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CALIFORNIA BURNING: UTILITY WILDFIRE PREVENTION AND RESPONSE

FOLLOW-UP TO THE NOVEMBER 2015 WILDFIRE SAFETY HEARING

The devastating wildfires that occurred throughout California in 2017 burned over 1.2 million acres[1], damaged thousands of structures, and caused multiple fatalities. The largest fire in the state's history, the Thomas fire in Southern California, began in early December of 2017 and consumed over 280,000 acres.[2] The most destructive fire in the state's history, the Tubbs fire in Northern California, began in early October of 2017 and burned over 5,600 structures.[3] The Tubbs, Redwood Valley, Atlas, and Cascade fires – all in October of 2017 – became four of the twenty deadliest fires in the state's history, resulting in 41 fatalities.[4] While the fires of the 2017 season remain under investigation and their causes uncertain, communities and decisionmakers are urgently searching to apply the lessons from this recent wildfire season in hopes of preventing the same conditions in subsequent years.

[1] Statistic includes all wildfires responded to by CAL FIRE and those occurring in US Forest Service area in California. These numbers are subject to change until the final fire season reports are completed. See: http://cdfdata.fire.ca.gov/incidents/incidents_stats?year=2017;

[2] "Top 20 Largest California Wildfires" CAL FIRE statistics; updated 01.12.2018; http://www.fire.ca.gov/communications/downloads/fact_sheets/Top20_Acres.pdf

[3] "Top 20 Most Destructive California Wildfires" CAL FIRE statistics; updated 01.12.2018; http://www.fire.ca.gov/communications/downloads/fact_sheets/Top20_Destruction.pdf

[4] "Top 20 Deadliest California Wildfires" CAL FIRE statistics; updated 11.29.2017; http://calfire.ca.gov/communications/downloads/fact_sheets/Top20_Deadliest.pdf

As highlighted by this Subcommittee two years ago, human-caused ignitions account for the majority of known wildfire sources, with electrical power lines being a subset. Power line fires occur hundreds of times each year. In 2015, the most recent year with complete fire activity statistics, electrical power accounted for 51% of total acres burned, with vegetation contact accounting for the majority of that percentage.[5] Rarely do these fires grow to be large and destructive, but when they do they can be catastrophic. The 2015 Butte fire – which was found to be caused by contact between a power line and a tree[6] – burned 70,868 acres, destroyed 921 structures, and caused 2 deaths.

The purpose of this hearing is to once again examine how utilities and state agencies respond to the risks associated with power line infrastructure, especially as those risks are elevated with drought, tree mortality, and urban growth into wildlands. The 2017 fire season made all Californians – both northern and southern, both rural and urban – aware of the very real presence of fire. Utility infrastructure needs to be both protected from this destruction as well as prevented from causing it.

Findings

- The impact of recent Legislative oversight into California Public Utilities Commission (CPUC) decision making has resulted in shifts to the assessment of utility risk and the funding of mitigation strategies.
- CPUC analysis of utility risk management strategies is still in its infancy, providing little insight into the current framework's successes or failings.
- The effects of high wind speed and extreme weather events should lead regulators and utilities to implement best practices to reduce the likelihood of future fires.
- "Best practices" can take multiple forms. Effective regulation often contains a mix of regulatory design types, rather than a single approach.
- The establishment of robust electric safety culture, both at utilities and the CPUC, is crucial for ensuring safety performance, especially in high-hazard situations.
- The very real risks posed by utility infrastructure in drought-ridden landscapes lend extreme urgency to the CPUC's task.

