Safety and Enforcement Division
Risk Assessment and Advisory Section
Staff Report
Pacific Gas and Electric Company (PG&E)
I.17-11-003 RAMP Filing

California Public Utilities Commission
April 17, 2017

Emergency Evacuation Procedure

In the event of an emergency evacuation:

- **Calmly Proceed out of the nearest exit.**

- **Proceed down Van Ness to McAllister Street. Cross McAllister and go to the plaza area between the War Memorial and Opera Buildings.**

- **Re-group on plaza area between these buildings until safe to return.**

Practical Information

WiFi Access
SSID: cpucguest
User: guest
Password: cpuc33118

Restrooms:
Past security to the other end of the entry way.

Call in information:

- **Phone line: 1-866-859-2737 Participant code: 1682922**

WebEx: When it's time, join the meeting.

Meeting Number: 717 960 554

Meeting Password: One682922

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Presentation Agenda

Table of Contents:

Introduction & Background

Commission Decision D.16-08-018 and D.14-12-025 establish requirements for RAMP:

- **Prioritization of risks**
- **Description of baseline controls and costs**
- **Prioritization of risk mitigations (Risk Spend Efficiency (RSE))**
- **Explain constraints, feasibility and affordability impacts factored into the mitigation plan**
- **Consideration of at least two alternative mitigation plans**
- **Remove shareholder financial interests from consideration of risks**

Sempra (SoCalGas & SDG&E) filed the first ever RAMP 11/30/16

D.14-12-025 & D.16-08-018

Requirements for PG&E's RAMP

Additional Items Required:

- Include description of safety culture, executive engagement and compensation.
- Identify any immediate safety situations.
- Provide assessment of substation risk.
- Provide overview of steady state replacement of critical infrastructure.

Overview

In general, Staff determined that PG&E's RAMP met the filing requirements:

- Identified and ranked top risks.

- Adequately identified and described baseline controls and 2016 costs.

- Essentially completed 1thru 8 of Cycla Steps.

- Provided RSE's for prioritizing proposed plans.

- Provided two alternative mitigation plans and reasons for rejection.

- Performed probabilistic modeling of risks.

What This Report Does Not Cover

- Evaluation or conclusions associated with adequacy and reasonableness on funding levels of mitigations, the risk scores, or prioritizing projects and programs.

- The safety culture (See OII – I.15-08-019)

- Substation risks

- Steady state of asset replacement

- Whether the models to use for evaluating risks in the RAMP should be adopted for future RAMPs.

Report - Table 3: Top Risks, Scores, and Forecast Mitigation Costs

Chapter	Risk Name	2017-2022						2017-2022	
		MARS-TA-Overall Average-Total	MARS-TA-Overall Average-Total-RANK	MARS-TA-Proposed Plan-Risk Score Reduction (all years)	Proposed Plan-Total spend (all years)	MARS-TA-Proposed Plan-Total RSE (Units/$M)	Proposed Plan Risk Reduction % of Baseline per Year	Proposed Plan Risk Reduction % of Baseline 6-Years (2017-2022)	Proposed Plan-Total spend (2020-2022)
1	Transmission pipeline	37.62	15	15.52	$3,259,252,592	0.0048	6.9%	41.3%	$1,583,968,171
2	Maintaining system capacity (GSO)	325.34	3	747.57	$460,169,278	1.6246	38.3%	229.8%	$177,958,106
3	Measurement & Control downstream	12.07	20	10.77	$583,120,367	0.0185	14.9%	89.2%	$302,637,873
4	Measurement & Control facility	17.49	18	1.94	$380,070,892	0.0051	1.8%	11.1%	$187,184,777
5	Distribution - Cross bore	28.46	16	34.58	$376,815,080	0.0918	20.2%	121.5%	$263,540,249
6	Compression & Processing facility	39.86	14	36.20	$120,133,419	0.3014	15.1%	90.8%	$57,647,061
7	Distribution - Non-cross bore	188.84	9	23.02	$147,037,344	0.1566	2.0%	12.2%	$54,222,072
8	Storage - Wells	12.68	19	0.00	$0		0.0%	0.0%	$0
9	Distribution OH conductor	824.35	1	46.60	$86,600,000	0.5381	0.9%	5.7%	$51,960,000
10	Transmission OH conductor	227.50	7	20.15	$300,579,881	0.0670	1.5%	8.9%	$214,388,506
11	Wildfire	257.58	5	76.97	$797,683,138	0.0965	5.0%	29.9%	$721,835,727
12	Nuclear core damage	6.65	21	0.00	$0		0.0%	0.0%	$0
13	Hydro dam failure	100.89	12	9.02	$57,344,398	0.1573	1.5%	8.9%	$41,100,000
14	Contractor Safety	181.48	10	519.21	$8,279,123	62.7135	47.7%	286.1%	$5,329,969
15	Employee Safety	263.01	4	1.12	$7,465,234	0.1494	0.1%	0.4%	$2,999,386
16	Motor Vehicle Safety	214.30	8	95.36	$2,917,299	32.6868	7.4%	44.5%	$2,917,299
17	Fitness for Duty	50.43	13	9.32	$31,650,372	0.2945	3.1%	18.5%	$14,421,782
18	Cyber attack	107.75	11	0.00	$0		0.0%	0.0%	$0
19	Insider Threat	233.79	6	0.00	$0		0.0%	0.0%	$0
20	ERIM	19.81	17	8.36	$73,768,316	0.1134	7.0%	42.2%	$33,614,737
21	Skilled and qualified	4.96	22	2.36	$6,110,000	0.3870			$6,110,000
22	Climate resilience	665.33	2	0.00	$0		0.0%	0.0%	$0

