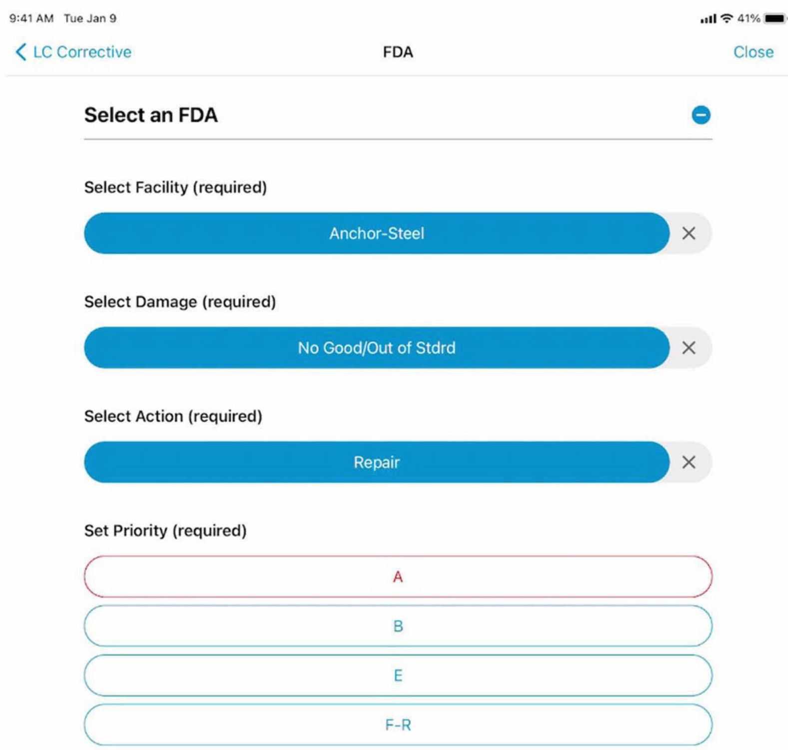
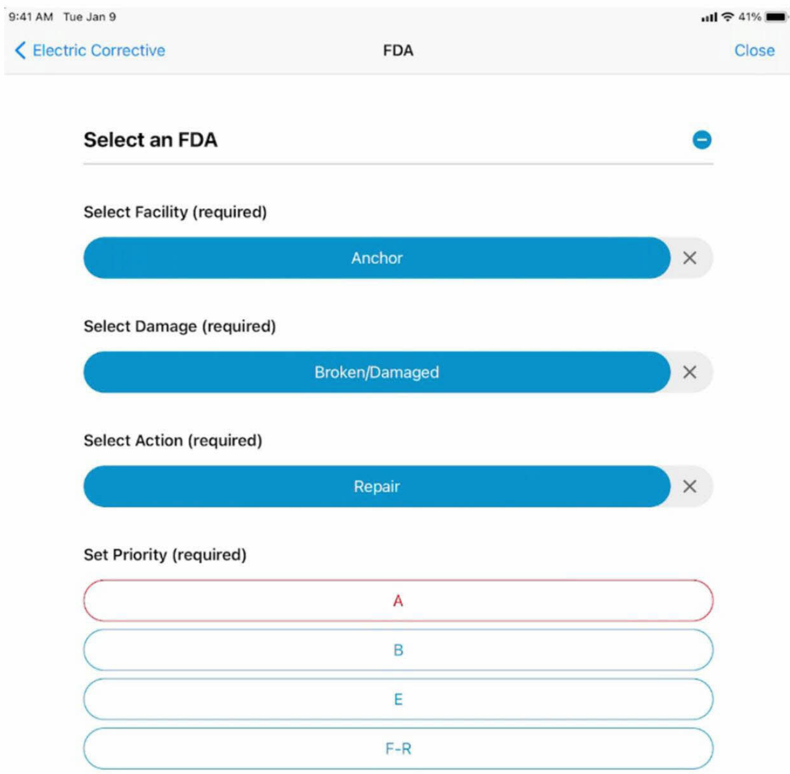


FIGURE PG&E-4.6-7: EXAMPLE - DISTRIBUTION INSPECT APP



(2) Priority Chart from TD-2305M Electric Distribution Preventive Maintenance Manual (EDPM_04012016, Assessments, Notifications and Forms section, page 5):

FIGURE PG&E-4.6-8: PRIORITY CHART FROM TD-2305M

Degree of Importance	Probability of Facility Failure	Impact of Failure and/or Exposure
Priority A **Emergency**	• A structure has already failed • Equipment has significant damage • The condition results in significant exposure to the general public	• Failure or exposure may lead to serious injuries • Failure has caused outages to customers • Requires immediate response or stand-by
Priority B **Urgent** **0-3 Months**	• A structure has already failed • Equipment has significant damage • The condition may result in significant exposure to the general public • The condition can be "made safe", but requires permanent repair within 3 months	• Failure or exposure may lead to serious injuries, significant outages • Failure or exposure will result in an imminent reliability concern • Failure or exposure is a safety issue with significant impact • Does NOT require immediate response or stand-by
Priority E **3-12 Months**	• A structure has already failed, but damage is such that repair is not required in the next 3 months • High likelihood that structure or equipment will fail in the next 12 months • The condition does not result in significant exposure to the general public	• Failure or exposure will not lead to serious injuries • Failure will result in an outage(s) • Failure or exposure is a safety issue with impact to PG&E operations and customers
Low **No EC Required**	• The condition is not structural • There is a low likelihood of failure • The condition does not have a significant impact to structural integrity • The condition is not likely to fail within 12 months	• There is little potential for injury or impact on reliability • Work procedures mitigate safety concerns • Failure or exposure does not present a significant impact to PG&E operations and customers
Priority F **Regulatory** **(As identified on the back of the EC Work Form)**	• N/A • Regulatory Facility/Damage/Action (FDAs) must be identified	• N/A • Regulatory Facility/Damage/Action (FDAs) must be identified

(3) Priority Table from TD-1001M Electric Transmission Preventive Maintenance Manual (ETPM_08312020_Rev 5, page 15), see Attachment 2021WMP_ClassA_Action-PGE-24_Atch05:

FIGURE PG&E-4.6-9: PRIORITY TABLE FROM TD-1001M

Table 3 lists the priority codes and the associated time frames for typical response/repair action.

Table 3. Priority Codes

Priority Code[1]	Priority Description
A[2]	The condition is urgent and requires immediate response and continued action until the condition is repaired or no longer presents a potential hazard. SAP due date will be 30 days to allow time for post-construction processes and notification close-out.
B[3]	Corrective action is required within 3 months from the date the condition is identified. The condition must be reported to the transmission line supervisor as soon as practical.
E	Corrective action is required within **12 months** from the date the condition is identified *EXCEPT FOR ITEMS WITHIN HFTD TIER 3 ARE REQUIRED WITHIN 6 MONTHS.*[4].
F	Corrective action is recommended within **24 months** from the date the condition is identified, (due beyond 12 months, not to exceed 24 months). *EXCEPT FOR ITEMS WITHIN HFTD TIER 3 ARE REQUIRED WITHIN 6 MONTHS AND WITHIN HFTD TIER 2 ARE REQUIRED WITHIN 12 MONTHS.*[5]

[1] Refer to 2.3.5.2, "Priority Code Due Dates for High Fire Risk Conditions within HFTDs" and 2.3.5.3, "Priority Code Due Dates for Non-Fire Risk Conditions within HFTDs."

[2] QCRs must report immediately any "Priority Code A" abnormal condition to the transmission line supervisor, and the transmission supervisor or QCR contacts GCC.

[3] In addition, QCRs must report any "Priority Code B" condition to the transmission line supervisor as soon as practical, to ensure that correction occurs within the appropriate time.

[4] If the condition in the HFTD Tier 3 does NOT create a fire risk (non-threatening) the corrective action is required within 12 months.

[5] If the condition in the HFTD Tier 3 OR Tier 2 does NOT create a fire risk (non-threatening) the corrective action is required within 24 months.

(4) TD-2305M-JA02 Electric Dist Overhead Inspection Job Aid.

(5) TD-2305M Electric Distribution Preventive Maintenance Manual (EDPM_04012016).

(6) TD-1001M Electric Transmission Preventive Maintenance Manual (ETPM_08312020_Rev 5).

ACTION PGE-25 (Class A)

In its 2021 WMP update, PG&E shall break down the additional costs of enhanced inspections compared to routine inspections.

Response:

In 2019, PG&E's WSIP significantly changed the volume of assets inspected each year, condensed the timeline for HFTD inspection units, increased complexity of asset data/information captured, expanded quality oversight protocols, extended training time, all of which increased the need for external labor. These factors linked to creating more structure and consistency in the inspections programs also contributed to higher costs for enhanced inspections compared with prior compliance inspections of similar assets.

As explained in the introduction to Section 7.3.4, PG&E plans to complete the HFTD inspection units earlier in the annual cycle, and for 2021 is targeting completion of those units by end of July 2021. Due to annual refreshment of the technology, checklist, and training, inspection cycles typically commence at the close of first quarter and therefore are constrained to under six months for execution. Due to the shortened HFTD inspection window, and increased volume in 2019 as compared to prior compliance cycles, WSIP and the new System Inspections department have required more than the historic complement of internal inspection personnel. For WSIP 2019, contractors completed nearly all the inspections, and in 2020 contractors represented more than three-quarters of detailed overhead inspections. In 2021, PG&E expects contractors to account for over half of the inspection workforce. Contracted personnel generally cost more per labor hour than comparable internal labor. In 2021, PG&E will again rely heavily on contracted labor for inspectors, supplementing the approximately 130 distribution, transmission towermen and troublemen personnel. PG&E continues to work to recruit and retain permanent full time Inspectors, adding eight headcount to the distribution department within System Inspections in 2020.

As to the additional data recorded, enhanced inspections document more photographs, more inspector annotation, and record checklist item responses, compared to the historic reporting which generally captured completion of inspection, and little more detail. The time required to accurately document each checklist answer digitally versus exception-only data entry also drives up the time required to complete each field inspection. PG&E estimates the time required to physically complete the incremental recordkeeping at each asset is increased two to four times, depending upon asset type.

Finally, the additional quality reviews and orientation durations imposed since 2019 also add cost to the program. For 2020 and 2021, inspectors from outside PG&E will receive three days of training, and internal inspectors will receive two days of refresher training. Both the cost of training delivery and personnel wages are captured in the cost of enhanced inspections. Costs from quality oversight arise from additional skilled and qualified labor that perform field validation and desk-based reviews of inspection findings prior to creating corrective work. Additionally, new personnel were hired to provide baseline staffing for an internal program quality oversight function. In prior practice, inspection supervisors provided the primary quality check in-cycle. The costs associated with this expanded onboarding process and centralized review team are allocated across all units completed in the year.

The drivers of increased costs between the baseline GO 165 programs and the enhanced inspections programs were:

- Incremental labor cost due to percentage of inspection units completed by contract vendor
- Incremental labor cost due to compressed execution schedule (increased overtime)
- Incremental time required to document a unit of inspection (checklist, photos, data corrections)
- Incremental administrative oversight of inspection quality (CIRT and QA/QC costs)
- Adjusted field execution that varied from established historical operational routes and patterns

An overview of the historic and forecast unit costs for routine and enhanced inspections is provided in Table-PG&E-4.6-7 below. Routine unit costs for pre-WSIP (i.e, before enhanced) inspections for transmission and distribution are included in the column for 2018. The columns for 2019 and 2020 reflect actual unit costs that include enhanced inspections. The column for 2021 reflects a forecast of unit.

TABLE PG&E-4.6-7: HISTORIC AND FORECAST UNIT COSTS FOR ROUTINE AND ENHANCED INSPECTIONS

	Fiscal year	2018 Pre-WSIP	2019 WSIP	2020	2021 forecast
	MAT	Unit Cost $	Unit Cost $	Unit Cost $	Unit Cost $
Distribution Overhead Detailed Inspections	BFB	[redacted]			
Transmission Tower Climbing Inspections	BFT				
Transmission Overhead Detailed Inspections	BFZ				

ACTION PGE-33 (Class A)

In its 2021 WMP update, PG&E shall

1) provide a detailed plan for how it intends to analyze and use extended vegetation clearance data specifically, including specific statistical methods it intends to use and how it will control for environmental variables (e.g., wind, soil, elevation, species), and 2) provide a plan on how PG&E will continue analyzing and collecting data relating to measuring EVM effectiveness.

Response:

For this analysis, PG&E will calculate the following: past outages/ignitions where distance from tree to conductor was estimated to be 12 feet or less at the time of the outage/ignition as a proportion of total outages/ignitions. The resulting value will be considered as the population of outages/ignitions that will be reduced as a result of expanding clearance to 12 feet. The 12 foot expanded clearance will be obtained regardless of environmental conditions (e.g., wind, soil, elevation, species).

PG&E will update its outage/ignition data periodically to evaluate the effectiveness of the extended vegetation clearance. In addition, PG&E will analyze outage/ignition rates pre- and post-EVM treatment to track overall EVM effectiveness.

ACTION PGE-34 (Class A)

In its 2021 WMP update, PG&E shall explain how it calculated the effectiveness for each sub-driver shown in Table 8 and include all inputs and algorithm(s) used.

Response:

We evaluated the specific EVM scope of work intended to address each subdriver listed in Table 8 and combined this information with field experience regarding outages/ignitions to estimate the potential effectiveness of our proposed EVM work addressing each subdriver The percentage effectiveness estimates were not based on specific algorithms.

4.6.2 Responses to WSD Actions for Class B Conditions

As referenced in the Table PG&E-4.6-2 above, PG&E has included responses to the WSD Actions for the Class B conditions in various sections within the WMP that are related to that Action. For Actions in which the response does not fit in with a specific WMP section, PG&E is providing the response below.

ACTION PGE-25 (Class B)

1) Integrate discussion on long-term planning within the respective section of each individual initiative.

Response:

PG&E has incorporated discussions around long term planning under each initiative after 5) Future Improvements to initiative. PG&E recognizes that it must improve its long-term planning capabilities. PG&E has learned a tremendous amount from all of its wildfire mitigation activities in 2018, 2019 and 2020, but we also recognize that it is imperative to shift from operating on a year-to-year basis to grounding our WMP effort into longer-term vision while continuing to maintain a flexible program (PG&E further discusses this consideration in Section 5.2).

PG&E is establishing certain considerations that underlie its long-term planning efforts. More specifically, utility budget and planning cycles (e.g., unit planning) is done on a three-year cycle, which is in line with industry practice. In addition, the goals detailed in Tables 4 through 13 from the First Quarterly Report are not firm commitments but rather aspirational capabilities. PG&E will certainly work towards maturing the capabilities, but it also must maintain the right to pivot to higher priority needs based on future events as they unfold (e.g., wildfire risk is dynamic, and PG&E continues to adapt and evolve as it learns more).

ACTION PGE-28 (Class B)

1) Provide a list of the electrical corporations PG&E has worked with so far regarding identification of high equipment failure rates
2) Explain how PG&E is working with each of the other utilities regarding data comparisons.

Response:

PG&E participates in various benchmarking studies and industry working groups to benchmark Electric Operations. One of them is managed by First Quartile Consulting where a consortium of 21 utilities (listed below) benchmark across a variety of topics and metrics on an annual basis, including outages and events due to equipment failures. Data analysis includes comparing common reliability metrics, such as SAIDI and System Average Interruption Frequency Index (SAIFI), as well as diving into specific sources that drive outages/equipment failure (e.g., equipment, weather, trees, etc.). As PG&E learns practices, metrics and processes from utilities that are in the top quartile, it will share them with the relevant departments throughout our enterprise for continuous improvement.

PG&E's Electric Operations organization established a dedicated team to focus on benchmarking activities starting in Quarter 3 2020. For future benchmarking efforts, the team plans to continue using learnings from previous years benchmarks and discussions to inform additional survey/benchmarking opportunities in order to evaluate equipment failure rates on an even more granular level.