[5] http://www.fire.ca.gov/downloads/redbooks/2015_Redbook/2015_Redbook_FINAL.PDF

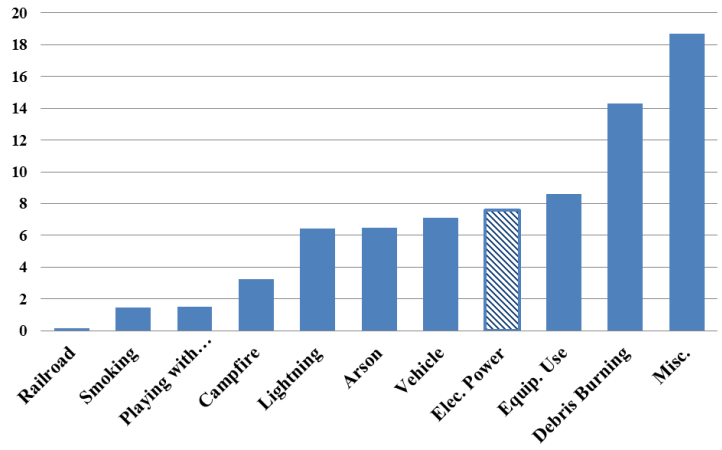
[6] CAL FIRE investigation report, 15CAAEU024918; Sept. 9, 2015; http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/Electric_Safety_and_Reliability/Facility_Safety/Citations/E20150916-01%20Public%20Butte%20Report%20Attachment%201%20CAL%20FIRE%20Report%20Redacted1.pdf

"A New Normal": Changes to California's Landscape

Over the last century California's average temperature has steadily marched upward.[7] Precipitation volume, on the other hand, remained steady while shifting from snow to rain.[8] Drought remained a periodic presence, but the recent, five-year drought marked the driest on record.[9] On January 17, 2014 Governor Brown proclaimed a State of Emergency as a result of this drought, and directed state officials to take action, including vigilance toward increased fire risk.[10] Almost two years later, on October 30, 2015, Governor Brown issued another State of Emergency, this time in response to the extraordinary level of tree mortality throughout California's forests.[11] The drought and resultant bark beetle infestation were largely found to be the cause of the tree die-off. On December 11, 2017, the USDA Forest Service announced that over 129 million trees spanning 8.9 million acres have died in California.[12]

Accompanying these trends has been increased population growth, increased residential development in woodland areas, and increased fire suppression efforts and forest densification.[13] All of these trends have greatly increased the risk of wildfire in California, posing a hazard to people and critical infrastructure.

Figure 1: Percent of Fires by Cause*
5 Yr. Avg. (2011-2015)



*Detailed cause information was not reported for every fire and will not equal total cause counts. ~24% of fires over the 5 year average were considered "undetermined" (bar not shown). Source: footnote 5.

While firefighting efforts in California have grown more sophisticated since 1932 – the date prior to which CAL FIRE's records become "less reliable"[14] – the intensity of California's fires has not. Over half of the largest, deadliest, and most destructive fires in California have occurred within the last 10-15 years.[15] Of

[7] National Oceanic and Atmos. Admin. "State Annual and Seasonal Time Series;" (1895-2015) https://www.ncdc.noaa.gov/temp-and-precip/state-temps/

[8] Dept. of Water Resources; "California Climate Science and Data;" June 2015; pg. 3 http://www.water.ca.gov/climatechange/docs/CA_Climate_Science_and_Data_Final_Release_June_2015.pdf

[9] http://www.ppic.org/publication/californias-latest-drought/

[10] https://www.gov.ca.gov/news.php?id=18379

[11] https://www.gov.ca.gov/docs/10.30.15_Tree_Mortality_State_of_Emergency.pdf

[12] http://calfire.ca.gov/communications/downloads/newsreleases/2017/CAL%20FIREandU.S%20ForestAnnouce129Million DeadTrees.pdf

[13] Stephens, S.L. et al, 2017. "Drought, Tree Mortality and Wildfire in Forests Adapted to Frequent Fire." *Bioscience* Advance Access XX, 1–38. https://doi.org/10.1093/biosci/bix146.

[14] "Top 20 Largest California Wildfires"

[15] Id.

these, a not insignificant number have been caused by electrical power lines, as shown in Figure 1. Several factors contribute to this over and above the already mentioned trends: electric utilities' obligation to serve, requiring stringing power lines through woodland areas; aging infrastructure with slow investment timelines;[16] and California's strong Diablo and Santa Ana winds that increase the likelihood of damaging infrastructure and then contribute immensely to the spread of any resultant fire. These conflating factors make wildfires unlike any other disaster.