Key Areas of Strength

The stand-alone model consistently produced results.

Use of probabilistic modeling for risk and risk reduction.

Made a first attempt at probabilistically modeling cross cutting risks in RAMP.

Key Areas of Strength

This RAMP builds on prior RAMP efforts.

General overview Chapters A and B.

Provided several lessons learned observations.

Key Areas for Improvement

Provide RSE's for existing controls and estimates of their risk reduction potential.

More thoroughly explain Subject Matter Expert and risk owner inputs.

Perform a more rigorous review of data, data sources, and data integrity.

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Key Areas for Improvement

Provide model outputs by "saving as value" in separate tabs in the model for transparency.

Cross-cutting approach and model need to be vetted in S-MAP.

Conclusions

The filing is in accordance with the Commission directives.

Risk assessment program is in a state of transition.

In the absence of common methodology or risk model, it is premature to conclude that PG&E's current model and outcomes can be used as the sole basis for determining reasonableness of proposed mitigation activities in the forthcoming GRC.

Conclusions

PG&E employed better quantification, where available, and to identify the sources of data used, but this aspect of the risk assessment is not fully transparent. A major issue is the extent PG&E relies its own data, industry-wide statistics, or subjective assessments.

The risk areas that have greater available data specific to PG&E seem to provide a more solid basis for evaluating the proposed mitigations.
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More can be done to assist decision makers and intervenors in following the trail from risk assessment to budget request.

Q & A

SED Approach

Recognition of PG&E effort and improvement on RAMP

Challenges:

- **Transparency**

- **Modeling Complexity**

- **Cross-cutting and Stand-alone models**

Approach

Summarize Risk and ease of assimilating chapter information (includes transparency and clarity).

Evaluated chapter for strengths, weaknesses, how it met RAMP filing objectives, and offer suggestions for improvement.

Did not perform detailed analysis of model function, but did try to understand the workings of model inputs and effect on outputs.