Table PG&E-4.6-8: CONSORTIUM OF UTILITIES

Utility Name	
Arizona Public Service	Oncor Electric Delivery
Abu Dhabi Distribution Co	Portland General Electric
Austin Energy	PSE&G
CenterPoint Energy	PSEG Long Island
CPS Energy	Southern California Edison
Entergy	TECO Energy
Exelon	Tucson Electric Power
Hydro One	UES Electric
Hydro-Quebec	Alabama Power*
Lower Colorado River Authority	Tennessee Valley Authority*
Omaha Public Power District	
*Transmission only	

ACTION PGE-29 (Class B)

1) Indicate which subset of outages in Table 17 it considers to be near-miss ignition events
2) Explain what each subcategory of "Unknown" or "Other" consists of in Tables 16 and 17 of PG&E's QR
3) Explain in more detail all "Unknown" and "Other" values, including what is included within those values.

1. In general, PG&E currently assumes that all outage events involving a fault condition represents a "near miss" ignition or a risk event.
2. PG&E has interpreted this request as asking for information outlined below. It should also be noted that PG&E's electric outage data base is structured so that a basic cause, a supplemental cause, and the involved equipment can be reported for each outage. Although these fields are reported for most outages, there are a small number of exceptions that are mentioned below and includes

some momentary outages are automatically reported via Smart meters and with limited cause details. PG&E also improved and modified its outage cause structure in 2015 and there are additional combinations when consolidating historical data from 2015 and earlier. In addition, the involved equipment is a data field that consists of important equipment but does not include all equipment.

The following information is listed by the referenced table, the involved Line Item, the listed Driver and Sub-Driver.

Table 16

- Line Item 1, Thirty Party, Third Party – Other: This designation refers to all other third party related outages not covered by the more specific third party related outages listed in this table, i.e., Third Party – Unknown, Balloons, and Vehicle.
- Line Item 2, Thirty Party, Third Party – Unknown: This designation refers to all third party related outages but not reported with a supplemental cause as described above.
- Line Item 9, Equip Failure, Equip Failure – Other: This designation refers to all other equipment failure related outages not involving the failed equipment listed in this table (i.e., not a Capacitor bank, Conductor, Crossarm, Equip Failure – Other, Fuse, Guy/Span Wire, Insulator, Pole, Recloser, Sectionalizer, Splice/Clamp/Connector, Switch, Transformer or Voltage Regulator).
- Line Item 10, Equip Failure, Equip Failure – Unknown: This designation refers to all equipment failure related outages but not reported with a supplemental cause as described above.
- Line Item 22, Unk or Other, Unk or Other – Other: This designation refers to all reported outages with an undetermined cause. In these cases, the supplemental case indicates either a detailed patrol was not conducted, or a detailed patrol was conducted but no cause was determined.
- Line Item 23, Unk or Other, Unk or Other – Unknown: This designation refers to outages reported with an unknown cause and with no supplemental cause provided as described above.
- Line Item 31, Vegetation, Other/Unknown: This designation refers to other vegetation related outages due to other ground related vegetation outages or reported without additional supplemental cause information as described above.

Table 17

- Line Item 1, Thirty Party, Third Party – Other: Same as that described above for Table 16.
- Line Item 2, Thirty Party, Third Party – Unknown: Same as that described above for Table 16.
- Line Item 13, Equip Failure, Equip Failure – Other: Same as that described above for Table 16.
- Line Item 52, Third Party, Other: Same as that described above for Table 16.
- Line Item 57, Vegetation, Other/Unknown: Other: Same as that described above for Table 16.
- Line Item 34, Other, Patrol – This designation refers to all reported outages with an undetermined cause. In these cases, the supplemental cause indicates a detailed patrol was conducted but no cause was determined.

- Line Item 35, Other, Patrol – This designation refers to all reported outages with an undetermined cause. In these cases, the supplemental cause indicates a detailed patrol was not conducted.
- Line Item 42, RIM, RIM - Other: This designation refers to other records and information management related outages due to incorrect tags, diagrams, switch logs and mis-coordination.

3) PG&E reviewed beyond Other and Unknown and looked at additional factors including supplemental, failed/involved equipment, and equipment condition. For example, an item that is listed as unknown but has conductor-overhead as the involved equipment is prevented by System Hardening. Details of the combination of basic cause, supplemental cause, failed/involved equipment, and equipment condition is included in the attachment '2021WMP_ClassB_Action-PGE-29_Atch01.'

ACTION PGE-71 (Class B)

1) define what a "veg point" is, and 2) discuss how 3.82 "veg points" was calculated for use when determining distribution EVM reallocation.

Response:

1. A Vegetation Point, or "veg point," is a single tree identified and listed in the Collector application for the EVM program.

2. The 3.82 veg point metric was not used to determine distribution EVM reallocation. PG&E did not shift personnel hours for distribution EVM and TVM work. The performance metric provided above was derived exclusively for ROW Expansion. We do not currently track the number of veg points completed per Full-Time Equivalent employee per weekly mile for EVM.

PACIFIC GAS & ELECTRIC COMPANY

SECTION 5

INPUTS TO THE PLAN AND DIRECTIONAL VISION FOR WMP

5 Inputs to the Plan and Directional Vision for Wildfire Risk Exposure

5.1 Goal of the Wildfire Mitigation Plan

The goal of the WMP is shared across WSD and all utilities: Documented reductions in the number of ignitions caused by utility actions or equipment and minimization of the societal consequences (with specific consideration to the impact on Access and Functional Needs populations and marginalized communities) of both wildfires and the mitigations employed to reduce them, including PSPS.

In the following sub-sections report utility-specific objectives and program targets towards the WMP goal. No utility response required for Section 5.1.

5.2 The Objectives of the Plan

Objectives are unique to each utility and reflect the 1, 3, and 10-Year projections of progress towards the WMP goal. Objectives are determined by the portfolio of mitigation strategies proposed in the WMP. The objectives of the plan shall, at a minimum, be consistent with the requirements of California Public Utilities Code §8386(a) –

Each electrical corporation shall construct, maintain, and operate its electrical lines and equipment in a manner that will minimize the risk of catastrophic wildfire posed by those electrical lines and equipment.

Describe utility WMP objectives, categorized by each of the following timeframes, highlighting changes since the prior WMP report:

1. *Before the next Annual WMP Update (by Feb 2022?)*
2. *Within the next 3 years (what years specifically 2020-2022)*
3. *Within the next 10 years – long-term planning beyond the 3-year cycle*

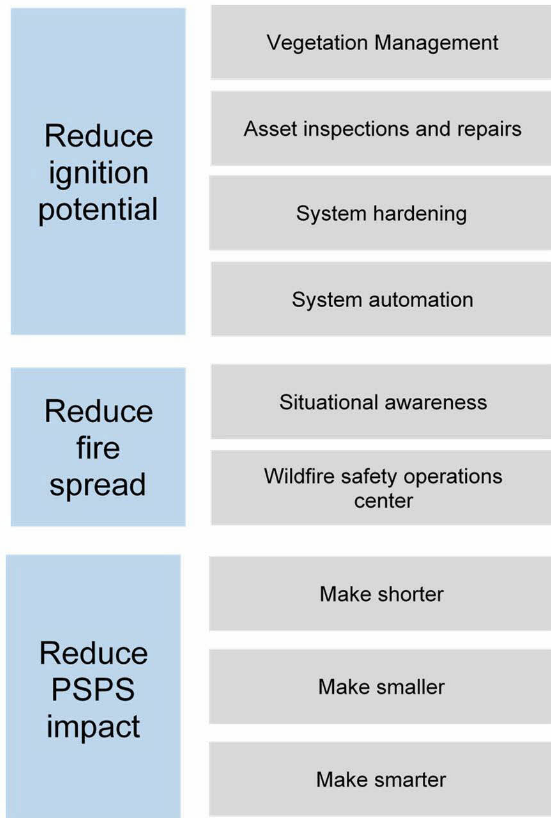
Pacific Gas and Electric Company's (PG&E) overall objective for its 2021 Wildfire Mitigation Plan (WMP) remains unchanged from its 2020 WMP objective. Consistent with the statutory goal stated above, PG&E seeks to reduce the risk and consequences of wildfires associated with utility electrical equipment, thereby avoiding catastrophic wildfires across central and northern California. PG&E's wildfire mitigation strategy is structured around three strategic imperatives: (1) reducing wildfire ignition potential, (2) reducing wildfire spread through enhanced situational awareness, and (3) reducing the impact of Public Safety Power Shutoff (PSPS) events. Figure PG&E-5.2-1 below shows the key elements of the PG&E wildfire mitigation strategy.

Reducing ignition potential is critically important because minimizing ignition risk inherently reduces the potential for fire to spread as well as the need for PSPS events. The imperative to reduce ignition potential is supported by first understanding the causes of utility-related fire ignitions. Vegetation is responsible for approximately half of utility-related ignitions in High Fire Threat District (HFTD) areas, with equipment failure representing roughly another third. Accordingly, reducing ignition potential is implemented at a tactical level by major initiatives that include vegetation management, inspections and repairs of electric facilities, a system hardening program that upgrades transmission and distribution assets, and a system automation program that enhances visibility into and control of the system. During high-risk weather periods, PSPS is also used in a targeted manner to reduce ignition risk on parts of the infrastructure that have not been hardened.

Reducing fire spread is supported by improving situational awareness through monitoring of high-risk fire areas, enabling earlier detection and warning of wildfires, and more effective response by fire crews. Limiting fire spread is also supported by the PG&E Wildfire Safety Operations Center (WSOC), a physical facility serving as the central wildfire-related information hub for PG&E. WSOC monitors, assesses, and directs specific wildfire prevention and response efforts. WSOC monitors for fire ignitions in real time, leveraging PG&E weather information, wildfire camera data, and publicly available weather information, as well as first responder and local and state data. WSOC compiles, interprets, and distributes this information across the company and to emergency response organizations to support limiting the spread of wildfires.

PG&E recognizes the high cost of PSPS to our customers, and uses PSPS only as a tool of last resort for wildfire mitigation. In the short, mid, and long-term, PG&E strives to continue making PSPS events shorter, smaller, and smarter. The intent of "shorter" is to reduce the outage time after the weather "All Clear," and "smaller" refers to reducing the number of customers impacted by each event given the event's weather footprint. The "smarter" objective is to reduce the impact to customers and communities that are de-energized, along with executing PSPS with excellence, keeping in mind lessons learned. The "shorter, smaller, smarter" PSPS efforts are described in more detail in Section 8.1.

FIGURE PG&E-5.2-1: KEY ELEMENTS OF PG&E'S WILDFIRE MITIGATION STRATEGY



In 2020, PG&E made significant progress on all three of its strategic imperatives. Key examples include: to reduce ignition potential, PG&E hardened 376 miles of distribution circuits, completed 1,878 miles of Enhanced Vegetation Management (EVM), and inspected 100 percent of transmission and distribution circuits in HFTD Tier 3. To reduce fire spread through increased situational awareness, PG&E installed over 200 cameras and 400 weather stations in 2020. PG&E also significantly reduced its PSPS impact relative to 2019. Through a number of tool and process improvements, combined with a suite of mitigation initiatives, PG&E reduced the number of customers impacted by PSPS by over 50 percent on average, relative to the number of customers that would have been impacted under the 2019 PSPS program.

Long-Term WMP Planning

Continued progress in PG&E's ability to reduce ignition potential, reduce fire spread, and reduce PSPS impact will require PG&E to develop additional capabilities. The Wildfire Safety Division's (WSD) Utility Wildfire Mitigation Maturity Model (WMM) provides a list of 52 capabilities across 10 categories that are critical for wildfire risk reduction. While PG&E has made significant strides in its wildfire mitigation program these last two years, we still have work to do to further advance in many of these capabilities.

PG&E has learned a tremendous amount from all of its wildfire mitigation activities in 2018, 2019 and 2020. We faced a steep learning curve with respect to developing wildfire mitigation capabilities and purposely designed our WMP program to be nimble and flexible so that it could pivot quickly to address emerging concerns, take advantage of new technologies, and quickly incorporate lessons learned. The focus on the past few years has been on aggressively pursuing opportunities that are identified and ensuring that our work plans remain prioritized based on risk and accounts for what we observed in the previous fire season.

While we have made significant strides in our wildfire mitigation capabilities, PG&E recognizes that we have largely been operating on a year-to-year basis with respect to planning for our many WMP initiatives. PG&E now needs to ground its entire WMP effort on longer-term planning while continuing to maintain a program that can adjust quickly to learnings. The deficiency that PG&E received from the WSD on its 2020 WMP on Condition Guidance-12 with respect to lack of long-term planning underscores this point. PG&E realizes that we need to move to a WMP program that utilizes longer-term benchmarks and goals within the limitations of the shorter utility planning and funding cycles. We will need to take more of a portfolio view, maturing the way that we use data and initiative-specific Risk Spend Efficiencies (RSE) to prioritize across different efforts.

PG&E initiated this longer-term planning effort when it responded to Condition Guidance-12 as part of its First Quarterly Report, submitted on September 9, 2020. In this response, PG&E identified and distinguished the underlying attributes that enable the WMM capabilities.[31] In the long-term, PG&E seeks to prioritize those attributes with respect to their impact on the WMP capabilities, prioritize its portfolio of initiatives and programs relative to their ability to support the attributes, and identify the actions to improve performance of the initiatives. This process, along with the full list of capabilities that PG&E envisions developing over the near, mid, and long-term time horizons, is described in more detail in PG&E's First Quarterly Report.[32]

However, as PG&E described in its response to Condition Guidance-12, it is difficult to commit to a specific set of plan elements beyond a horizon of three to five years for a number of reasons. Long-term planning and forecasting is challenging due to the many changes in wildfire risk understanding, energy technologies, economics, customer, societal preferences, climate change, and institutional and political direction in California and the broader U.S. Furthermore, PG&E's distribution business operates on 4-year financial planning cycles through the General Rate Case (GRC) process, with specific work plans developed annually. PG&E's work plan, budget and funding processes are generally aligned to these shorter annual or 4-year cycles.

Sometimes even making one-, two- or three-year goals is challenging given the dynamic nature of wildfire risk. For example, the unprecedented size and destruction from the 2020 August lightning fires caused shifts in PG&E's system hardening portfolio, creating a new focus on fire rebuilds across our system. New work replaced some of what we originally envisioned completing. Retaining the ability to quickly pivot

---

31 First Quarterly Report, pp. 59-65.

32 First Quarterly Report, pp. 59-89.

investment decisions will be essential for PG&E to successfully navigate ever-evolving risks and opportunities.

The early maturity level of PG&E's WMP program also makes setting longer-term goals challenging. PG&E's various models and risk assessments underlying key WMP programs such as EVM, inspections, and PSPS mitigation efforts are still improving by leaps and bounds each year, driving not only changes to our work plans, but also creating limitations in terms of forecasting long-term wildfire mitigation needs. Even forecasting the quantity of work that needs to be accomplished is challenging when our understanding of what constitutes a high-risk location continues to evolve.

The role of the newly created Wildfire Risk Governance Forum is to ensure that our work plan and annual goals remain prioritized despite changing models. While the learning curve remains steep, our plans are very likely to change and evolve as PG&E develops a deeper understanding of the nature of the wildfire risk and the most effective mitigations together with the California Public Utilities Commission (CPUC) and other stakeholders.

Finally, while we are deeply committed to the goal of reducing the risk of catastrophic wildfires, it cannot be our only goal. While safety remains PG&E's first priority, PG&E has been asked by our customers and the State of California to reimagine and build the electric grid of the future as a secure, resilient, reliable, affordable, and integrated platform that enables continued gains for clean-energy technologies and California's economy. This grid of the future can leverage low-carbon resources, high levels of energy efficiency and demand flexibility, electrification, and advanced energy storage. It will provide customers maximum flexibility, more choices in how they use energy, and ultimately increased value from their utility grid in a dynamic energy future. PG&E needs to account for these broader goals when considering how to reduce the risk and consequences of wildfires associated with utility electrical equipment.

PG&E is committed to improving its long-term WMP planning despite these challenges. A long-term plan is essential because it provides a trajectory to attaining the capabilities we need to reduce wildfire risk. PG&E considers the items under its 1-year goals section below to be its WMP commitments. The goals and capabilities described in the Quarterly Report as well as in the Long-Term WMP Objectives and in the 3- and 10-year list of goals below are based on PG&E's best available knowledge today. While we are working toward these milestones, our plans and capabilities may need to change in response to unknown future events and circumstances. PG&E looks forward to working with the CPUC to find the right balance between longer-term plans and short-term requirements and actions.