Rulemaking in Response to Wildfire Threat

Despite wildfires being characterized as capricious, natural phenomenon, many of California's recent fires are marked by human influence. As such, human intervention and management could offer many of the solutions to mitigating fire's associated risks. For the case of power line caused wildfires, they tend to ignite under high wind conditions that stress utility infrastructure or under conditions where equipment is run to failure. The catastrophic "Black Saturday" bush fires of early 2009 in Victoria, Australia highlight this. A Royal Commission report found that while electric infrastructure accounted for about 1.5 percent of all wildfire ignitions they were responsible for a disproportionately high number of the wildfires that caused significant damage, noting:

"*…on days of extreme fire danger the percentage of fires linked to electrical assets rises dramatically. Thus, electricity-caused fires are most likely to occur when the risk of a fire getting out of control and having deadly consequences is greatest."*[17]

Yet, the risk associated with power line fires should be lessened relative to the rigor applied to power lines' engineering and maintenance. In other words, equipment built and maintained to higher standards should perform at higher standards. However, for most investor-owned utilities, the regulatory compact means the Public Utilities or Service Commission is often tasked with balancing developing regulations while not driving up electric bills with ineffective solutions.

The Royal Commission report goes on to note:

"*Victoria's electricity assets are ageing, and the age of the assets contributed to three of the electricity-caused fires on 7 February 2009—the Kilmore East, Coleraine and Horsham fires. Distribution businesses' capacity to respond to an ageing network is, however, constrained by the electricity industry's economic regulatory regime. The regime favours the status quo and makes it difficult to bring about substantial reform. As components of the distribution network*

[16] CPUC Policy and Planning Division; "Utility Investment Valuation Strategies: A Case for Adopting Real Options Valuation;" Oct. 3, 2013; http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/Final2RRM.pdf

[17] 2009 Victorian Bushfires Royal Commission; Final Report Summary; July 2010; http://royalcommission.vic.gov.au/Commission-Reports/Final-Report/Summary/Interactive-Version.html

age and approach the end of their engineering life, there will probably be an increase in the number of fires resulting from asset failures unless urgent preventive steps are taken."[18]

Texas Wildfire Mitigation Project**

Following historic wildfires in Texas throughout 2011, decisionmakers in the state were faced with how to apply safety goals in a largely deregulated electricity market.

Rather than impose strict rules, Texas officials appropriated money for technology development aimed at mitigating wildfire.

Academics at Texas A&M recognized that *powerline apparatus failures,* such as degrading connectors, clamps or switches, impact both reliability and create ignition sources for wildfires. However, they also observed that many distribution system operators were "flying blind," lacking real-time knowledge of the health and condition of circuits.

While many apparatus failures develop over a period of weeks or months, failure is often not detected until a line is out or a wildfire has ignited.

The researchers developed an automated analytics monitoring system, called Distribution Fault Anticipation (DFA), which claims to create near real-time awareness of system conditions and identification of misoperating or broken devices, enabling detection and remediation days to weeks prior to critical failure.

**See: Footnote 21; and http://www.puc.texas.gov/industry/

In Wisconsin, a number of fires in the late 1980s resulting from hazard trees falling into electric distribution lines, prompted its Public Service Commission to create its own requirements for power line inspections.[19] Colorado, in 2009, established requirements for community-based wildfire protection plans; however, few requirements were placed on electric utilities.[20] In Texas, over 4,000 power line caused wildfires occurred during a three-and-a-half year period, prompting state lawmakers and academics to form the Texas Wildfire Mitigation Project in 2013.[21] The Project, officially completed in August 2017, resulted in a predictive modeling technology that detects power line failure mechanisms in real-time. The culmination of the Project is now being sold and distributed to Texas utilities.