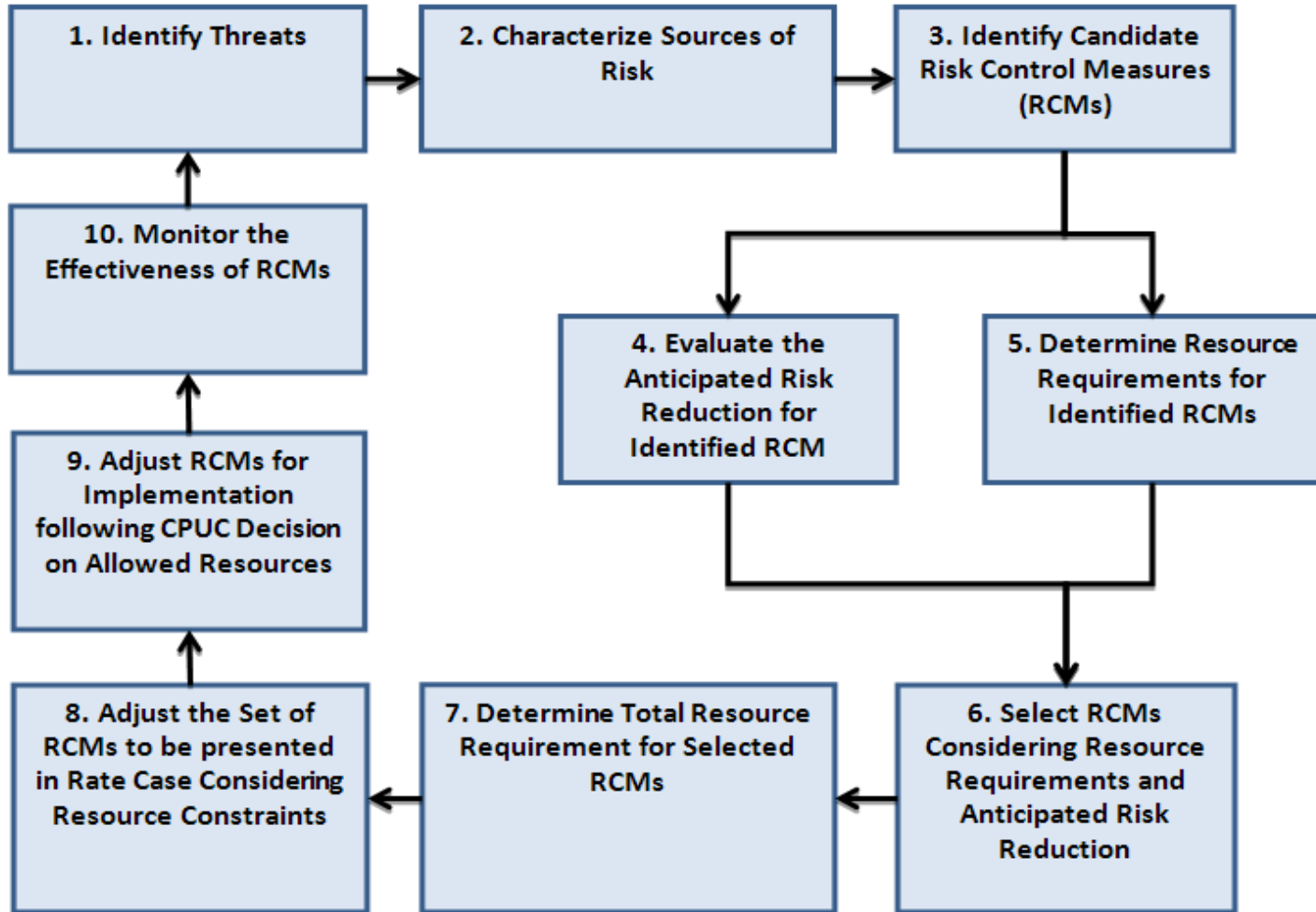# Cycla's 10-steps for Risk-Informed Resource Allocation for Rate Cases

Steven Haine, P.E.

Senior Engineer, Risk Assessment Section (SED)

California Public Utilities Commission

April 17, 2018

Cycla Corp's 10-step Risk-informed Resource Allocation Process

1. Identify Threats → **2. Characterize Sources of Risk** → **3. Identify Candidate Risk Control Measures (RCMs)**

4. Evaluate the Anticipated Risk Reduction for Identified RCM

5. Determine Resource Requirements for Identified RCMs

6. Select RCMs Considering Resource Requirements and Anticipated Risk Reduction

7. Determine Total Resource Requirement for Selected RCMs

8. Adjust the Set of RCMs to be presented in Rate Case Considering Resource Constraints

9. Adjust RCMs for Implementation following CPUC Decision on Allowed Resources

10. Monitor the Effectiveness of RCMs

For all 10 steps: Document all steps and processes
Goal: Consistency and Repeatability

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Step 1: Identify Threats

Step looks at robustness of process to identify various threats.

PG&E's process starts at the line of business level, where SMEs and other key participants look at all potential events that can negatively impact the line of business' ability to carry out its objectives. Potential risk drivers that can cause the events are identified.