Long-Term WMP Objectives

In principle, PG&E expects that its 3- and 10-year WMP objectives will remain the same as the objectives for the 2021 WMP: to reduce ignition risk, prevent fire spread, and reduce PSPS impact.

In the three year time frame, PG&E anticipates continued progress on all three of its WMP objectives, but our overall capabilities will still be relatively immature. PG&E indicated in the First Quarterly Report that PG&E will still be in the foundational, early maturity phase for all but two of the ten Maturity Model categories within these three years. Accordingly, PG&E will be heavily focused on solidifying the quantitative framework underlying its entire WMP program, including PSPS. In particular, we will develop how we use RSEs to shape the portfolio and aggressively adjust our risk models to pinpoint the riskiest locations in our system. While these foundational activities are taking place, PG&E will largely continue to maintain the suite of mitigations proposed in this WMP.

Within three years, PG&E hopes to reach a mid-maturity level with respect to the following two Maturity Model categories: Situational Awareness and Forecasting and Emergency Preparedness and Response. This mid-maturity level indicates that these capabilities and their implementation will have surpassed a foundational level and reached a point where they are being refined and advanced.

In the area of Situational Awareness and Forecasting, PG&E's camera and weather station deployment programs will be largely complete, significantly reducing the chance of a large fire becoming catastrophic. In the area of emergency planning and response, we anticipate making significant progress. This program, together with our public safety partners, supports the goal of limiting and slowing the rate of fire spread once a fire begins. In the three year time frame, in addition to taking a leading role in integrating PG&E's wildfire plan with the plans of other stakeholders, the emergency planning and preparedness team will have evolved the company's wildfire plan to incorporate confounding and simultaneous disasters. We will also have developed a utility standard for after-action reviews and procedures.

In the ten-year time frame, all of PG&E's WMP initiatives will no longer be in their foundational phases, but will have advanced significantly towards maturity. PG&E expects that it will be close to achieving its "target" or "vision" wildfire mitigation capabilities in all ten areas of the WMM.

With respect to Grid Design and System Hardening, this accomplishment means that PG&E will have transformed its transmission and distribution systems to account for wildfire risk while continuing to support other objectives, including maintaining overall reliability and advancing grid capabilities to integrate Distributed Energy Resources and support decarbonization goals. PG&E will have adequately mitigated the riskiest areas in our system through various mitigations, including but not limited to system hardening, undergrounding, line sensing, or emerging technologies. In the select instances when these mitigations still are not enough to protect our customers, PG&E will continue to use PSPS in a very limited and surgical fashion to eliminate wildfire risk, while working to minimize the impacts to our customers.

With the maturation of risk models and quantitative frameworks underlying the WMP, PG&E anticipates having a portfolio in the ten-year time frame that is significantly more optimized than today. Through our programs and pilots, we will have identified the most effective tools to prevent wildfire ignition and spread in our service territory and to reduce the impacts of PSPS. While the work will never be complete as long as wildfire risks remain, PG&E may be able to begin envisioning what initiatives might comprise part of a steady-state set of wildfire mitigation activities.

Below, we list our 1-,3-, and 10-year objectives for wildfire mitigation and map them, where appropriate, to the specific capability categories described in WSD's WMM.

Additional goals specifically related to reducing the PSPS impact are discussed in Section 8.1.

1. *Before the next Annual WMP Update*

For the next planning year, PG&E has identified these specific goals to provide immediate improvements in key maturity categories.

TABLE PG&E-5.2-1: 2021 WMP Commitments Due by Next Annual Update

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
Risk Assessment and Mapping	A.01	7.3.1.5	Match drop simulations (24 additional hours of forecast data)	Enhance the wildfire spread project in 2021 by expanding the forecast horizon from three to four days.	12/31/2021
Risk Assessment and Mapping	A.02	7.3.1.5	Match drop simulations (update fuel model layers)	Update the fuel model layers on annual basis (Technosylva).	12/31/2021
Risk Assessment and Mapping	A.03	7.3.1.3	Re-Train Vegetation Probability of Ignition and Equipment Probability of Ignition Models	In 2021, PG&E's Vegetation Probability of Ignition and Equipment Probability of Ignition Models will see more improvements with another year of data (2020) to be incorporated.	12/31/2021
Risk Assessment and Mapping	A.04	7.3.1.1 / 4.5.1	Risk Mapping Improvements (Transmission)	Improve Transmission Risk Modeling to provide more standardized wildfire risk mapping/ranking between the various controls and mitigations.	12/31/2021
Risk Assessment and Mapping	A.05	7.3.1.1/ 7.3.1.4	Risk Mapping Improvements (Distribution)	Improve Distribution Risk Modeling to include: 1) ability to compare wildfire risks for different risk drivers, 2) ability to measure the risk reduction of specific mitigations, 3) add wildfire risk values for distribution line locations beyond the HFTD and High Fire Risk Areas (HFRA) areas to include all of PG&E's distribution lines.	12/31/2021
Situational Awareness and Forecasting	B.01	7.3.2.1.1	Numerical Weather Prediction	Make enhancements to numerical weather prediction program.	12/31/2021
Situational Awareness and Forecasting	B.02	7.3.2.1.2	Enhancements to Fuel Moisture Sampling and Modeling efforts	Expand the historical Dead Fuel Moisture (DFM) and Live Fuel Moisture (LFM) climatology at 2 x 2 km resolution to back-fill all of 2020.	6/1/2021
Situational Awareness and Forecasting	B.03	7.3.2.1.2	Enhancements to Fuel Moisture Sampling and Modeling efforts (24 additional hours of forecast data)	Evaluate extending the deterministic DFM and LFM forecast to provide another 24 hours of forecast data.	6/1/2021

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
Situational Awareness and Forecasting	B.04	7.3.2.1.3	Enhancements to Weather Station Project (Installations and Optimization)	Install or optimize the location of 300 additional weather stations throughout PG&E's territory.	12/31/2021
Situational Awareness and Forecasting	B.05	7.3.2.1.3	Enhancements to Weather Station Project (Wind Gust Model)	Develop a weather-station specific wind gust model based on machine-learning or statistical techniques.	12/31/2021
Situational Awareness and Forecasting	B.06	7.3.2.1.6	Medium- to Seasonal-Range Diablo Wind Forecasting	Develop and deploy a seasonal Diablo wind event forecasting system based on statistical, machine learning and/or artificial intelligence techniques to obtain longer lead-times of an upcoming Diablo winds event in order to provide crucial preparation time for PG&E and potential communities impacted by these events.	12/31/2021
Situational Awareness and Forecasting	B.07	7.3.2.1.6	Information Sharing	Make adjustments to the public 7-day forecast to provide more granularity and clarity around the potential for a PSPS event. This forecast is aimed at providing as much lead time as possible for the public to prepare for a possible PSPS event.	6/1/2021
Situational Awareness and Forecasting	B.08	7.3.2.2.2	SmartMeters - Partial Voltage Detection	Implement expanded coverage of Partial Voltage Detection capabilities to the three phase meters during Q2 2021.	6/1/2021
Situational Awareness and Forecasting	B.09	7.3.2.2.4	Sensor IQ Pilot Deployment	Deploy Sensor IQ (SIQ) functionality on all planned SmartMeters (500,000) by June 1, 2021 and complete the full evaluation for how to use the technology by October 31, 2021.	10/31/2021
Situational Awareness and Forecasting	B.10	7.3.2.2.6	Distribution Arcing Fault Signature Library	By end of 2021, the Distribution Arcing Fault Signature Library project will have completed a 6-month minimum analytic stage capturing all events on the installed circuit (Half Moon Bay 1103).	12/31/2021
Situational Awareness and Forecasting	B.11	7.3.2.4	Enhancements to Fire Potential Index (FPI) Model	Enhance the FPI Model by September 1, 2021 using additional data and an enhanced fire occurrence dataset. PG&E also plans to incorporate the new Technosylva fuel mapping layer into FPI calculations if it provides more predictive skill of large fires.	9/1/2021
Situational Awareness and Forecasting	B.12	7.3.2.5	Personnel monitoring areas of electric lines and equipment in elevated fire risk	Maintaining SIPT staffing levels to support fire prevention and mitigation activities.	12/31/2021

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
			(Safety and Infrastructure Protection Team (SIPT) Staffing)		
Situational Awareness and Forecasting	B.13	7.3.2.5	Personnel monitoring areas of electric lines and equipment in elevated fire risk (Technology Improvements to Field Automation System (FAS))	Technology improvements to improve data capture in FAS system.	12/31/2021
Situational Awareness and Forecasting	B.14	7.3.2.5	Personnel monitoring areas of electric lines and equipment in elevated fire risk (New Technology to improve data capture)	Technology improvements to improve data capture for routine and emergency work: Develop and pilot ESRI Collector App (New technology development).	6/30/2021
Situational Awareness and Forecasting	B.15	7.3.2.6	Enhancements to Outage Producing Wind (OPW) Model	Recalibrate the OPW Model using the 2 km climatology that will be extended to capture all events in 2020. This will include all 2020 sustained and momentary outages, as well as damages found in PSPS events of 2020.	9/1/2021
Situational Awareness and Forecasting	B.16	7.3.2.7	Wildfire Safety Operations Center (WSOC) – Procedure Update	Update WSOC Procedural Documentation to include expansion of WSOC into All Hazards Center.	12/31/2021
Situational Awareness and Forecasting	B.17	7.3.2.7	Wildfire Safety Operations Center (WSOC) – Expand Active Incidents Visibility	Expand current Active Incidents Dashboard for additional stability, incorporate new data streams, and expand the number of viewers.	10/1/2021
Grid Design and System Hardening	C.01	7.3.3.8.1	Assess Motorized Switch Operator (MSO) switches	Assess various alternatives to address the ignition risk with MSO switches. PG&E plans to explore several pilot options that will help inform which are the best alternatives and select the appropriate corrective action for MSO's for the next WMP update.	12/31/2021
Grid Design and System Hardening	C.02	7.3.3.11.1	Generation for PSPS Mitigation (Temporary Distribution Microgrids)	For 2021, develop at least 5 additional distribution microgrid Pre-installed Interconnetion Hubs (PIH).	12/31/2021
Grid Design and System Hardening	C.03	7.3.3.11.1	Generation for PSPS Mitigation (Substation	Prepare at least 8 substations to receive temporary generation for 2021 PSPS mitigation.	8/1/2021

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
			Distribution Microgrids)		
Grid Design and System Hardening	C.04	7.3.3.11.3	Emergency Back-up Generation – PG&E Service Centers & Materials Distribution Centers	Equip at least 23 PG&E Service Centers & Materials Distribution Centers to receive permanent or temporary generation by the end of 2021. Equip the 72 remaining PG&E Service Centers & Materials Distribution Centers to receive permanent or temporary generation by the end of 2022.	12/31/2021
Grid Design and System Hardening	C.05	7.3.3.17.5	Remote Grid	Begin operations of the first Remote Grid project by the end of 2021.	12/31/2021
Grid Design and System Hardening	C.06	7.3.3.8.1	Distribution Sectionalizing (automated devices)	During 2021, install at least 250 more distribution sectionalizing devices integrating learnings from 2020 PSPS events, a 10-year historical look-back of previous severe weather events, and feedback from county leaders and critical customers.	12/31/2021
Grid Design and System Hardening	C.07	7.3.3.8.2	Supervisory Control and Data Acquisition (SCADA) Transmission Switching (switches)	Install 29 SCADA transmission switches to provide switching flexibility and sectionalization for PSPS events	9/1/2021
Grid Design and System Hardening	C.08	7.3.3.9.1	Distribution line legacy 4C controllers	Replace all remaining (~84) distribution line legacy 4C controllers that are located in Tier 2 and Tier 3 HFTD areas by the end of 2021.	12/31/2021
Grid Design and System Hardening	C.09	7.3.3.9.2	Fuse Savers (Single phase reclosers)	Install 70 sets of single phase reclosers by the end of 2021	12/31/2021
Grid Design and System Hardening	C.10	7.3.3.17.4	Rapid Earth Fault Current Limiter (REFCL) Pilot	PG&E plans to have the final results from this pilot project by the end of June 2021. The result of the pilot project will drive the longer-term REFCL strategy.	6/30/2021
Grid Design and System Hardening	C.11	7.3.3.7	Expulsion Fuse Replacement (non-exempt equipment)	Replace approximately 1,200 fuses/cutouts, and other non-exempt equipment identified on poles in Tier 2 and Tier 3 HFTD areas in 2021.	12/31/2021
Grid Design and System Hardening	C.12	7.3.3.7.13	System Protection (surge arrester)	Replace at least 15,000 of the remaining 21,400 Tier 2 and Tier 3 non-exempt surge arresters, by the end of 2021.	12/31/2021
Grid Design and System Hardening	C.13	7.3.3.17.1	System Hardening (line miles)	System Hardening; 180 miles in 2021.	12/31/2021

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
Grid Design and System Hardening	C.14	7.3.3.17.6	System Hardening (Butte County Rebuild)	Butte County Rebuild; 27 miles in 2021.	12/31/2021
Asset Management and Inspections	D.01	7.3.4.1	Distribution HFTD Inspections (poles)	For 2020 through 2022, complete enhanced detailed inspections of overhead distribution assets in the following recurrence intervals: (1) Tier 3 – annually; and (2) Tier 2 – every three years.	7/31/2021
Asset Management and Inspections	D.02	7.3.4.15	Substation HFTD Inspections (substations)	For 2021, complete supplemental ground and aerial inspections of 100 stations: 42 in HFTD Tier 3, 38 HFTD Tier 2 and 19 Tier 2/3 Adjacent stations.	12/31/2021
Asset Management and Inspections	D.03	7.3.4.2	Transmission HFTD Inspections (structures)	In 2021, 100 percent of overhead transmission poles in HFTD Tier 3, one third of poles in HFTD Tier 2 will be subjected to detailed enhanced inspections and some form of aerial assessment (helicopter, drone, aerial lift, climbing).	7/31/2021
Asset Management and Inspections	D.04	7.3.4.5	Infrared Inspections of Transmission Electric Lines and Equipment	For 2021, conduct Infrared inspections on 100 percent of transmission circuits in Tier 3, 33 percent of transmission circuits in Tier 2, and 20 percent of transmission circuits in non-HFTD areas. Circuits supporting Diablo Canyon Power Plant (DCPP) and Morro Bay Power Plant, and the tie lines for the Western Electric Coordinating Council (WECC) will be inspected by Infrared. Planned scope of approximately 5,500 miles.	12/31/2021
Vegetation Management and Inspections	E.01	7.3.5.2	EVM (line miles)	Complete 1,800 circuit miles and mitigate approximately 190,000 trees in both 2021 and 2022, for the EVM program.	12/31/2021
Vegetation Management and Inspections	E.02	7.3.5.1	Additional Efforts to Manage Community and Environmental Impacts	Expansion of the month ahead workplan reports to the Regional Water Quality Control Board Representatives in 2021	12/31/2021
Grid Operations and Protocol	F.01	7.3.6.3	Personnel Work Procedures and Training in Conditions of Elevated Fire Risk	Incorporate learnings from pilot quality control audit into expansion of Quality Control (QC) program and adjust findings.	9/1/2021
Data Governance	G.01	4.4.1	Research Proposals (Open Innovation Challenge)	Initiate an "Open Innovation Challenge" to identify novel technologies that could potentially reduce PG&E-caused wildfire risk.	9/1/2021

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
Data Governance	G.02	4.4.1	Research Proposals (Cal Poly Wildland Urban Interface (WUI) Fire Information Research and Education (FIRE) Institute)	Partner with, and advise on the direction of research and associated activities by the FIRE Institute as it embarks on the development of solutions for sustainable fire-resilient communities and safer and more effective fire-preparedness and response operations through applied research and incorporation of technology.	12/31/2021
Emergency Planning and Preparedness	I.01	7.3.9.1	Staffing to Support Service Restoration	Hire approximately 40 Linemen and 100 Apprentices.	12/31/2021
Emergency Planning and Preparedness	I.02	7.3.9.1	Adequate and Trained Workforce for Service Restoration	All required personnel to complete all trainings to improve PSPS event execution (Phase III SEMS training, Integrating Access and Functional Needs training, PSPS-0001WBT PSPS Restoration Overview Trainings, and PSPS-0002WBT DCC Operator Trainings).	12/31/2021
Stakeholder Cooperation and Community Engagement	J.01	7.3.10.1/ 8.4	Community-Based Organizations (CBOs) Coordination	Partner with CBOs in targeted communities to increase their capacity to serve AFN communities, such as medically sensitive customers, low-income, limited- English speaking and tribal customers.	12/31/2021
Stakeholder Cooperation and Community Engagement	J.02	7.3.9.2 / 7.3.10.1	Community Engagement	Engage community stakeholders through holding/offering: Wildfire Safety Working Sessions, workshops that review PG&E's PSPS Policies and Procedures document, listening sessions, Energy and Communications Providers Coordination Group meetings.	2/1/2022
Stakeholder Cooperation and Community Engagement	J.03	7.3.9.2 / 7.3.10.1	Customer and Community Outreach	Continue to enhance communications and engagement efforts with a focus on wildfire safety and preparedness for PSPS events - including Webinars/Community Meetings, Direct-to-Customer Outreach, developing and delivering informational video resources.	12/31/2021
Protocols on PSPS	K.01	8.4/8.2.4	Customer and Agency Outreach During PSPS Events	Improve Customer and Agency Outreach During PSPS Events by: developing opt-in address alerts, conducting new message testing, promoting enrollment, hosting briefings, hosting cooperator calls.	12/31/2021

Plan Area	Unique ID	Section Reference	Activity	Commitment Description (brief)	Commitment Date/ Narrative
Protocols on PSPS	K.02	8.2.1	Mitigation Impacts on De-Energized Customers	Work with partner organizations to provide outreach and support to vulnerable customers through programs such as the Disability Disaster Access and Resources Program (DDAR) and the Portable Battery Program (PBP). Eligible customers will receive support that may include emergency planning assistance, a back-up battery, and/or in-event resources such as hotel accommodations, accessible transportation, etc.	12/31/2021

2. *Within the next 3 years*

Over the next three years, PG&E has identified the following focus areas to help accelerate our maturity in key capabilities. PG&E will continue to explore innovative ways to significantly help meet our core WMP objective of reducing fire risk, fire spread, or PSPS impact. A more detailed view of the capabilities expected to be developed over the next in the short, mid, and long-term planning horizons can be found in PG&E's Quarterly Report.