In comparison, California stands as a leader in its wildfire mitigation policies, especially as they relate to requirements placed on electric utilities to reduce the risk of wildfire. A number of fires in the early 1990s prompted the Legislature to require the CPUC to adopt standards for electric distribution operations and maintenance, including tree trimming and brush clearing requirements.[22] Today, these standards are outlined in hundreds of

[18] See Footnote 17

[19] Wisconsin PSC §113.0512 https://docs.legis.wisconsin.gov/code/admin_code/psc/113/V/0512

[20] C.R.S.A. § 23-31-313

[21] https://wildfiremitigation.tees.tamus.edu/wp-content/uploads/2013/12/201312.WildfireProject.KickoffMeeting.Tees.RussellBenner.pdf

[22] D. 96-09-097

pages of prescriptive rules, mostly General Orders 95 and 165.[23]

Following the 2007 Fire Siege in Southern California, where 17 people died, over 3,069 homes and other structures were destroyed and a million acres were burned,[24] the CPUC initiated rulemakings to improve fire safety from power lines.[25] In the near-decade that followed, the CPUC adopted measures to enhance vegetation management,[26] require electric utilities to submit fire prevention plans,[27] approve an initial Fire Map of high fire threat zones,[28] and adopt overhead power line rules to account for pole sharing between electric and telecommunication companies.[29]

In December 2017, largely as a response to the 2017 fire season, the CPUC adopted new measures to again enhance vegetation management and require more frequent inspections around power lines.[30] Additionally, the recently adopted rules include an updated Fire Map, shown in Figure 2, which includes areas impacted by the tree mortality crisis. The new map now accounts for 44% of California's total land area, more than doubling the high fire threat

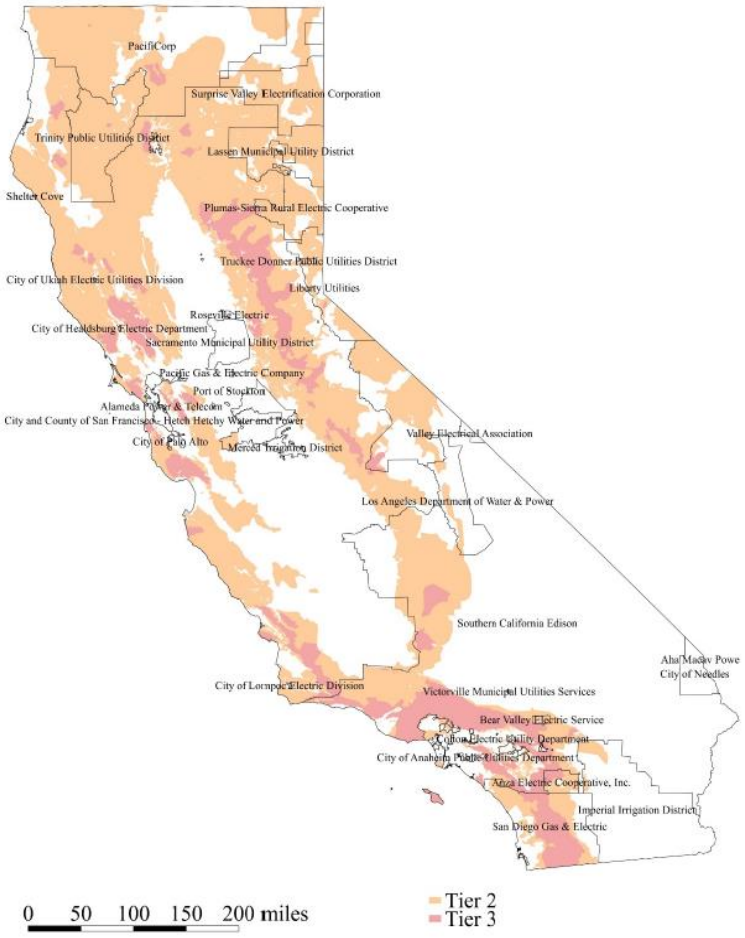


Figure 2 Interim Review Team – Approved Map overlaid with boundaries of electric utility service territories. Source: footnote 30

[23] http://www.cpuc.ca.gov/gos/GO95/go_95_startup_page.html and http://www.cpuc.ca.gov/gos/GO165/GO_165_startup.html

[24] pg. 6; *California Fire Siege 2007*; http://www.fire.ca.gov/fire_protection/downloads/siege/2007/Overview_CompleteFinal.pdf

[25] Originally, R. 08-11-005, then R. 15-05-006

[26] D.09-08-029 and D.17-12-024

[27] D.12-01-032

[28] D.16-05-036

[29] D.14-02-015

[30] D.17-12-024

zones from earlier maps.[31] The new fire rules require the adoption of the old regulations within the expanded map boundaries no later than September 1, 2018,[32] prior to the autumn fire season.