Evaluation result: Satisfactory.

Step 2: Characterize Sources of Risk

Step looks at how robust and thorough the process is in evaluating risks.

Process evolved greatly since the 2013 rate case and the last GT&S.

PG&E now uses a 2-stage process. It uses the RET to select risks for the RAMP. It then uses rigorous risk modelling and simulations to arrive at the MARS scores. The modeling in MARS step has a great deal more mathematical sophistication and rigor compared to the RET.

Step 2: (Continued)

Evaluation result: Satisfactory

Step 3: Identify Candidate RCMs

This step looks at the process the operator uses to identify risk control measures.

In the majority of cases the proposed RCMs are a continuation of existing RCMs. In many cases the mitigations also evolved as circumstances changed. Generally PG&E did a good job documenting the justifications for the proposed RCMs, particularly when they are new RCMs.

Evaluation result: Satisfactory.

Step 4: Evaluate Anticipated Risk Reduction for Identified RCMs

PG&E did a good job explaining qualitatively how each candidate RCM addresses the identified risk drivers.

What isn't always clear is how the magnitude of the anticipated risk reductions are determined.

There is also no estimate of the uncertainty of the anticipated risk reductions.

Step 5: Determine Resource Requirements for Identified RCMs

SED did not look into the reasonableness of the resources required or the cost estimates of the identified RCMs.

In most cases, proposed RCMs are continuations of existing RCMs. One would expect the resource requirements and costs for the proposed RCMs to closely track historical resources and costs.

PG&E will firm up resource and cost estimates in GRC filing.

SED may revisit this when the GRC is filed.

Step 6: Select RCMs Considering Resource Requirements and Anticipated Risk Reduction

Broadly speaking, the selection among candidate mitigations tends to favor those with the highest RSE and those that are continuations of existing controls.

The biggest drawback is the Risk Spend Efficiency (RSE) formula has a 6-yr. horizon. This relatively short horizon tends to bias selection in favor of O&M spending over capital spending.

Step 6: (Continued)

We didn't find any evidence of any acceptable risk threshold or risk tolerance having guided the decision making process.

In fact the post-mitigation residual risk as measured by the MARS varies very widely from risk to risk.

Evaluation result: The decision-making process would benefit from a formalized procedure to arrive at some standardized end state or standard risk threshold.

Step 7: Determine Total Resource Requirements for Selected RCMs

For this step the operator has to determine the cumulative cost of all selected mitigations.

PG&E presented the recorded costs for existing controls but did not generally present the methodologies for the cost estimates of the proposed mitigations.

SED also did not evaluate the reasonableness of the projected costs.

Step 8: Adjust RCMs Considering Resource Constraints

For this step the operator has to identify constraints used to justify the scope, pace, or mix of mitigations.

In most cases they are justified as continuations of existing strategies, but generally what is lacking is a more detailed discussion of constraints justifying those decisions.

Evaluation result: There should be more discussion of resource constraints.

Step 9: Adjust RCMs for Implementation Following Rate Case Decision (for current rate case)

- Adjust implementation plan to maximize total system-wide risk reduction within revenue constraint

- Take into account operational and resource constraints, available personnel

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Step 10: Monitor Effectiveness of RCMs

- Between rate cases identify metrics to gauge effectiveness of RCMs and impact on overall risks

- Change implementation of RCMs in next rate case based on their actual effectiveness

Chapter 2 – Failure to Maintain Capacity for System Demands

Arthur O'Donnell

Risk Category Overview

- **Nature of Risk and How It's Triggered**

- **Estimated Risk Significance**

- **History of Risk Occurrence**

- **Proposed Mitigation Plan**

- **Cost and Risk-Spend Efficiency (RSE) Summary**

- **Strengths of PG&E Risk Category Treatment**

- **Areas for Improvement**

Risk of De-pressurization

Nature of Risk and How It's Triggered

- **PG&E's gas pipeline maintenance program is vast and accelerated with a limited number of qualified expert inspectors**

- **Scheduling may require projects to extend into winter months when gas demand is high**

- **Pipeline maintenance requires intentional de-pressurization of gas lines**

Risk of De-pressurization

Nature of Risk and How It's Triggered (cont.)