- **Situational Awareness and Forecasting:** Deploy cameras to cover approximately 90 percent of the high fire-risk areas.
- **Emergency Planning and Preparedness:** Evolve wildfire plan to incorporate confounding and simultaneous disasters.
- **Asset Management and Inspections:** Move toward risk-informed inspection protocols and recurrence intervals.
- **Risk Assessment and Mapping:** Increase granularity of ignition risk reduction to below the circuit level, including integration of fire spread consequences.
- **Vegetation Management and Inspections:** Increase fuel reduction programs and assess the benefits of these efforts.

3. *Within the next 10 years – long-term planning beyond the 3-year cycle*

Across the longer-term, 10-year planning horizon, PG&E will focus on broadening and deepening its WMP efforts, by maturing across WMM capabilities to make our overall program more robust, while extending particularly effective programs to further protect our customers and communities.

- **Performance Assessment:** Track and assess performance of implemented wildfire risk and PSPS impact mitigation activities over an extended period of time to validate effectiveness. Based on observed performance, continue using, modifying, and improving elements of wildfire mitigation programs.

- **Risk Modeling:** Full automation of current risk level, reduction, and RSE tools.

- **Grid Design and System Hardening:** Harden our highest risk distribution circuits in HFTD areas and eliminate all non-exempt equipment in HFTD areas.

- **Vegetation Management and Inspections:** Extend EVM to most distribution line miles in Tier 2 and Tier 3 HFTDs.

Together with the long-term vision presented in the First Quarterly Report, these goals serve as a guiding roadmap for PG&E. They represent our current state of knowledge and understanding about wildfire risk and associated mitigation programs. As *technology* and policy continue to evolve, and our own understanding and risk management practices improves, the specific goals and wildfire mitigation approaches PG&E adopts will likely evolve as well. PG&E will stay connected to industry innovations in wildfire risk reduction, grid hardening, and related fields through our memberships in Electric Power Research Institute (EPRI), International Wildfire Risk Mitigation Consortium (IWRMC), and other peer groups. These relationships will continue to support our ability to identify and incorporate promising innovations into our wildfire mitigation programs.

5.3 Plan program targets

Program targets are quantifiable measurements of activity identified in WMPs and subsequent updates used to show progress towards reaching the objectives, such as number of trees trimmed, or miles of power lines hardened.

List and describe all program targets the electrical corporation uses to track utility WMP implementation and utility performance over the last five years. For all program targets, list the 2019 and 2020 performance, a numeric target value that is the projected target for end of year 2021 and 2022, units on the metrics reported, the assumptions that underlie the use of those metrics, update frequency, and how the performance reported could be validated by third parties outside the utility, such as analysts or academic researchers. Identified metrics must be of enough detail and scope to effectively inform the performance (i.e., reduction in ignition probability or wildfire consequence) of each targeted preventive strategy and program.

The commitments outlined in PG&E's 2021 WMP include both quantitative and qualitative targets. For the purposes of this section of the WMP, Table 5.3-1 reflects a summary of all quantitative targets that involve work being performed on assets (i.e., inspections, repairs, replacements, new installations). For a complete list of all qualitative and quantitative 2021 WMP Commitments please refer to Section 5.2.

TABLE 5.3-1: LIST AND DESCRIPTION OF PROGRAM TARGETS, LAST 5 YEARS

PENDING COMPLETION

Program Target Name	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022[33]	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
B.04 - 7.3.2.1.3 - Enhancements to Weather Station Project (Installations and Optimization)	426	404	300	TBD	# of weather stations installed or optimized / moved existing located in Tier 2 and Tier 3 HFTD	Between 2018 and end of 2021, we will have installed over 1300 weather stations, exceeding the original scope of the program. Beyond 2021, in collaboration with external partners, we will assess the need to install additional weather stations as well as optimize the locations of existing stations.	Annual	SAP Work Orders
B.018 - 7.3.2.1.4 - HD Cameras	75	216	135	TBD	# of HD Cameras Installed	Cameras are considered installed and operational when they successfully begin providing images to Alertwildfire.org (site utilized by PG&E for viewing all camera input)	Annual	SAP Work Orders
C.02 – 7.3.3.11.1C – Generation for PSPS Mitigation (Temporary Distribution Microgrids)	1 [+3 temporary configurations]	3 (2 additional) [+3 temporary configurations]	8 (5 additional)	15 (7 additional)	Cumulative # of Distribution Temporary Micro Grids (PIHs) operationally-ready to receive temporary generation	Primary unit of measure reflects cumulative YOY PIHs available and ready to operate for PSPS events. (The number in parenthesis represents the incremental PIHs made operationally ready in the respective year.) [The brackets represent the temporary configurations that were	Annual	SAP Work Orders

33 Project Targets for 2022 are forecast based on current data available and is subject to change during 2021

Program Target Name	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022[33]	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
						available in the respective year]		
C.03 – 7.3.3.11.1B – Generation for PSPS Mitigation (Substation Distribution Microgrids)	0	60	8	8	# of substations operationally-ready as a temporary microgrid	Substation microgrid program began in 2020 There were two additional substation solutions at Calistoga and Placerville that are categorized under the Temporary Distribution Microgrids (section 7.3.3.11.1C) that also utilized substation temp gen equipment, bringing the total to 62.	Annual	SAP Work Orders
C.04 – 7.3.3.11.3 – Emergency Back-up Generation – PG&E Service Centers & Materials Distribution Centers	0	0	23	72	# of locations equipped to receive permanent or temporary generation (Operational)	New initiative started in 2021, each Center becomes ready to receive permanent or temporary generation	Annual	SAP Work Orders
C.05 – 7.3.3.17.5 – Remote Grid	0	0	1	20	# of Remote Grid sites operational	This was a New Technology initiative that started in 2020	Annual	SAP Work Orders confirmation

TABLE 5.3-1: LIST AND DESCRIPTION OF PROGRAM TARGETS, LAST 5 YEARS (CONTINUED)

Program Target	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
								SAP Work Orders confirmation

TABLE 5.3-1: LIST AND DESCRIPTION OF PROGRAM TARGETS, LAST 5 YEARS (CONTINUED)

Program Target	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
C.06 – 7.3.3.8.1 – Distribution Sectionalizing (automated devices)	228	603	250	100	# of new installations of Automated Sectionalizing Devices (SCADA Commissioned)	Devices located on lines traversing into Tier 2 and Tier 3 HFTD boundaries	Annual	PSPS 2020 Commissioned Completions
C.07 – 7.3.3.8.2 – SCADA Transmission Switching (switches)	0 (For PSPS mitigation)	54	29	65	# of switches installed to mitigate PSPS impacts	Switches were expedited with locations determined to be in high priority for PSPS events	Annual	SCADA Wave and PSPS Master Data
C.08 – 7.3.3.9.1 – Distribution line legacy 4C controllers	0	20	~84 / 100% of remaining in Tier 2 and Tier 3 HFTD	0	# of distribution line Legacy 4C Controllers replaced with SCADA enabled reclosers in Tier 2 and Tier 3 HFTD	Approximately 50 4C reclosers were replaced by other programs (COE, System Hardening) leaving 84 to complete 100 percent of the remaining	Annual	SAP Work Orders
C.09 – 7.3.3.9.2 – Fuse Savers (Single phase reclosers)	0	0	70	70	# of single phase reclosers sets installed (SCADA Commissioned)	PG&E piloted the devices in 2018-2019 to determine if they work as designed. In 2020, the devices were used for the Distribution Line Sectionalizing (123 locations). For 2021 and 2022, the plan is use the FuseSaver device to mitigate risk from back-feed conditions on long tap lines (70 locations annually). The FuseSaver and similar devices have multiple applications and can be used to open all phases whether it's for PSPS sectionalizing (under	Annual	SAP Work Orders

Program Target	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
						MAT 49H) or for mitigating back-feed conditions (under MAT 49T).		
C.11 – 7.3.3.7 – Expulsion Fuse Replacement (non-exempt equipment)	708	643	1,200	1,200	# of Expulsion Non-Exempt Fuses replaced in Tier 2 and Tier 3 HFTD	2020 Performance is Pending IA Validation	Annual	IA 2020 Final Review
C.12 – 7.3.3.7.13 – System Protection (surge arrester)	4,602	9,896	at least 15,000 of the remaining 21,400	19,314	# of Non-Exempt Surge Arresters replaced in Tier 2 and Tier 3 HFTD	Validated replaced or mitigated devices In 2017, the Program started replacement of the existing surge arresters with new Cal Fire EXEMPT arresters	Annual	SA 2020 Locations Verified
C.13 – 7.3.3.17.1 – System Hardening (line miles)34	171	342	180	464	# of line miles hardened; Miles located in Tier 2, Tier 3 HFTD	2020 Final line miles Pending IA validation	Annual	IA 2020 Final Review
C.14 – 7.3.3.17.6 – System Hardening (Butte County Rebuild)	0	21.7 (HFDT Only) 30 (Total)	23	23	# of UG miles hardened in both non-HFTD and HFTD areas within Butte County	Constructed miles pass Quality Assurance (QA) and Internal Audit (IA) review	Annual	Butte WMP Reportable Miles - 2020 Final
C.15 - 7.3.2.3.17.2 - System Hardening - Transmission Conductor	40	103	92	111	# of transmission line conductor miles hardened that traverse HFTD	Mileage is based on the line(s) associated with the project and whether the line traverses an HFTD region. Some of the mileage may not be in HFTD since there are lines that traverse both HFTD and non-HFTD regions. Additionally, only electric transmission capital orders greater than $1M identified in the STAR filing is reported. Smaller span	Annual	STAR Project Data Spreadsheet

34 Tier 1 area miles that are required to complete the hardening in the Tier 2/3 area or otherwise recommended by a public Safety Specialist are excluded in the System Hardening Actual or Target totals

Program Target	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
						reconductoring via maintenance tags is not counted in the overall mileage. Placeholders for In-year emergency or break-in work is not included. 2021 target is adjusted from the STAR filing to account for potential execution risks.		
D.01 – 7.3.4.1 – Distribution HFTD Inspections (poles)	694,250[35]	339,728	402,000 Poles 199,730 Tier 3, 195,270 Tier 2, 7,000 Zone 1	~395K	# of overhead distribution structures Inspected in HFTD and Buffer Zone "Zone 1"	2019 measured on # of inspections, 2020 measured # of poles inspected	Annual	Inspection Records (SAP)
D.02 – 7.3.4.15 – Substation HFTD Inspections (substations)	222[36]	99	100 Stations: 42 Tier 3, 38 Tier 2 20 Tier 2/3 Adjacent	~100	# of substations inspected in HFTD and adjacent T2/3A	2019 measured on # of inspections, 2020 measured # of substations inspected	Annual	Inspection Records (SAP)
D.03 – 7.3.4.2 – Transmission HFTD Inspections (structures)	49,715[37]	26,282	24,092 Total 100% Tier 3 (11,312), approximately 33% Tier 2 (12,780)	~24K	# of structures inspected Tier 2 and Tier 3 HFTD	2019 measured on # of inspections, 2020 measured # of structures inspected (ground only)	Annual	Inspection Records (SAP)

35 2019 Distribution inspections were based on the number of inspections, revised in 2020 to measure the number of poles inspected.

36 2019 Substation inspections were based on the number of inspections, revised in 2020 to measure the number of Substations inspected.

37 2019 Transmission inspections were based on the number of Ground inspections, revised in 2020 to measure the number of Structures inspected.

D.04 – 7.3.4.5 – Infrared Inspections of Transmission Electric Lines and Equipment	~4,354 HFTD Tier 3, 2 and Zone 1 [~9,905 system wide]	~2,600 HFTD Tier 3, 2 and Zone 1 [~5,250 system wide]	~2,844 HFTD Tier 3, 2 and Zone 1 [~7,761 system wide]	~2,844 HFTD Tier 3, 2 and Zone 1 [~7,761 system wide]	# of circuit miles infrared inspected in HFTD [total systemwide # of circuit miles infrared inspected]	Primary unit of measure for the commitment is HFTD miles (Tier 3, 2 and Zone 1) [Secondary unit of measure that ties to the financial tables includes all mileage] Note: Infrared inspections are dependent on loads. If load does not materialize, infrared inspection cannot be performed In 2019 and prior, infrared inspections were performed within the system on a five year cadence (approx. 20% per year). Additionally, lines would typically be based on local knowledge for seasonal operational readiness In 2020, infrared inspections were performed on all summer-peaking transmission lines with structures in Tier 2 or Tier 3 HFTD areas. Winter peaking transmission lines with structures in Tier 2 or Tier 3 will have Infrared inspections performed in January/February 2021. In total, the 2020 transmission Infrared program covered 5,313 miles systemwide. For 2021, we plan to conduct Infrared inspections on 100% of transmission circuits in Tier 3 HFTD areas,	Annual	Inspection Records (SAP)

Program Target	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
						33% of transmission circuits in Tier 2 HFTD areas, and 20% of transmission circuits in non-HFTD areas. Circuits supporting Diablo Canyon Power Plant (DCPP) and Morro Bay Power Plant, and the tie lines for the Western Electric Coordinating Council (WECC) will be inspected by Infrared. The planned scope of Transmission Infrared Inspections in 2021 is approximately 8,000 miles systemwide. For 2022, infrared effectiveness will be evaluated prior to continuing or changing cycle times set in 2021 scope.		

TABLE 5.3-1: LIST AND DESCRIPTION OF PROGRAM TARGETS, LAST 5 YEARS (CONTINUED)

Program Target	2019 Performance	2020 Performance	Projected Target by end of 2021	Projected Target by end of 2022	Units	Underlying Assumptions	Update Frequency	Third-Party Validation
E.01 - 7.3.5.2 - EVM (line miles)	2,498	1,878	1,800	1,800	# Line miles verified Tier 2 and Tier 3 mileage	Miles are verified	Annual	EVM Work Verification Report
E.03 - 7.3.2.5.3 - VM Transmission Right of Way Expansion	198	216	200	125	# of miles of Transmission ROW expanded in HFTD	2021 mileage is based on a subset of the overall 2021 workplan. This subset was determined based on 2020 actual performance – although we are planning for more mileage, accounting for potential execution risk we are committing to around the same level as 2020	Annual	Project Team Work Order Tracking file

Notes on fields provided above in Table 5.3-1:

- The “Update Frequency” is primarily listed as “annual” since PG&E plans its work and updates it WMP on an annual cycle.
- The “third-party validation” column includes documents or records that support the commitment completion that could be provided to third parties looking to assess the work completed in these programs.