The Utility of Regulations

These efforts by the CPUC show an increased awareness of the wildfire threat posed by electric infrastructure throughout the state. However the prescriptive regulations are just one mechanism for addressing risk associated with power lines. As noted by Commissioner Cliff Rechtschaffen upon the adoption of the rules: "*These regulations are a very important step, but we also need to continually evaluate whether our wildfire safety practices are enough.*"[33]

In 2015, this Subcommittee met to discuss what electric utilities have done to improve safety since the devastating Southern California wildfires of 2007. The Subcommittee report[34] notes the considerable effort California's largest electric utilities, especially San Diego Gas and Electric (SDG&E) Company, have exerted to prevent and mitigate wildfires within their territories. The report goes on to note that despite the creation of risk-based ratemaking, the effectiveness of wildfire prevention measures are uncertain as the measures have not been evaluated by the CPUC.

Take for instance Pacific Gas and Electric Company's (PG&E) electric distribution risk management filings as part of their 2017-2019 General Rate Case (GRC).[35] Wildfire is categorized as the greatest risk to PG&E and subject to the greatest mitigation related expenditures. PG&E notes it has formally-tracked wildfire risk since 2006, and as of May 2015 has undertaken enhanced measures to address fire risk.[36] However, in the CPUC's evaluation of PG&E's fire risk assessment, CPUC "staff has been unable to fully determine how the RIBA [risk informed budget allocation] model risk ranks projects and cannot render an opinion on its efficacy."[37]

Yet the GRC, already long and contentious, need not be the vehicle to evaluate efficacy of mitigation measures. Rather, relevant fire safety oversight in other proceedings is necessary. The utility Fire Prevention Plans (FPP),[38] only require utilities to describe mitigation measures without justification of effectiveness. In fact, the static nature of the FPP filing is evidenced by some utilities rarely updating them.[39] In response to the FPP inadequacy, the Legislature

[31] http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M201/K352/201352402.PDF

[32] D.17-01-009

[33] http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M201/K352/201352402.PDF

[34] http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/11-18-15_background.pdf

[35] GRC 2017 Phase I (A 15-09-001); exhibit PG&E-4; September 1, 2015; https://pgera.azurewebsites.net/Regulation/search

[36] Id. Pg. 2-12

[37] Pg. 50; Safety and Enforcement Division Risk Assessment Section staff Report, PG&E 2017-2019 GRC; March 7, 2016; http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=10180

[38] D. 12-01-032

[39] Most recent FPPs by Edison and PG&E list dates of August 2014 and 2015, respectively. SDG&E, in contrast, updated its FPP in late October 2017.

passed in 2016 a requirement for utilities to file fire mitigation plans, establishing performance-based metrics of fire prevention that the CPUC reviews and comments upon, and requires audits be conducted on plan compliance.[40] The CPUC is still in the process of implementing this legislation.[41]

What are "Best Practices" for Preventing Wildfire?

Determining utility "best practices" for fire prevention can be challenging, as geography, climate, weather, infrastructure age, and technical expertise can vary dramatically across utilities.

What follows is a selection of different actions taken by California's utilities aimed at preventing wildfire.

- Vegetation management*
- Power line inspections*
  Manual or automated (i.e. LIDAR)
- Weather station monitoring
- Pole replacement
  Wood-to-steel or accelerated replacement programs
- Disabling equipment that automatically energizes a line after a fault is tripped
  (i.e. reclosers)
- Proactive line de-energization
- Replacing copper conductors
- Dead tree removal
- Remote control and data analytics of power lines
  (i.e. SCADA or line telemetry)
- Animal abatement

*Required by CPUC General Orders

While CPUC oversight of utility action on wildfire prevention may currently be underactive, the utilities for their part have spent considerable sums of ratepayer money on wildfire mitigation, both self-initiated and in compliance with CPUC rules. What results is a hodgepodge of what is considered "best practice," as utilities in different regions and climates interpret risks associated with wildfire differently.