- **Risk is introduced in two ways, both the result of temporary gas service shut-off:**

  – When gas service is restored, pilot lights on older residential appliances may be out, which could result in accumulation of gas with ignition

  – Customers may resort to carbon-monoxide device use indoors leading to CO poisoning

Risk of De-pressurization

Estimated Risk Significance

- **Estimated worst-case scenario of one injury every 1.4 years; one fatality every four years**

- **The RAMP model estimates an event frequency of once approximately every three years, with a MARS-TA of 325.34, third among the 22 identified risks**

- **Likelihood of the event is low; consequences expected to be high**

Risk of De-pressurization

History of Risk Occurrence

- **No documented occurrence in PG&E service territory**

- **No documented occurrence ever in California**

- **No known occurrence within U.S. gas industry**

Risk of De-pressurization

<u>Proposed Mitigation Plan</u>

- **Baseline controls consist of hydraulic analysis to improve on-time project completion rate**
  - This, in turn, would minimize scheduling of gas safety projects in winter months
- **Mitigations consist of focused pressure restoration projects, and completion of large transmission capacity projects**

Risk of De-pressurization

Cost and Risk–Spend Efficiency (RSE)

- **$178 million three-year program cost estimate with total six-year projected cost of $460.2 million (third overall among risks)**

- **PG&E estimates a 2020-2022 proposed mitigation plan RSE of 1.6246**

- **PG&E estimates a potential 38 and 41 percent reduction to the overall multi-attribute risk score (MARS) for the 2017-2022 and 2020-2022 time periods**

- **The proposed mitigation plan has a MARS-TA RSE of 1.6246, ranked third, at a This risk's MARS-TA-Proposed Plan-Risk Score Reduction (all years) of 747.522 is ranked first — highest — of the RAMP's 22 identified risk chapters.**

Risk of De-pressurization

Strengths of PG&E Risk Category Treatment

- **PG&E checked assumptions informing its RAMP model against an older, existing model and was able to replicate its modeled risk outcome**

  – This means that in addition to applying a high level bow tie-based operational risk model, PG&E also applied a **probabilistic model** that pre-dates the development of the RAMP model.
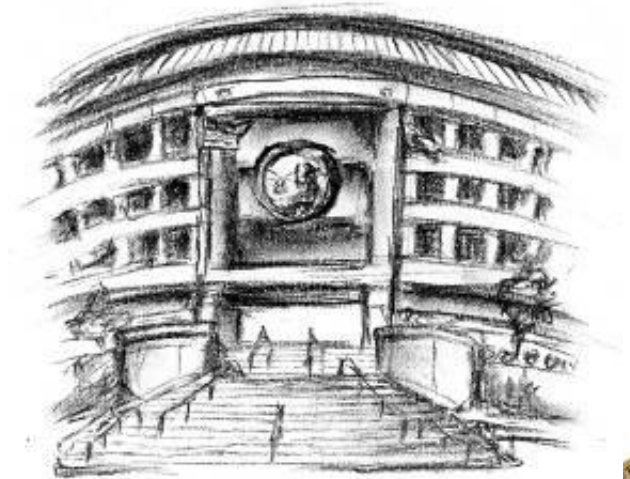
RAMP Overview

Areas for Improvement:

- **PG&E acknowledges that its model and analysis suffer from a paucity of data on this little-considered risk**

- **PG&E is perhaps over-reliant on SME judgment in assigning risk**

- **PG&E proposes an overall Risk Reduction score (748) that exceeds the Risk's assigned baseline (325)**

Questions?

Arthur O'Donnell

Chapter 3 - Measurement and Control Failure
Release of Gas with Ignition Downstream

Fred Hanes

Chapter 3

- **A Measurement and Control Station's failure to control pressure causes downstream rupture with ignition (Trans and Distr.).**

  - Note: Station design requires a second regulator or relief valve per 49 CFR Part 192

Tompkins Hill M&R Station

Drivers, Data, Exposure

- **Drivers from ASME list are logical**
  - Equipment, incorrect operations
    - Allocated by station type
- **Incident data**
  - 34 PG&E events (no ignition) 2011-2016
  - National database used for ignition likelihood
- **Exposure: 5,381 Stations**
  - 556 Transmission; 4825 Distribution