5.4 Planning for Workforce and Other Limited Resources

Report on worker qualifications and training practices regarding wildfire and PSPS mitigation for workers in the following target roles:

1. *Vegetation inspections*
2. *Vegetation management projects*
3. *Asset inspections*
4. *Grid hardening*
5. *Risk event inspection*

For each of the target roles listed above:

1. *List all worker titles relevant to target role (target roles listed above)*

2. *For each worker title, list and explain minimum qualifications with an emphasis on qualifications relevant to wildfire and PSPS mitigation. Note if the job requirements include the following:*
    a. *Going beyond a basic knowledge of GO 95 requirements to perform relevant types of inspections or activities in the target role*
    b. *Being a "Qualified Electrical Worker" (QEW) and define what certifications, qualifications, experience, etc. is required to be a QEW for the target role for the utility.*
    c. *Include special certification requirements such as being an International Society of Arboriculture (ISA) Certified Arborist with specialty certification as a Utility Specialist*
3. *Report percentage of Full Time Employees (FTEs) in target role with specific job title*
4. *Provide a summarized report detailing the overall percentage of FTEs with qualifications listed in (2) for each of the target roles.*
5. *Report plans to improve qualifications of workers relevant to wildfire and PSPS mitigation. Utilities will explain how they are developing more robust outreach and onboarding training programs for new electric workers to identify hazards that could ignite wildfires.*

For consistency and clarity in responding to the five Items of information identified for the target roles, we have created a summation table to address Items 1 through 4. These items are referenced at the top of each table. Note that the Item 3 percentages include all listed active roles in 2020 and Item 4 percentages are based only on the roles with "High Interest" qualifications from Question 2 such as QEWs. Both Items 3 and 4 percentage totals sum to 100 percent representing the distribution of those resources across the different worker titles. Item 5 (plans to improve qualifications) is included in the narrative following each table.

5.4.1 Target role: Vegetation Inspections

TABLE PG&E-5.4-1: TARGET ROLE: VEGETATION INSPECTIONS

(1) Contractor Titles	(2a.b.c) Minimum Qualifications*	(1) Qualifications Relevant to Wildfire and PSPS Mitigation	(3) FTE % by Target Role	(4) FTE % by High Interest Qualification
Vegetation Control (VC) Technician (Crew and PI)	N/A	VC position that carries out physical pole clearing work and pre-inspection	10%	
Vegetation Management (VM) Consulting Utility Forester	N/A	VM Patroller (AKA Pre-Inspector or PI) under Routine, Defined scope or CEMA etc.	75%	
VM Estimating Arborist (EA)	N/A	VM position that does EA work as a primary function	4%	
VM Senior Consulting Utility Forester	N/A	VM position that supervises a group of Pre-Inspectors	5%	
Right of Way (ROW) Pre-inspector	N/A	ROW enhancement, lays out individual projects	2%	
ROW Consulting Utility Forester	N/A	ROW field inspector	3%	
ROW Senior Consulting Utility Forester	N/A	ROW position that supervises a group of ROW Consulting Utility Foresters	2%	
			100%	

* Note: The Minimum Qualification only listed the qualifications outlined in part 2 (a, b, and c), the other qualifications for these positions are listed in the "Qualification Summary" section below.

<u>Minimum Qualifications</u>:

The Vegetation Management Inspection (VMI) roles do not require any of the three minimum qualifications (Qualified Electrical Worker (QEW), special certifications, advanced knowledge of General Order (GO) 95). Some VM project inspectors are certified arborists, but it is not a requirement for these roles.

PG&E uses the completion of training to ensure minimum qualifications are met before contractors can gain access to databases that are required to perform work in the field. Only after successfully completing specific training related to certain positions will the user be allowed access to the PG&E databases. Training requirements specific to the employee or contractor role are summarized below.

Qualification Summary:

- VC workers must complete VEGM -0302 PI Basics Structured Learning Path (SLP) described in the chart below
- ROW Pre-Inspectors, Consulting Utility Foresters and Senior Consulting Utility Foresters must complete the PI Basics SLP.
- Anyone working for EVM must also complete VEGM-0410 before receiving access. This course provides an overview of EVM procedures and the scope of work.

SLP class summary of qualifications:

TABLE PG&E-5.4-2: SLP CLASS SUMMARY OF QUALIFICATIONS

Course Number	Course Name	Description
VEGM-0101WBT	Introduction to Pre-Inspection Basics	Electrical equipment basics, the VM patrol process, tree work, and customer relations.
VEGM-0102WBT	Mapping Patrol Line Segments	How to identify patrol line segments on the index map.
VEGM-0103WBT	Pre-Inspection Tools and Practices	Tools and procedures pre-inspectors must follow during vegetation management work activities.
VEGM-0104WBT	Tree Assessment Tool (TAT)	How to use the Tree Assessment Tool (TAT)
VEGM-0105WBT	Tree Strike Potential	Strike potential decision process and data entry into the mobile device.
VEGM-0106WBT	Major Woody Stem Exemption	Major woody stem exemption decision process.
VEGM-0107WBT	Tree Growth Potential	Tree growth potential decision process and data entry into the mobile device.
VEGM-0108WBT	Abnormal Field Conditions Reporting	Identify abnormal field conditions during VM work activities.
VEGM-0109WBT	Assess Treatment of Re-sprouting Stumps	How to identify and treat re-sprouting stumps.
VEGM-0110WBT	Skills Assessment for Pre-Inspectors	Final skill assessment that will test key subjects from past vegetation management training.

Plans to Improve Worker Qualifications:

Broadly, PG&E is supporting the further development of certifications within the VM industry in alignment with utility VM laws and regulations (including in specific states). In 2021, PG&E will expand on the success of the 2020 rollout of the PI basics SLP. We will be clarifying and defining internal training that must be completed to ensure understanding of key concepts as well as developing new training where gaps are identified.

PG&E will continue to work with our internal environmental partners to ensure that the identified environmental training for 2021 fulfill all our internal and external commitments. We are developing new training courses to support changes, such as Assessing Burned Redwoods in response to the 2020 fires and focusing training on Priority Tags in response to procedural changes. In all cases our training will be developed with and managed through the PG&E Academy to ensure proper development and learner completion tracking.

ACTION PGE-31 (Class A):

In its 2021 WMP update, PG&E shall: (1) describe how long it takes to complete tree crew training, (2) describe the type of certification earned upon the completion of pre-inspector training, (3) elaborate on how PG&E supports obtaining an International Society of Arboriculture (ISA) certification, (4) provide the number and percentage of contracted versus internal pre-inspectors and describe whether contracted pre-inspectors undergo the same training as internal pre-inspectors, (5) describe how PG&E ensures proper certification of contracted pre-inspectors, and (6) explain how it ensures proper training is completed by subcontractors.

1) Tree crew training is continuous to ensure individuals are always improving upon and gaining new skills. However, prior to performing working on PG&E's behalf, all vegetation management contractors or employees must complete PG&E's SLP Program. The SLP consists of a phased approach that can take up to 12 months to complete a full comprehensive training for pre-Inspectors and tree crews. Once the initial SLP is completed, a second SLP opens to track progress quarterly for the first year.

2)
Upon completing the courses associated with the SLP, specifically VEGM-0110 (Skills Assessment for pre-inspectors) pre-inspectors receive credit for completing the course, no official certification is provided. However, completion of the course allows for 6 credit hours to be applied towards Continuing Education units to the ISA if a student is ISA certified.

3) In our effort to encourage employees and contractors to seek ISA certification, PG&E adds training courses that are eligible for Continuing Education hours that can be used towards ISA certification renewals. Certification is currently not a requirement for pre-inspectors. For pre-inspectors to become certified, they require a certain level of experience and on-the-job training. For example, to become an ISA Certified Arborist, you must be trained and knowledgeable in all aspects of arboriculture and meet a minimum qualification of having three or more years of on the job experience. With that, PG&E has taken the approach of developing Tree Crew and Inspector Training programs to support a steady pipeline of qualified personnel who may later join our contract or internal VM workforce. PG&E's PI basics SLP and related training courses provide contractors with an opportunity to earn continuing education credit that can be used towards obtaining certification. Our partnership with Butte College allows us to provide employees and contractors with a direct path of obtaining certification.

4) While PG&E has started employing internal pre-inspectors, they comprise less than 1 percent of the VM workforce. Training requirements are the same for both internal and contracted pre-inspectors.

5)
Certification is currently not a requirement for pre-inspectors. PG&E uses the method of on the job training to ensure pre-

inspectors are professionally trained. Every training that a pre-inspector takes is managed by the Learning Academy within PG&E. (Please see the comprehensive list of training requirements above in Table PG&E-5.4-2)

6)
To confirm subcontractors are following proper training protocols, PG&E has the prime contractor sign affidavits for each subcontractor as part of PG&E's approval process for the use of the subcontractor. Pre-inspectors and other related VM personnel, including subcontractors, are not granted access to PG&E systems until training is completed. Course completion is documented and retained in PG&E's System of Record. (See Section 5.4.1 Target Role Vegetation Inspections)

5.4.2 Target role: Vegetation Management Projects

TABLE PG&E-5.4-3: TARGET ROLE: VEGETATION MANAGEMENT PROJECTS

(1)	(2a.b.c)	(1)	(3)	(4)
Contractor Titles	**Minimum Qualifications**	**Qualifications relevant to wildfire and PSPS mitigation**	**FTE % by Target Role**	**FTE % by High Interest Qualification**
VM Project Coordinator	N/A	VM position that oversees a project - not a Pre-Inspector	16%	
VC Project Coordinator	N/A	VC Project Coordinator	11%	
VM Project Manager	N/A	VM position that oversees and is responsible for an entire project	26%	
ROW Project Manager	N/A	ROW position that oversees several enhancement projects	47%	
			100%	

<u>Minimum Qualifications</u>:

Similar to Vegetation Management Inspection roles mentioned in Section 5.4.1 (Target Role: Vegetation Management Inspection) VM project roles do not require any of the three minimum qualifications (QEW, special certifications, advance knowledge of GO 95).

PG&E uses the completion of training to ensure minimum qualifications are met before contractors can gain access to databases that are required to perform work in the field. Employees and contractors in VM project roles are required to complete SLP training as outlined in Section 5.4.1. The SLP requires the completion of a comprehensive training program that includes web-based training (WBT), scenario-based skills assessments, on the job training (OJT), and mentoring relationships with experienced Pre-Inspectors.

Plans to improve worker qualifications:

Please refer to Section 5.4.1 for details on how VM is working to improve worker qualifications for both the Vegetation Inspection and Vegetation Management Projects.

In this section PG&E also addresses Actions PGE-28 (Class A), PGE 29 (Class A), PGE 30 (Class A) and PGE-32 (Class A).

ACTION PGE-28 (Class A)

In its 2021 WMP *update, PG&E shall describe its process for identifying the most effective contract employees.*

***Response*:**

VM works with our Contract Management department to engage with contract vendors to recruit appropriate personnel to support our VM programs across our service territory, including CEMA (Catastrophic Event Memorandum Account) inspections, EVM inspections, routine inspections, and emergency work. In order to identify the most effective contract vendors, we verify that the vendor performs the appropriate scope of work identified, and we validate the vendors' safety presence in the industry. We evaluate the safety present by reviewing Key Performance Indicators like Serious Injury and Fatality actual counts, at fault Dig-ins, injuries, motor vehicle incidents, work procedure errors, work procedure violations, line strikes, timely notifications, and cause evaluations. Additionally, PG&E assures our vendors follow Occupational Safety and Health Administration (OSHA) qualified electrical worker 1910.269 and California Code of Regulations, Title 8 Section 2950.

ACTION PGE-29 (Class A)

In its 2021 WMP update, PG&E shall provide *further explanation on how it is working with other utilities to ensure that it is not limiting other utilities' resources.*

Response:

The market for vegetation contractors is an open and competitive market. In support of that open market, PG&E does not coordinate with other utilities on the hiring, sharing or balancing of vegetation contractors. PG&E understands that coordination of resource levels or contracting approaches potentially affecting the free market would be prohibited by antitrust laws. So while PG&E meets regularly with other utilities such as Southern California Edison Company (SCE) and San Diego Gas &

Electric Company (SDG&E) to discuss VM safety practices, industry news and best practices, we do not coordinate on resource sharing or contracting plans and details.

ACTION PGE-30 (Class A)

In its 2021 WMP update, PG&E shall describe the increase in external VM workforce from 2018 to 2020.

Response:

Since 2018, the VM workforce has increased its external VM workforce by more than 100 percent. The VM workforce has added 4,000+ tree crew workers, and 1,000+pre-inspectors through the end of 2020. In implementing our incremental Vegetation Management work in 2018 (the Fuel Reduction Program, Accelerated Wildfire Risk Reduction activities, and EVM Program), we knew that our then-existing contractor workforce was not large enough to address the volume of work required to address trees in HFTD areas with the potential to strike PG&E overhead lines. Accordingly, we have made a concerted effort to significantly increase our external VM workforce to address our wildfire prevention measures.

ACTION PGE-32 (Class A)

In its 2021 WMP update, PG&E shall describe how it prioritizes work based on labor constraints. Specifically, PG&E shall discuss whether it has reduced the scope of VM work due to labor constraints and, if so, explain the analysis to support that decision-making, including risk assessment and prioritization.

Response:

In 2020, labor constraints did not force any scope changes. If we were to have a labor constraint, we would prioritize by risk. It is imperative that we review the scope of work identified in HFTD and prioritize that work accordingly. We use approaches such as inspections and risk assessments to determine necessary mitigations in HFTDs.

5.4.3 Target role: Asset Inspections

TABLE PG&E-5.4-4: TARGET ROLE: ASSET INSPECTIONS INTERNAL ROLES

(1)	(2a.b.c)	(1)	(3)	(4)
PG&E Titles	Minimum Qualifications	Qualifications relevant to wildfire and PSPS mitigation	FTE % by Target Role	FTE % by High Interest Qualification
Compliance Inspector	QEW	Journeyman Linemen (International Brotherhood of Electrical Workers (IBEW)), QEW (distribution only)	73%	81%
Compliance Inspector – Underground	QEW	Journeyman Linemen (IBEW), QEW (distribution only)	2%	2%
Transmission Troubleman	QEW	Journeyman Linemen (IBEW) QEW (transmission OH only)	15%	17%
Transmission Towerman	QP	Journeyman Towerman (IBEW) QP (structural climbing assessments only), Qualified Persons but are not journeyman linemen classifications	10%	
Inspection Review Specialist, Senior	QEW	See Job Family (QEW or Engineer), new role starting in 2021		
Inspection Review Specialist, Expert	QEW	See Job Family (QEW or Engineer), new role starting in 2021		
			100%	100%

TABLE PG&E-5.4-5: TARGET ROLE: ASSET INSPECTIONS EXTERNAL ROLES

(1) Contractor Titles	(2a.b.c) Minimum Qualifications	(1) Qualifications relevant to wildfire and PSPS mitigation	(3) FTE % by Target Role	(4) FTE % by High Interest Qualification
CONT – Aerial Inspection Review (AIR) Inspector		Journeyman Lineman, or Engineer	16%	
CONT – AIR SME		Journeyman Lineman, or Engineer	3%	
CONT – Compliance Inspector (Canus)	QEW	Journeyman Linemen (IBEW), QEW	11%	14%
CONT – Compliance General Foreman	QEW	Journeyman Linemen (IBEW), QEW	1%	2%
CONT – Compliance Foreman	QEW	Journeyman Linemen (IBEW), QEW	1%	1%
CONT – Compliance Inspector	QEW	Journeyman Linemen (IBEW), QEW	66%	81%
Hiring Hall Compliance Inspector	QEW	Journeyman Linemen (IBEW), QEW	1%	2%
			100%	100%

In this section PG&E also addresses Actions PGE-19 (Class B), PGE 20 (Class B), PGE-21 (Class B) and PGE-23 (Class B)

ACTION PGE-19 (Class B)

PG&E shall differentiate and describe the differences between the hiring and training process of an outside hire compared to an internal promotion or reassignment.