PG&E, with its 70,000 square mile service area[42] covering much of the Sierra Nevada Mountains, prioritizes vegetation management and clearance standards in response to the current tree mortality crisis. For their 2017-2019 GRC, PG&E forecasted over $200 million, their largest risk mitigation related expenditure, on wildfire mitigation through vegetation management and line inspections.[43] This figure will likely increase in response to the increased area of PG&E service territory included in Fire Map 2, now under stricter vegetation standards.

SDG&E, with its smaller 4,100 square mile service area spanning 2 counties along the southwestern border of California,[44] has forecast over $100 million for what they consider "baseline" mitigation measures (vegetation management, line inspections) and seeks to expand the measures by an additional $500 million to further their wildfire

[40] SB 1028 (Hill, Chapter 598, Statutes of 2016)
[41] http://cpuc.ca.gov/fireincidentsdata/
[42] https://www.pge.com/tariffs/tm2/pdf/ELEC_MAPS_Service_Area_Map.pdf
[43] See Footnote 37; Pg. 47
[44] https://www.sdge.com/our-company/about-us/our-service-territory

prevention capabilities (replacement of copper lines, joint agreements with CAL FIRE, etc.).[45] SDG&E's aggressive approach to wildfire spending likely arises from its history of devastating wildfires and the large proportion of its service area in high fire threat zones.

This utility spending, on its surface, could be construed as performance-based regulation, where the CPUC calls on utilities to spend on mitigation and allows the utilities discretion and flexibility for determining best practice. As explained in the 2015 Subcommittee report,

"The CPUC's rules for electric safety are largely prescriptive – they dictate the clearances between power lines and trees, the weight of equipment allowed on poles, the permissible sag of power lines – and assume that compliance with those requirements will sufficiently ensure safety. Performance- or risk-based safety rules, on the other hand, focus on the identification of hazards and the setting of goals, giving the utility flexibility in achieving these safety goals. These rules have a heavy reliance on the identification of metrics to judge success in reaching a particular safety goal."[46]

However, in order to be considered a performance-based regulation, the regulator needs to not only identify the metrics by which to judge success but also to actively judge. As best highlighted by the FPPs, this has not always been the case with the CPUC's oversight of fire safety.

Recently, the CPUC has incorporated wildfire mitigation analyses into the Risk Assessment and Mitigation Phase (RAMP) filings of the utilities.[47] The RAMP filing is meant to highlight a utility's risk priorities and mitigation plans, and includes safety metrics and forecasted risk reduction. In this way, the RAMP could be seen as a performance-based tool. In their decision adopting RAMP guidelines, the CPUC notes that "it has made it clear that it expects more quantitative information to inform safety expenditure choices in the future; in this regard, the utilities' current models do not meet Commission expectations."[48] The adoption of RAMP filings, however, is a very recent CPUC action; with PG&E filing its RAMP in late November 2017.[49]

Through these measures –the adoption of RAMP filings and the review and auditing of utilities' fire mitigation plans – it appears the CPUC is moving toward addressing the two criticisms of the previous Subcommittee wildfire hearing: that a performance-based approach for risk mitigation should be adopted, and that efforts to incorporate safety into rate cases are futile unless analysis of safety measures occur in other proceedings. As these CPUC actions are still in their infancy, it is currently uncertain if their approach will achieve the desired outcomes. The question remains if it is reasonable to expect good safety outcomes through these measures.

[45] SDG&E RAMP filing; Nov. 30th, 2016; https://www.sdge.com/sites/default/files/regulatory/SDGE-1_RAMP_Wildfires_Caused_by_SDG%26E_Equipment_FINAL.pdf

[46] Pg. 6-7 http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/11-18-15_background.pdf

[47] D.16-08-018; http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M165/K862/165862364.PDF

[48] Id. Pg. 179

[49] OII 17-11-003 file:///C:/Users/mcwillle/Downloads/RAMP-2017_Report_PGE_20171130_431187.pdf

Including a Management-Based Approach

Despite the adoption of new prescriptive fire regulations in tandem with implementing performance-based standards, the CPUC – and the utilities it regulates – must consistently question the efficacy of their wildfire safety practices.