Response:

There are two ways to become a full-time employee QEW Journeyman Lineman at PG&E.

- Internal and external candidates can apply to join PG&E as an apprentice lineman. Selection requires successfully completing a comprehensive assessment process. Promotion to journeyman requires completion of a multi-year apprentice training and assessment program.
- Certified Journeymen from other utilities can apply for a Journeyman position at PG&E:

- The process to qualify as a PG&E Journeyman includes the following steps: 1) On-line application, 2) A Certification Review confirming the candidate has completed a valid apprenticeship and maintains Journeyman qualifications, 3) Successfully passing the Journeyman Lineman Knowledge Assessment, a proctored web-based assessment, 4) Completing the Journeyman Lineman Assessment Program which includes a full day's physical assessment conducted on-site at PG&E, 5) Interviews with PG&E Supervisors and/or Superintendents, and 6) Completing a successful background investigation, including DOT drug test.

Journeyman Linemen candidates for Qualified Company Representative (QCR) Inspector roles must complete the same requirements as listed above and the PG&E orientation and coursework for Inspectors as outlined in the training-related response. Regular status journeymen employees who bid into the System Inspections department, or are externally hired into the department, must complete pre-employment testing, multi-day orientation to inspection work, and participate in knowledge checks within the training material. They must also complete OJT support once they join System Inspections.

Minimum QCR Inspector Qualifications:

PG&E separates out the minimum requirements for personnel performing inspections aligned with its Local IBEW 1245 Collective Bargaining Agreement (CBA) based on the type (electrical, structural) and voltage (transmission, distribution) of the assets being evaluated. The minimum position qualification for detailed transmission or distribution overhead (or underground) electrical inspections is that of a Journeyman Lineman, who are QEWs. Cal OSHA Title 8 regulations and the Department of Industrial Relations defines a QEW as a "qualified person who by reason of a minimum of two years of training and experience with high-voltage circuits and equipment and who has demonstrated by performance familiarity with the work to be performed and the hazards involved." In some instances, work can be performed or supported by various non-QEW roles, but the work is always performed under the direction of a QEW. Minimum qualifications required for structural climbing assessments of transmission overhead tower structures are Journeymen Towermen, who are trained in the construction and assessment of structural integrity. Apprentice Towermen may support such climbing assessments but must be under the direction of a Journeyman. Journeymen Towermen are considered Qualified Persons (QP) and QCR but these are not QEW classifications per PG&E's Local 1245 CBA. Therefore, the assessments completed by Towermen focus on the structural soundness of the towers and foundations, aligned with their training and experience. Evaluation of aerial imagery is completed by AIR+ Inspection Review Specialists or contractors who hold either engineering credentials or QEW status. PG&E's contractual terms also reference the Local 1245 CBA agreement, which spells out the universal requirements for each union classification. The Statement of Work (SOW) for inspection contractors states that only Journeymen Linemen and Foremen are qualified to perform detailed inspections, and QEWs or engineers are permitted to assess aerial imagery for the purpose of asset inspections.

Upon hire, or upon execution of a contract SOW to complete electric asset inspections (detailed overhead inspections), the journeyman (or engineering) credentials of the worker are confirmed. Contracted personnel must also complete ISNetworld (third-party online portal) registration and intake training prior to arrival and onboarding into the inspection program. Upon acceptance of worker eligibility and ISN credentials, personnel who will complete electric asset inspections are provided a multi-day orientation on the expectations, guidelines, and tools relevant for the work. Inspection personnel, whether contracted or employees, must complete this training before being released to on-the-job orientation and oversight. PG&E employees in inspection roles are also provided annual refresher training to update them on any changes to guidelines, tools, and processes.

ACTION PGE-20 (Class B)

1) Provide the details regarding the internal training course required in order to qualify for a System Inspections Program QCR position, including:

a) a description of the materials it covers
b) components of the course (such as WBT, OJT, etc.)
c) the length of time it takes to complete each component of the course.

Response:

System Inspections requires inspectors who act as QCRs to complete training beyond the Journeyman Lineman certification. This additional training is both instructor-led and web-based (see Table PG&E-5.4-7):

- Orientation to inspection work: For PG&E QEWs, this is multi-day new employee training focused upon System Inspections requirements.
    - For QEWs that will be assigned Distribution Inspection work, this is a two-day course explaining PG&E's Electric Distribution Procedure Manual (EDPM), related Job Aids, and Technology training.
    - For QEWs and QCRs assigned to Transmission Inspection work, this is a three-day course explaining PG&E's Electric Transmission Procedure Manual (ETPM) and related Job Aids. Technology training is introduced at a later time.
- For Contracted QEWs for Distribution and Transmission work, this is a three-day course explaining PG&E field processes, either the EDPM or ETPM manuals, related Job Aids, and technology training. Refresher training for System Inspections' internal, regular status QCR Inspectors is provided annually. It may be shorter and supplemented by web-based training.

Contracted QEWs who have successfully completed a valid apprenticeship program to become journeymen, must complete a series of safety trainings courses on ISNetworld platform and attend PG&E's 3-day (8 hours a day) orientation and training for all personnel who conduct detailed inspections (QCR). The orientation and training include the following:

- Contractor Pre-Arrival Training (See Table 5.4-6)
    - ISNetworld (ISN) safety training completed per Utility Standard SAFE-1003S and TD-1952P-01. Course completion is validated by both the Vendor and PG&E prior to the contractor conducting field inspections.
    - ISN safety training may be validated in the field by scanning ISN contractor badge.
- PG&E-provided Training:

- Electric Distribution and Electric Transmission: 3-day (8 hours a day), and OJT up to 2 days.
- Substation: 2-day classroom and 1-day OJT (8 hours a day).
- For further details, see Table PG&E-5.4.-2.

Table PG&E-5.4-6: System Inspections Scope of Work

Scope of Work	Definition
Inspector Qualifications	QEW who are well-qualified, having the qualities and capabilities required by law and training to efficiently and effectively perform this Work. Subcontractor shall have the same safety and training requirements as those of the Contractors.
Pre-Work before Deployment	**ISNetworld Training:** Trainings complete per SAFE-1003S and TD-1952P-01. Badge issued by employer. **PG&E Training:** Distribution and Transmission: 3-days at PG&E facility (remote due to COVID-19). Substation: 2-day orientation (remote due to COVID-19) and 1-day On the Job training.
Technology	Inspectors must be prepared to work in remote setting with appropriate technology (paperless process - iPad).
Crew size	Ground inspections: single-man crew. Climbing inspections: three-man crew, with four-man crew, max.

Table PG&E-5.4-7: System Inspections Safety and Compliance Training

Training Delivery	Distribution	Duration
ISNetworld	Corporate Contractor Safety Orientation, SAFE0101	40 min
	SAFE-1503WBT, Fire Danger Precautions	60 min
	SAFE-4513WBT, Electric Operations Safety Foundations for Contractors	150 min
Administered by Vendor	N/A	
PG&E My Learning	CORP-9044WBT: Records & Info Management	45 min
	ISEC-9020WBT: Security & Privacy Awareness	45 min
Training Delivery	**Transmission**	**Duration**
ISNetworld	Corporate Contractor Safety Orientation, SAFE0101	40 min
	SAFE-1503WBT, Fire Danger Precautions	60 min
	SAFE-4514WBT, T-Line Contractor Safety Orientation	150 min

Administered by Vendor	N/A	
PG&E My Learning	CORP-9044WBT: Records & Info Management	45 min
	ISEC-9020WBT: Security & Privacy Awareness	45 min
Training Delivery	**Substation**	**Duration**
ISNetworld	Corporate Contractor Safety Orientation, SAFE0101	40 min
	SAFE-1503WBT, Fire Danger Precautions	60 min
Administered by Vendor	Substation Safety Field Orientation (SSFO) 2020-2021	
PG&E My Learning	PSOS-2500WBT: MAD/ARC for Substations (35 minutes)	35 min
	SAFE-1505WBT: Arc-Flash Hazard Control Basics (30 minutes)	30 min
	CORP-9044WBT: Records & Info Management	45 min
	ISEC-9020WBT: Security & Privacy Awareness	45 min

Because PG&E's Journeymen Towermen perform structural construction, maintenance, and assessment on a regular basis as part of their normal work duties, the QCR training is a refresher training. Towerman training has emphasis on new or updated PG&E processes, standards, and procedures, including technology that is used while performing field inspections on Tower assets. Training duration is approximately 4 1/2 hours and is currently provided remotely due to COVID19 social distancing protocols. Materials covered in the training are summarized in Attachment 2021WMP_ClassB_Action-PGE-20_Atch01.

ACTION PGE-21 (Class B)

1) Explain why Journeyman Lineman trainings are not provided to contracted QCR inspectors
2) Describe any assessment taken to demonstrate qualifications of Journeyman Lineman regarding "routine job knowledge," or explain why PG&E does not find it necessary, if one is not required.

Response:

1) PG&E has established relationships with multiple vendors to ensure that we have a sufficient number of externally recruited QEWs to act in the capacity of QCRs. Only qualified IBEW Journeymen Linemen and Foremen with active union memberships will perform inspections upon completion of inspection-related orientation. Miscellaneous Equipment Operators (MEO), groundmen, towermen, construction managers, and inspection review specialists are not acceptable substitutes but may be used to support the safety of climbing inspection activities.

PG&E's contracts with third-party vendors require the vendors to provide resources with the knowledge and abilities required, to complete the tasked assigned based on their training and experience. The underlying competency for completing inspections at PG&E is currently a Journeyman Lineman QEW. Therefore, individuals who complete a state Joint Apprentice and Training Committee-sanctioned apprenticeship program that is endorsed by IBEW are considered eligible to be oriented for inspection work. PG&E may seek to validate a person's Journeyman Lineman QEW status, but PG&E does not undertake to provide the multi-year apprenticeship training to vendor-provided Journeyman Lineman QEW personnel. Further, it is the responsibility of the IBEW, and the third-party entity, to train their resources. Generally, it is not appropriate for PG&E to administer the training to third-party resources.

2) For externally contracted inspectors, PG&E confirms their Journeyman Lineman credential in coordination with IBEW Local 1245.To further validate the contractors' skillset, PG&E may further seek evidence of the Journeyman Lineman certificate. PG&E has also developed an Intake Form for contractors to self-identify as a QEW which triggers validation of IBEW labor qualifications. PG&E performs a monthly audit of submitted Intake Forms ensuring all forms are fully completed, and in turn takes a 10% sample of monthly onboarded personnel to validate qualifications via receipt of scans of the official journeyman credential.

As indicated above, partner vendors provide qualified personnel who possess required credential qualifications, as stated in the inspection program contract with PG&E as follows:

> "Contractor shall provide only Qualified Electrical Workers ("QEW") (per Title 29, Code of Federal Regulations (CFR), Part 1910, Subpart S), along with Journeyman Lineman (hereinafter, "Inspector") who are well-qualified, having the qualities and capabilities required by law and training to efficiently and effectively perform this Work."

PG&E requires these personnel to complete online training and pre-qualification tasks (e.g., ISN) aligned to the Contractor Safety Standard (SAFE-3001S) and program guidelines prior to receiving inspection program orientation. Additionally, during the multi-day inspection program orientation, Knowledge Checks are taken to test for understanding of the curriculum. While pre-arrival knowledge examinations are being considered for 2022, PG&E does not currently require, nor provide, pre-employment screenings for externally contracted QEW inspectors. Upon commencement of inspections, worker performance is monitored to enable on the job corrective feedback.

Outlier reports are produced and monitored by the asset inspections program quality department. The department flags personnel for additional attention and intervention when their inspection productivity, corrective notification find rate, and accuracy are reported above or below the average range of their peers. The performance monitoring flags personnel for intervention by field leaders, up to and including release from inspection work responsibilities.

ACTION PGE-23 (Class B)

1) Implement an assessment for all external recruits in order to ensure proper training levels are met.

Response:

Current Multi-Day Inspection Program Orientation:

Prior to COVID-19, Electric Distribution's Compliance required a Knowledge Assessment at the end of the New Inspector Training session that required a pass/fail grade in three allotted attempts. Failure to pass the course meant the lineman was released from duty as an Inspector. A passing grade advanced the lineman to his/her direct supervisor for execution of inspection duties as a QCR. This pass/fail requirement applied to internal QEWs who bid into the QCR Compliance Inspector role as permanent regular-status employees. Contracted personnel were not used to perform asset inspections prior to Wildfire Safety Inspection Program (WSIP) in 2019.

During COVID-19, in order to practice social distancing, the New Inspector Training classes are being held virtually, using Cisco WebEx or Microsoft Teams. Many in these remote learning classes are in different locations to promote a safe learning environment during the COVID-19 pandemic. This remote learning environment imposes new logistical restrictions for maintaining the integrity of pass/fail Knowledge Assessments. However, students are still required to pass the New Inspector Training course that requires a pass/fail grade in three allotted attempts prior to acting as QCRs for inspection tasks. Students who fail to pass the course will not obtain credit for the course and an alert is provided to their assigned supervisor to take corrective action.

The 2020 and 2021 Distribution and Transmission New Inspector Orientation courses contain Knowledge Checks at the end of each training topic or section. Knowledge Checks are provided within the training material at the end of chapter in the form of multiple choice or true/false questions. These are exercises designed to invite participation amongst remote learners and to highlight key learning content. This practice allows for team learning events, while recognizing the logistical challenges for maintaining integrity of a pass/fail post-training assessment in a remote learning and virtual environment. Therefore, a QEW's full attendance in the multi-day orientation and participation in Knowledge Checks is currently required to receive credit and be admitted to perform inspection tasks.

The day after the remote class ends, Inspectors are exposed to unstructured OJT to ensure they have understood the training material. Newly trained Inspectors meet with leaders (Supervisors or Inspection Review Specialists) in the field to discuss work and the training they just received. OJT is a key transition from classroom learning to field learning. It is designed to support (a) compliance with PG&E's field safety protocols, (b) open communication between the assigned supervisor and Inspector to promote clarification of requirements and to provide the Inspector with opportunities to ask questions in furtherance of their training comprehension, and (c) verification that the Inspector is equipped with usable technology required to perform field inspections.

In 2021, a new Transmission-focused WBT that includes information on the ETPM and related Job Aids will be assigned to internal and external QCRs who perform transmission asset inspections. The ETPM WBT includes pass/fail course Knowledge Assessments comprised of 5 to 10 questions with multiple choice or true/false answers. Students are required to pass Knowledge Assessments to successfully complete the course, even if it takes multiple attempts. Students who fail the Knowledge Assessments will not obtain credit for the course and an alert is provided to their assigned supervisor on the training-timeliness dashboard for supervisor action.

Plans to Improve Worker Qualifications:

PG&E has historically used an in-person proctored pass/fail Knowledge Assessment practice for employee distribution Inspectors aligned with the Local 1245 CBA. Collaborating with IBEW and internal training experts, PG&E intends to re-deploy the distribution pass/fail individual assessments in PG&E's remote learning and virtual environment. This will involve additional testing technologies to maintain the integrity of the test without physical on-site test proctoring. PG&E also plans to improve Inspector qualifications via the deployment of an additional pass/fail Knowledge Assessment at the conclusion of the initial multi-day Inspector Orientation training for Transmission or Substation Asset Inspectors.

Upon this expansion to Substation and Transmission, internal and external QEW personnel who seek to perform inspection work will then be required to successfully complete the relevant Knowledge Assessment or be disallowed from performing inspection tasks. This expansion of best practice will require a joint agreement with our Local IBEW partner and the support of a certified psychometrician to ensure the tests are valid and suited to the intended purpose. PG&E intends to expand these pass/fail Inspector training assessments more broadly in 2022, via remote learning or proctored delivery, COVID-19 restrictions permitting.

Other enhancements under development in 2021 include targeted refresher content related to areas of Inspector underperformance as determined by the inspection program quality teams. Inspectors whose work quality is found to be consistently poor are provided feedback and, in some cases, barred from returning to the asset inspection function in the future. In 2020, PG&E released at least one contract Inspector for quality performance issues and pursued similar remedial action against internal Inspectors.