As safety regulators in high-hazard industries use different combinations of regulatory designs to inform choices, much uncertainty can persist around which regulatory tools are well suited to a particular circumstance. Recently, the National Academy of Science was commissioned by the Pipeline and Hazardous Materials Safety Administration (PHMSA) to inform its choices of regulatory tools.[50] Last year, the National Academy of Science published their report, laying out a framework through which to evaluate safety regulation in high-hazard industries. The report concluded that the use of management systems, an example of which would be establishing and executing a safety management program, can often be critical to ensuring safety performance. As the report notes:

An Excerpt on Organizational Safety Culture***

"The term "safety culture" was coined after the 1986 Chernobyl nuclear plant disaster. Since then it has been referenced in the media, scholarship, and organizational management both as an explanation for accidents and as a means for improving the safety of complex and tightly coupled technologies posing risks of major accidents.

The term has been adopted to refer to the ongoing processes that align what is important to an organization with how things actually work and what is routinely done.

…

The effectiveness of implementing a safety culture depends on providing workers and managers with information about changing vulnerabilities and the means for addressing these vulnerabilities. It also depends on workers and managers continually revising approaches to work in efforts to remain sensitive to the possibility of failure and on their knowledge that they may be only partially aware of the possibilities for failure. A culture of safety depends on remaining dynamically, persistently engaged in self-assessments to avoid stale, narrow, or static representations of the dynamic and evolving paths to system failure."

***See footnote 50, excerpt from pg. 11

"The impetus for this report, one that suffuses the debate about how best to regulate high-hazard industries, is a particular interest in regulations that require firms to establish management systems to identify, prioritize, and mitigate their safety risks. Often mischaracterized as 'performance-based,' these regulations are more aptly described as having a macro-means design, because they require firms to address the overall risk – that is, at a macro-level – by using the specified means of a management system. Notably, these regulations do not require firms to achieve specified ends or performance outcomes, such as a demonstrable reduction in major incidents. Such an outcome would be particularly difficult to demonstrate for regulations that are intended to prevent catastrophic failures, given their complexity and rare occurrence. The regulations instead presume that consistent attention to organizational dynamics and emergent risks should reduce the probability of such failures, even if that reduction may not be provable empirically."

[50] National Academies Transportation Research Board Special Report 324; "Designing Safety Regulations for High-Hazard Industries"; 2017; DOI 10.17226/24907; http://nap.edu/24907

The report, in effect, is calling on regulators to establish and promote safety culture within high hazard industries, not only from safety staff but all aspects of the organization. In doing so, regulators may infuse a greater sense of responsibility and accountability into the regulated organizations, and avoid the development of a collection of highly targeted, but perhaps ineffectual, direct regulations. As noted, "…the common rationale for requiring the use of management systems to promote safety in high-hazard industries is that safety risks, especially catastrophic risks, can arise from interactions among conditions and activities that are difficult to anticipate and may be specific to each firm or work site." The report goes on to say that calling for increased safety management is not to dismiss other regulatory approaches. Rather, as evidenced by the case studies in the report, effective regulatory design often contains a mix of regulation design types, rather than a single approach.

So the question posed by Commissioner Rechtschaffen of *"whether our wildfire safety practices are enough"* remains. How far have the CPUC and its regulated entities come, not only in prescriptive metrics and performance-based standards, but also in establishing and encouraging safety cultures. As part of the decision establishing guidelines for the utility RAMP filings[51] the CPUC requires utilities to outline their commitments to safety cultures. The RAMP filings should show "whether the utilities' executive and senior management are sufficiently engaged in the risk assessment, prioritization, mitigation, and budgeting process."[52] Moreover, the CPUC called on utilities to tie executive compensation, at least partially, to safety performance. PG&E, for its part, ties its short-term incentive program to annual safety performance.[53] It additionally reports a seemingly robust safety management system, one that largely developed in response to the disastrous San Bruno pipeline explosion in 2010.