5.4.4 Target Role: Grid Hardening

Grid hardening projects are generally assigned to either contract or internal crews for the duration of the project construction. Therefore two tables have been provided below reflecting the resource composition for contracted grid hardening jobs as compared to internally resourced projects.

TABLE PG&E-5.4-8: CONTRACTED GRID HARDENING PROJECTS

(1) Contractor Titles	(2a.b.c) Minimum Qualifications	(1) Qualifications Relevant to Wildfire and PSPS Mitigation	(3) FTE % by Target Role	(4) FTE % by High Interest Qualification
Lineman	QEW	Contractor company is responsible for the qualifications of their employees. Multiple PG&E departments perform safety observations of contractors and perform quality audits of completed work. Contractors should have ISN badges that are confirmed by EH&S organization during site visits.	61%	82%
Apprentice Lineman			8%	
Foreman	QEW		14%	18%
Groundman			14%	
General Forman			3%	
			100%	100%

TABLE PG&E-5.4-9: INTERNALLY RESOURCED GRID HARDENING PROJECTS

(1) PG&E Titles	(2a.b.c) Minimum Qualifications	(1) Qualifications Relevant to Wildfire and PSPS Mitigation	(3) FTE % by Target Role	(4) FTE % by High Interest Qualification
Lineman	QEW	Required Training see below minimum qualifications and list of specific trainings	23%	60%
Apprentice Lineman			31%	
Foreman	QEW		15%	40%
Utility Worker			15%	
Miscellaneous Equipment Operator			15%	
			100%	100%

<u>Minimum Qualifications</u>:

In order to perform this work, at least one worker on site must be a QEW. Cal OSHA Title 8 regulations/ Dept. of Industrial Relations defines a Qualified Electrical Worker as a "qualified person who by reason of a minimum of two years of training and experience with high-voltage circuits and equipment and who has demonstrated by performance familiarity with the work to be performed and the hazards involved." In some instances, work can be performed by various non-QEWs roles, but the work is always performed under the direction of a QEW. For internal PG&E positions, the "Groundman" role could include Utility worker, Ground Worker, T&D Assistant or Electric Line Assistant.

Plans to Improve Worker Qualifications:

No material improvements have been identified at this time. Enhancements to training will be implemented based on changes to processes and procedures or in response to any lessons learned or identified gaps. New or modified training, as needed, will be developed and delivered to personnel to drive a safe and competent workforce.

Related Qualifications For This Resource Group:

PG&E has a PSPS training program for QEW workers focused on inspecting, patrolling and reporting findings related to wildfire mitigation. That qualification training summary includes:

PSOS-0414 Transmission Inspections—Overhead
The purpose of this training is to ensure that all personnel responsible for patrol, inspection, and maintenance of the overhead, underground, and tower electric transmission line systems have a thorough understanding of how to apply general inspection and patrol procedures of electric transmission facilities. This training course focuses on the overhead portion of the ETPM Manual.

Upon completion of this course you will be able to: Identify and document abnormal conditions and prioritized the corrective actions required; Describe and comply with the following patrol and inspection procedures: Overhead, Infrared (IR), and Corrective Maintenance.

PSOS-0415 Transmission Inspections—Underground
The purpose of this training is to ensure that all personnel responsible for patrol, inspection, and maintenance of the overhead, underground, and tower electric transmission line systems have a thorough understanding of how to apply general inspection and patrol procedures of electric transmission facilities. This training course focuses on the underground sections of the ETPM Manual.

Upon completion of this course you will be able to: Identify and document abnormal conditions and prioritized the corrective actions required; Describe and comply with the following patrol and inspection procedures: Underground, IR, and maintenance

PSOS-0416 Transmission Inspections—Towerman
The purpose of this training is to ensure that all personnel responsible for patrol, inspection, and maintenance of the overhead, underground, and tower electric transmission line systems have a thorough understanding of how to apply general inspection and patrol procedures of electric transmission facilities. This training course focuses on the tower sections of the ETPM Manual.

Upon completion of this course you will be able to: Identify and document abnormal conditions and prioritized the corrective actions required; Describe and comply with the following patrol and inspection procedures: Tower and Maintenance.

SAFE-0256 Aerial Patrol
ILT: This course prepares patrolmen and pilots to work together as a team so they can avoid hazards while patrolling in the utility environment. Course participants will learn how to: (1) Prepare for the patrol prior to taking flight; (2) Establish roles and responsibilities within the crew; (3) Apply crew resource management behaviors; (4) Implement safe patrol techniques; (5) Identify and call out hazards; (6) Respond in emergency situations; and (7) Identify lessons learned during the post-flight debrief.

5.4.5 Target Role: Risk Event Inspections

TABLE PG&E-5.4-10: TARGET ROLE: RISK EVENT INSPECTIONS

(1) PG&E Titles	(2a.b.c) Minimum Qualifications	(2) Qualifications Relevant to Wildfire and PSPS Mitigation	(3) FTE % by Target Role	(4) FTE % by High Interest Qualification
Troublemen	QEW	While these roles do not have certifications directly related to Wildfire and PSPS mitigation, these roles and their work is important to the ongoing, safe operation of PG&E equipment throughout our Service Area, including to mitigate wildfire risks.	86%	98%
Cablemen	QEW		1%	2%
Distribution Line Technicians			12%	
			100%	100%

Minimum Qualifications:

In order to perform this work, a worker needs to be a QEW. Cal OSHA Title 8 regulations/ Dept. of Industrial Relations defines a Qualified Electrical Worker as a "qualified person who by reason of a minimum of two years of training and experience with high-voltage circuits and equipment and who has demonstrated by performance familiarity with the work to be performed and the hazards involved." In some instances, work can be performed by various non-QEWs roles, but the work is always performed under the direction of a QEW.

Plans to Improve Worker Qualifications:

No material improvements have been identified at this time. Enhancements to training will be implemented based on changes to processes and procedures or in response to any lessons learned or identified gaps. New or modified training, as needed, will be developed and delivered to personnel to drive a safe and competent workforce.

PACIFIC GAS & ELECTRIC COMPANY

SECTION 6

PERFORMANCE METRICS AND UNDERLYING DATA

6. Performance metrics and underlying data

Instructions: Section to be populated from Quarterly Reports. Tables to be populated are listed below for reference.

NOTE: Report updates to projected metrics that are now actuals (e.g., projected 2020 spend will be replaced with actual unless otherwise noted). If an actual is substantially different from the projected (>10% difference), highlight the corresponding metric in light green.

6.1 Recent Performance on Progress Metrics, last 5 years Instructions for Table 1

In the attached spreadsheet document, report performance on the following metrics within the utility's service territory over the past five years as needed to correct previously-reported data. Where the utility does not collect its own data on a given metric, the utility shall work with the relevant state agencies to collect the relevant information for its service territory, and clearly identify the owner and dataset used to provide the response in the "Comments" column.

Pacific gas and Electric Company (PG&E) has enclosed the Table 1 data in the Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below on the Table 1 data.

Comments for Table 1:

Item 1. Description – Grid Condition Findings From Inspection – Distribution:

- Level 1 findings are defined as Priority A tags. Level 2 findings are defined as Priority B and E tags. Level 3 findings are defined as priority F and H tags.
- PG&E does not track inspection data by circuit mile. Circuit miles shown are estimated based as a fraction of total circuit mileage and are assumed proportional to the percentage of structures inspected for each inspection category.

Item 1. Description – Grid Condition Findings From Inspection – Transmission:

- Findings by inspection/patrol type are not available before 2019; all findings were assigned to Detailed Inspections.
- Level 1 findings are defined as Priority A tags. Level 2 findings are defined as Priority B and E tags. Level 3 findings are defined as priority F tags.
- PG&E does not track inspection data by circuit mile. If a structure/circuit was patrolled multiple times in a year, mileage is only counted once for that year. Fraction of total mileage was assumed proportional to the percentage of structures inspected.

Item 2. Description – Vegetation Clearance Findings From Inspection:

- The number of spans inspected with noncompliant clearance is based on applicable rules and regulations at the time of inspection.

- PG&E does not track the precise data requested as PG&E's vegetation management data is generally tracked by tree. Therefore, the closest available data has been provided with an estimated translation to the "Percentage of right-of-way with noncompliant clearance" data that was requested. PG&E vegetation management pre-inspectors identify a tree that is currently violating minimum clearance distances, or may violate minimum clearance in the near future, with a special designation of being a Hazard Notification (HN). Not all HNs represent actively non-compliant trees, as in many cases the tree is currently compliant but may be at risk of violating minimum clearances before the normal tree work cycle can be completed. Nonetheless, HNs are the best estimate PG&E has for the number of trees that were identified as being inside or near the minimum clearance requirements and have been provided above as the "Trees identified as being currently, or at risk in the near future, of being out of compliance" data.
- This estimate for the number of electric overhead spans has been determined by assuming an average span length (distance between poles) of 275 feet.

Item 3. Description – Community Outreach Metrics: # Customers in an Evacuation Zone for Utility-Ignited Wildfire; # Customers Notified of Evacuation Orders:

- PG&E does not issue wildfire evacuation notices to customers and does not maintain metrics on the number of customers in an evacuation zone or the number of customers notified of evacuation orders. In an effort to gather this data, PG&E's Public Safety Specialists reached out to safety personnel from 38 counties to determine if any evacuation data was available for the utility-ignited wildfires as defined in Table 2. Most replies from county personnel indicated that the requested data was not available. PG&E did receive data from 3 counties for the following incidents which are included in Table 1: 2018: Nimshew, Camp, 2019: Kincade, and 2020: Drum, as well as an unnamed incident in Santa Barbara County. PG&E cannot determine if this data is complete or accurate. Data for the Kincade fire includes the total number of phone calls, text messages, and emails sent. Santa Barbara county provided information on the number of residents notified but did not provide the number of residents in the evacuation zone. The percentage of customers notified was calculated based upon the numbers provided. No utility-ignited wildfires occurred in Quarter 1 2020.

Item 4. Assumptions for Inspection Data in 1.a,1.b,1.c

- See note below re: Table 8 (historical grid data unavailable for 2014-2018); circuit mileage is assumed to be the same as our 2019 data for 2015-2018 for the purposes of Table 1
- Mileage was extrapolated using approximate unit counts of historical detailed inspection & Pole Test & Treat data & relative circuit mileage in High Fire Threat District (HFTD) and Non-HFTD

6.2 Recent Performance on Outcome Metrics, Annual and Normalized for Weather, Last 5 Years

Instructions for Table 2:

In the attached spreadsheet document, report performance on the following metrics within the utility's service territory over the past five years as needed to correct previously-reported data. Where the utility does not collect its own data on a given metric, the utility shall work with the relevant state agencies to collect the relevant information for its service territory, and clearly identify the owner and dataset used to provide the response in "Comments" column.

Provide a list of all types of findings and number of findings per type, in total and in number of findings per circuit mile.

PG&E has enclosed the Table 2 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below on the Table 2 data.

<u>Comments for Table 2:</u>

The data in Table 2 is derived from ignitions that are linked to a wildfire, which is defined as a fire greater than 10 acres in size**.**

- **Items 3.a (Fatalities due to utility-ignited wildfire [total]) and 3.b (Injuries due to utility-ignited wildfire (total)):** PG&E provides in the attached data table 2015 through 2019 for wildfires that the California Department of Forestry and Fire protection (CAL FIRE) concluded were caused by PG&E equipment.
- **Item 4a (Value of assets destroyed by utility-ignited wildfire [total]):** PG&E provides in the attached data table all 2015-2020 wildfires that involve disputes regarding destroyed assets that have settled. These settlements are lump sum settlements that do not break out the settlement dollars by damage category. In addition, the settlements reached related to the 2017 North Bay Fires and the 2018 Camp Fire (other than the settlement with the cities and counties) do not break out the settlement dollars by fire. Any attempt to break out the dollars by fire and/or damage category would be speculative. The settlements are totaled based on the year of the fire. The one exception is the 2018 Camp Fire which is reported with the 2017 North Bay Fires for the reasons described above. The chart does not include 2015-2020 wildfires that have not settled, which remain under investigation and/or civil discovery on causation issues, damages issues, or both.
- **Item 5b (Critical infrastructure damaged/destroyed by utility-ignited wildfire [total]):** 'Critical infrastructure' is defined in accordance with the definition adopted in Decision (D.) 19-05-042 and modified in D.20-05-051. The number of critical infrastructure damaged/destroyed reflects the count of unique Service Point ID's (meters) for red-tagged structures defined as critical infrastructure at the time of the wildfire.
- **Item 7a-d (Number of utility wildfire ignitons):** The 2015 through 2018 ignition data is primarily based on fire incident reports filed with the California Public

Utilities Commission (CPUC or Commission) annually in accordance with D.14-02-015. These reports include fire incidents that may be associated with PG&E facilities and meet the following conditions: (1) a self-propagating fire of material other than electrical and/or communication facilities (2) the resulting fire traveled greater than one linear meter from the ignition point, and (3) PG&E has knowledge that the fire occurred. Where not already included as part of the CPUC fire incidents report data, PG&E also included data for 2015 through 2018 wildfires that CAL FIRE concluded were caused by PG&E equipment. As of the time of the 2021 WMP submission, 2020 ignition data is being reviewed by PG&E in preparation for its 2020 fire incident that will be submitted by April 1, 2021 pursuant to D.14-02-015. The 2020 data in this table is preliminary and may be revised by the time that report is submitted.

6.3 Description of Additional Metrics

Instructions for Table 3:

In addition to the metrics specified above, list and describe all other metrics the utility uses to evaluate wildfire mitigation performance, the utility's performance on those metrics over the last five years, the units reported, the assumptions that underlie the use of those metrics, and how the performance reported could be validated by third parties outside the utility, such as analysts or academic researchers. Identified metrics must be of enough detail and scope to effectively inform the performance (i.e., reduction in ignition probability or wildfire consequence) of each preventive strategy and program.

PG&E provided several metrics in the 2020 WMP for this section. With the update of the WMP template, all of these metrics were incorporated and included in other parts of the 2021 WMP. PG&E has no new or additional metrics to include to evaluate wildfire mitigation that are not already captured in other sections of the 2021 WMP. However, PG&E may analyze and look to reuse these metrics in ways not documented in the WMP as we continue to mature our data sets and modeling.

6.4 Detailed Information Supporting Outcome Metrics

Instructions for Table 4:

Enclose detailed information as requested for the metrics below. In the attached spreadsheet document, report numbers of fatalities attributed to any utility wildfire mitigation initiatives, as listed in the utility's previous or current WMP filings or otherwise, according to the type of activity in column one, and by the victim's relationship to the utility (i.e., full-time employee, contractor, of member of the general public), for each of the last five years as needed to correct previously-reported data. For fatalities caused by initiatives beyond these categories, add rows to specify accordingly. The relationship to the utility statuses of full-time employee, contractor, and member of public are mutually exclusive, such that no individual can be counted in more than one category, nor can any individual fatality be attributed to more than one initiative.

PG&E has enclosed the Table 4 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below on the Table 4 data.

<u>Comments for Table 4</u>:

1. Data for "Member of public" was derived from review of PG&E's "Riskmaster" database, which tracks third party claims.
2. PG&E's Community Wildfire Safety Program (CWSP), under which PG&E tracks its wildfire mitigation activities, was developed in 2018, with the above activities implemented in late 2018. Therefore, the "Year 2018" data above represents data from late 2018.

Instructions for Table 5:

In the attached spreadsheet document, report numbers of OSHA-reportable injuries attributed to any utility wildfire mitigation initiatives, as listed in the utility's previous or current WMP filings or otherwise, according to the type of activity in column one, and by the victim's relationship to the utility (i.e., full-time employee, contractor, of member of the general public), for each of the last five years as needed to correct previously-reported data. For members of the public, all injuries that meet OSHA-reportable standards of severity (i.e., injury or illness resulting in loss of consciousness or requiring medical treatment beyond first aid) shall be included, even if those incidents are not reported to OSHA due to the identity of the victims.

For OSHA-reportable injuries caused by initiatives beyond these categories, add rows to specify accordingly. The victim identities listed are mutually exclusive, such that no individual victim can be counted as more than one identity, nor can any individual OSHA-reportable injury be attributed to more than one activity.