While the CPUC has called on the electric utilities to examine, outline, and compensate safety performance, it is unclear if internally the CPUC is doing similarly. The CPUC's Office of Safety Advocate, established in 2016 by the Legislature,[54] seeks to advocate for the "continuous, cost-effective improvement of the safety management and safety performance of public utilities."[55] OSA does not just look externally at safety performance, but also internally at measures the CPUC can undertake to improve safety management and culture. While OSA's first compliance report highlights a nascent division – hiring staff, establishing protocols, engaging in a handful of proceedings – the report also suggests a siloed CPUC, where safety training is not being conducted outside of the Safety and Enforcement Division (SED). As noted in the 2015 Safety Action Plan,[56] "the Commission's staff outside of SED report being unaware of channels to communicate and address safety concerns." Aside from training, a healthy safety culture

[51] See footnote 50

[52] Id, pg 140

[53] See footnote 45, Chapter D

[54] SB 62 (Hill, Chapter 806, Statutes of 2016)

[55] OSA 2017 Annual Report; Jan. 10, 2018;
http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/About_Us/Organization/Divisions/Safety_Advocates/OSA%2018%20Legislative%20Report.pdf

[56] CPUC Safety Action Plan and Regulatory Strategy; Feb. 12, 2015;
http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/SafetyActionPlanRegulatoryStrategyFeb12FINAL.pdf

encourages employees' to speak up about observed deficiencies, to share information, and have difficult conversations. The CPUC's Safety Flag system, which sought to address the lack of clear safety channels at the CPUC, was mentioned in the 2015 Safety Action Plan but is absent from the 2017 plan update.[57] In fact, the 2017 plan provides little internal suggestions for improving CPUC safety culture.

The very real risks posed by utility infrastructure in drought-ridden landscapes lend extreme urgency to the CPUC's task, as it implements and assesses its new prescriptive measures, continues to develop its performance-based approaches, and prioritizes the development of safety culture both internally and externally. Adapting to this multi-pronged regulatory approach can help mitigate the pitfalls inherent in each singular approach: over-prescription, confirmation bias, and nuance in regulating a dynamic industry against rare events. As the National Academy of Science report notes:

"Discerning whether any of its regulations, regardless of design, are having the intended effect of reducing the risk of low-frequency, high-consequence events is a challenge for a regulator of a high-hazard industry. A lengthy period without a major incident may cause a regulator to believe its regulatory regime is having a positive effect in controlling risks that can lead to catastrophes when that may not be the case. Alternatively, the occurrence of a single catastrophe may create an understandable but potentially false perception that the regime has failed to manage risks effectively and may prompt calls for it to be overhauled or supplemented with alternative regulatory designs."

[57] http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/Safety/Other/2017_Safety_Action_Plan.pdf

Lessons Learned: Report from the Oroville Dam Spillway Incident^

In the midst of widespread rainfall in February 2017, the main spillway of the tallest dam in the United States, Oroville, failed. While water was diverted from the main spillway to assess the damage, the lake level continued to rise, ultimately exceeding the concrete lip of the emergency spillway. Erosion of the emergency and main spillways led to a heightened risk of collapse to the dam's concrete lip. The potential consequences of such a collapse led to an evacuation order for hundreds of thousands of downstream residents.

Earlier this month, the Independent Forensic Team released its report on the Oroville Dam spillway incident. The report highlighted a number of lessons to be learned from the incident.

- Mature safety management programs are essential, and should be based on a strong "top-down" safety culture, where executives are as engaged in safety as safety personnel.
- More frequent physical inspections are not always sufficient for managing safety and identifying risks.
- Acting as insular organizations inhibit knowledge-sharing and development of technical expertise

^Independent Forensic Team Report Oroville Dam Spillway Incident; Jan 5, 2018; https://damsafety.org/sites/default/files/files/Independent%20Forensic%20Team%20Report%20Final%2001-05-18.pdf