PG&E has enclosed Table 5 data in Attachment 1 – All Data Tables Required by WMP 2021 Guidelines.xlsx. In addition, PG&E is providing *the* following comments below on the Table 5 data.

<u>Comments for Table 5</u>:

1. PG&E does not generally and centrally track Occupational Safety and Health Administration (OSHA) reportable incidents for contractors. Contractors are responsible for complying with OSHA reportable notification requirements. The data in Table 6 reflects all OSHA recordables, including any reportable incidents, that PG&E tracks for internal purposes.
2. Data for "Member of public" was derived from review of PG&E's "Riskmaster" database, which tracks third party claims.
3. PG&E's CWSP, under which PG&E tracks its wildfire mitigation activities, was developed in 2018, with the above activities implemented in late 2018. Therefore, the "Year 2018" data above represents data from late 2018.

6.5 Mapping Recent, Modelled, And Baseline Conditions

Underlying data for recent conditions (over the last five years) of the utility service territory in a downloadable shapefile GIS format, following the schema provided in the spatial reporting schema attachment. All data is reported quarterly, this is a placeholder for quarterly spatial data.

The underlying data for recent conditions (over the last five years) of the utility service territory is enclosed with the Geographic Information System (GIS) Data Standards.

6.6 Recent Weather Patterns, Last 5 Years

Instructions for Table 6:

In the attached spreadsheet document, report weather measurements based upon the duration and scope of NWS Red Flag Warnings, High wind warnings and upon proprietary Fire Potential Index (or other similar fire risk potential measure if used) for each year. Calculate and report 5-year historical average as needed to correct previously-reported data.

PG&E has enclosed the Table 6 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below on the Table 6 data.

Comments for Table 6:

Table 6 shows the trends of National Weather Service (NWS) issued Red Flag Warnings (RFWs) and High Wind Warnings (HWWs) over the last 5 years impacting PG&E circuits across the territory through the metrics RFW Circuit Mile Days and HWW Circuit Mile Days. NWS RFWs are a proxy for high fire danger conditions, while HWWs are issued for solely high wind threats, regardless of humidity values and fire danger. These values have changed from previous reports, which calculated RFW Day Circuit miles based on Fire Index Areas. For these metrics, circuit miles are now calculated by the NWS RFW and HWW polygons to give a more accurate and precise values for RFW Circuit Mile Days and HWW Circuit Mile Days.

6.7 Recent and Projected Drivers of Ignition Probability

Instructions for Table 7:

In the attached spreadsheet document, report recent drivers of ignition probability according to whether or not risk events of that type are tracked, the number of incidents per year (e.g., all instances of animal contact regardless of whether they caused an outage, an ignition, or neither), the rate at which those incidents (e.g., object contact, equipment failure, etc.) cause an ignition in the column, and the number of ignitions that those incidents caused by category, for each of last five years as needed to correct previously-reported data.

Calculate and include 5-year historical averages. This requirement applies to all utilities, not only those required to submit annual ignition data. Any utility that does not have complete 2020 ignition data compiled by the WMP deadline shall indicate in the 2020 columns that said information is incomplete.

Table 7.1: Key recent and projected drivers of ignition probability, last five years and projections – reference only, fill out attached spreadsheet to correct prior reports

PG&E has enclosed the Table 7.1 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx, separating the data into *Distribution* (Table 7.1-1) and Transmission (Table 7.1-2). In addition, PG&E is providing the following comments below for the Table 7.1-1 and Table 7.1-2 data.

Comments for Table 7.1-1: Key Recent and Projected Drivers of Ignition Probability, Last 5 Years (Distribution System):

To the extent available, PG&E's Integrated Logging Information System – Operations Data Base (ILIS-ODB) was used to provide the level of detail contained in Table 7.1 that includes both sustained and momentary outages experienced on its distribution system. When reviewing this data, the following should be noted:

- Based on PG&E's standard definition, a distribution wire down event results in a reportable outage event and occurs when a normally energized electric primary distribution conductor is broken, or stays intact, and falls from its intended position to rest on the ground or a foreign object. PG&E used this standard definition in this year's report and thus it does not include any secondary related wire down events. However, it should also be noted that any primary or secondary wire down condition that resulted in an outage event is also reported in the distribution outage results.

- In our 2020 WMP, PG&E utilized a different data extraction method attempting to identify a larger number of distribution wire down event conditions. However, it was subsequently determined this method resulted in an erroneously higher number of distribution wire down events due to various data issues such as momentary outages resulting from the same wire down event/condition that was also reported as a sustained outage.

- For sub-cause category 2.a."Connector damage or failure – Distribution," it was assumed that the word "Connector" was meant to indicate "Conductor" since connector damage would typically be reported as splice damage.

- For sub-cause category 8.a. "Unknown – Distribution," this generally does not apply to distribution wire down events.

- PG&E was unsure what was intended by the use of the term "Fuse damage or failure" because when a fuse isolates a fault condition, it will become permanently damaged and by design will no longer conduct electricity. For this subcategory, PG&E has interpreted it as only those outage events when a fuse was reported as the actual failed equipment.

- PG&E does not have an outage cause classification that specifically matches the terms, "Tap damage or failure – Distribution" and "Tie wire damage or failure – Distribution" and thus did not use these categories in this report.

- For "Wire-to-wire contact/Contamination," PG&E typically does not use this term for distribution wire down events. In addition, PG&E typically uses contamination more as a condition of the equipment and not normally as a basic cause. For this category under the Distribution outages, PG&E assumed this cause refers to a Basic Cause of "Unknown" and a Fault Type of "Line to Line."

- For "Contamination – Distribution," PG&E uses contamination more as a condition of the equipment and not as a basic cause. As such, PG&E does not have an outage classification that matches this term.

- For "Unknown – Distribution" outages, this category omits outages reported with a Basic Cause of "Unknown" and a Fault Type of "Line to Line" covered as "Wire-to-wire contact/Contamination" outages noted in the above bullet item.

- Due to their relatively small contribution, the Commission does not require transformer-only outages be reported in the annual electric system reliability metrics. However, transformer-only outages are reported within PG&E's Field Automation System (FAS) and most were also reported in PG&E's ILIS-ODB outage data base. PG&E is including these transformer-only outages in the WMP reporting to reflect the full picture of outage incidents which could have represented ignition potential. PG&E also further enhanced its reporting process/controls in September 2020 to ensure future transformer-only outages are fully reported in its ILIS-ODB outage data base and is working to improve outage cause reporting.

- In Table 7.1-1, columns under the category 'Projected risk events' depict the projections in the respective years. Projections are based on forecasts submitted in the 2020 RAMP Report.

<u>Comments for Table 7.1-2: Key Recent and Projected Drivers of Ignition Probability, Last 5 Years (Transmission System)</u>:

PG&E's Transmission Operations Tracking & Logging (TOTL) application was used as the primary data source for Table 7.1-2 which includes unplanned outages experienced on the transmission (i.e., >50 kV) system. Unplanned outages include those due to an "automatic" operation (i.e., the transmission line relayed automatically by a protective device (typically a circuit breaker) and either automatically tested OK, tested no good, or was set up not to test (e.g., automatics disabled or cut out for wildfire risk mitigation)). Unplanned outages also include those where the line was manually removed from service by Operations on an "emergency" basis, usually to repair or replace an imminent failure of an asset. Such emergency forced outages (EFOs) are taken without securing approval from the California Independent System Operator (CAISO). Planned or "scheduled" outages are not included. Scheduled outages differ from EFOs in that PG&E garnered CAISO approval prior to the line being removed from service.

Based on PG&E's standard definition, a transmission wire down event (similar to distribution) results in a reportable outage event (note: customers may or may not have been de-energized) and occurs when a normally energized electric transmission conductor fails in service and falls from its intended position to rest on the ground or a foreign object.

- Sub-cause category 10.a. “Connector damage or failure – Transmission,” PG&E assumed that the word “Connector” was meant to indicate “Conductor” since connector damage would be reported separately in 10.b..

- Sub-cause category 10.f. “Tap damage or failure – Transmission,” PG&E does not have an outage cause classification that specifically matches such.

- Sub-cause category 10.g. “Tie wire damage or failure – Transmission” does not exist in PG&E outage reporting.

- Sub-cause category 11.a. and 27.a. “Wire-to-wire contact/Contamination-Transmission” does not exist in PG&E transmission outage reporting and therefore has no data entries.

- Unlike distribution outage reporting, cause category “Contamination – Transmission” is tracked and reported accordingly.

- Every effort is made to minimize the number of outages assigned a cause category “Unknown – Transmission” for automatic type outages. At least one and sometimes more patrols are conducted after the outage to determine cause and certainly to find and correct any damaged equipment, usually with the help of fault location data provided by System Protection to help focus on the failure point. It’s also important to note that any outage due to animal contact is one where the patrol found a carcass to support the cause of animal, otherwise the choice “Unknown” is used.

- Sub-cause category 26.c. “Fuse damage or failure” has no meaning for unplanned transmission outages.

- Sub-cause category 26.h. “Crossarm damage or failure – Transmission” is not separately reported but included as part of reporting in the Sub-cause category “Pole damage or failure – Transmission,” if applicable.

- Sub-cause category 26.j. “Recloser damage or failure – Transmission” represents outages where a circuit breaker failed in service and let to an outage. PG&E has very few traditional reclosers in its Transmission system.

- Sub-cause category 26.l. “Sectionalizer damage or failure – Transmission” has no entries; rather, transmission lines are sectionalized using line switches, hence such failures are captured in cause Category 26.e. “Switch damage or failure-Transmission.”

- In Table 7.1-2, columns under the category ‘Projected risk events’ depict the projections in the respective years. Projections are based on forecasts submitted in the 2020 RAMP Report.

Table 7.2: Key recent and projected drivers of ignition probability by HFTD status, last 5 years and projections

PG&E has enclosed the Table 7.2 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below on Table 7.2.

Comments for Table 7.2:

In Table 7.2, the ignition data is based on fire incident reports filed with the CPUC annually in accordance with D.14-02-015. These reports include fire incidents that may be associated with PG&E facilities and meet the following conditions:

1. A self-propagating fire of material other than electrical and/or communication facilities

2. The resulting fire traveled greater than one linear meter from the ignition point, and

3. PG&E has knowledge that the fire occurred. At the time of this report, 2020 ignition data is being reviewed by PG&E in preparation for its 2020 fire incident report that will be submitted by April 1, 2021 per D.14-02-015. The data in this table is preliminary and may be revised by the time that report is submitted. The following comments should be noted regarding the ignition data:

   - The note regarding the subcategories "Conductor failure— wires down" and "Wire- to-wire contact/contamination" for the outage data also applies to the ignition driver data. As a result, data is not input into these fields in Table 7.

   - The note regarding the categories "Fuse failure – all" and the "Fuse failure- conventional blown fuse" for the outage data also applies to the ignition data.

In Table 7.2, columns under the category 'Projected ignitions by HFTD Tier' depict the projections of ignition frequency in the respective years. Projected ignitions are based on forecasted ignitions submitted in the 2020 RAMP Report.

6.8 Baseline State of Equipment and Wildfire and PSPS Event Risk Reduction Plans

6.8.1 Current Baseline State of Service Territory and Utility Equipment

Instructions *for Table 8:*

In the attached spreadsheet document, provide summary data for the current baseline state of HFTD and non-HFTD service territory in terms of circuit miles; overhead transmission lines, overhead distribution lines, substations, weather stations, and critical facilities located within *the territory; and customers by type, located in urban versus* rural *versus highly rural areas and including the subset within the Wildland-Urban Interface (WUI) as needed to correct previously- reported data.*

The totals of the cells for each category of information (e.g., "circuit miles (including WUI and non-WUI)" would be equal to the overall service territory total (e.g., total circuit miles). For example, the total of number of customers in urban, rural, and highly rural areas of HFTD *plus those in urban, rural, and highly rural areas of non-HFTD would* *equal the total number of customers of the entire service territory. Table 8:* State of service territory and utility equipment – reference only, fill out attached spreadsheet to correct prior reports

PG&E has enclosed the Table 8 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below for the Table 8 data.

Comments for Table 8:

Table 8 seeks information regarding the current baseline state of HFTD and non-HFTD service territory, as located in urban versus rural versus highly rural areas, including a subset with the Wildland-Urban Interface (WUI). The WUI is defined as areas where homes are built near or among lands prone to wildland fires. PG&E identifies WUI areas within PG&E's service territory based upon data provided by the University of Wisconsin-Madison SILVIS Lab, available here: http://silvis.forest.wisc.edu/data/wui-change/, shows the WUI areas within California as of 2010.

PG&E planned and executed a multi-year project starting in 2013 that included the scope of work to convert data about the electric facilities into a single enterprise GIS database using legacy sources of information. The conversion of the electric facilities started in 2014 and was completed in 2018, the conversion of the electric facility data was created, reviewed, and accepted in phases for the entire PG&E service territory during these project years. There is not an historical database of the electric facilities during the requested years from 2015 to 2018 that would contain a complete and accurate inventory of all the electric facilities metrics requested in Table 8.

6.8.2 Additions, Removal, and Upgrade of Utility Equipment by End of 3-Year Plan Term

Instructions for Table 9:

In the attached spreadsheet document, input summary information of plans and actuals for additions or removals of utility equipment as needed to correct previously-reported data. Report net additions using positive numbers and net removals and undergrounding using negative numbers for circuit miles and numbers of substations. Report changes planned or actualized for that year – for example, if 10 net overhead circuit miles were added in 2020, then report "10" for 20212020. If 20 net overhead circuit miles are planned for addition by 2022, with 15 being added by 2021 and five more added by 2022, then report "15" for 2022 and "5" for 2021. Do not report cumulative change across years. In this case, do not report "20" for 2022, but instead the number planned to be added for just that year, which is "5."

PG&E has enclosed the Table 9 data in Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is *providing* the following comments below for the Table 9 data.

Comments for Table 9:

The data presented in Table 9 are based on the best knowledge and data that is available as of January 2021. As better data becomes available, this will be updated in the quarterly updates. For transmission overhead line additions and removals for 2021 and 2022, project prioritization and timing have yet to be fully determined or mapped. The data presented for 2021 Distribution removals/additions represents the work for removal of idle facilities. There are many other reasons that conductor may be added or removed. For weather station additions and removals for 2022, project prioritization and timing have yet to be fully determined or mapped. The 2020 Actual data was derived by subtracting the 2019 data from the 2020 data in Table 8, and reflects the total net change in *the* system year-over-year as shown in the GIS system. The same layers used in Table 8 have been used to determine Population Density, HFTD, and WUI.

Instructions for Table 10:

Referring to the program targets discussed above, report plans and actuals for hardening upgrades in detail in the attached spreadsheet document. Report in terms of number of circuit miles or stations to be upgraded for each year, assuming complete implementation of wildfire mitigation activities, for HFTD and non-HFTD service territory for circuit miles of overhead transmission lines, circuit miles of overhead distribution lines, circuit miles of overhead transmission lines located in Wildland-Urban Interface (WUI), circuit miles of overhead distribution lines in WUI, number of substations, number of substations in WUI, number of weather stations and number of weather stations in WUI as needed to correct previously-reported data.

If updating previously-reported data, separately include a list of the hardening initiatives included in the calculations for the table.

PG&E *has* enclosed the Table 10 data in the Attachment 1 – All Data Tables Required by 2021 WMP Guidelines.xlsx. In addition, PG&E is providing the following comments below for the Table 10 data.

Comments for Table 10:

The data presented in Table 10 are based on the best knowledge that PG&E has as of January 2021. As better data becomes available, this will be updated in the quarterly updates. PG&E reconductored 50.66 miles of transmission conductor across its service territory in 2020. The data on the location of these jobs is locked in as-built sketches that would need to be digitized

PG&E does not upgrade weather stations.

PG&E is in the process of replanning Distribution system hardening for 2021 and 2022. The underlying risk model is being updated as well. Because of this, the 2022 planning is not yet complete, and we will need to update the 2021 mileage when the replanning is complete.

PG&E does not have a regular system hardening program for transmission conductor. There will be upgrades during 2021 and 2022 to the transmission lines in the normal course of PG&E's business.

The same layers used in Table 8 have been used to determine Population Density, HFTD, and WUI.