Frequency Result

- **Model estimate: 1 ignition in 15 years**
- **PG&E: 1 rupture in 6 years, no ignition**

Proposed Mitigations

- **Critical Documents update**

- **HPR Replacement**

- **SCADA Visibility**

- **Overpressure Protection Enhancements**
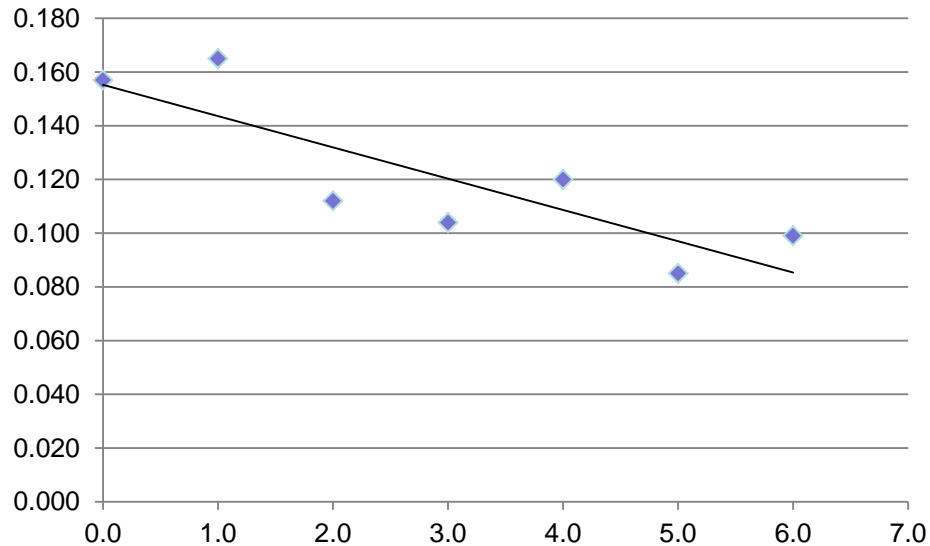 - Upgrade equipment @ 80 stations/year

Model Results

	Baseline-before	Mitigated-after	Annual average reduction
Overall TA MARS	12.07	10.3	15% (x6 yrs = 90%?)
Overall Safety TA MARS	4.47	3.26*	28%*
Injuries-natural units	1 in 1.5 years	1 in 2 years*	28%*
Fatalities-natural units	1 in 6 years	1 in 9 years*	28%*

*Based on RASA calculation from 10,000 model outcomes

Risk Reduction Trend

Mitigated Outcomes, fatalities, 6 years
Average reduction from start: 28%
Trended reduction from start: 43%

Risk Spend Efficiency

- **Overall RSE of 0.0185 MARS/Million**
- **$300 Million to continue programs '20-'22**
  - $280 million forecast '17-'19
- **Safety risk reduction 30%**
  - Fatality 1 in 9 years, from 1 in 6 years
  - Injuries 1 in 2 years, from 1 in 1.5 years
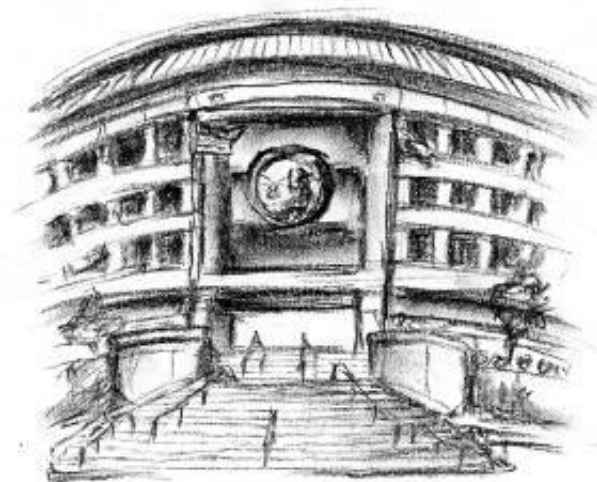 - $580 million adds 3 years to one life?

Conclusion

- **The RAMP Process was followed.**

- **Evaluation begs the questions:**
  - As Low As Reasonably Practical?
  - What is acceptable risk?

Questions?

Fred Hanes

Chapter 11 – Wildfire

Martin Kurtovich, P.E.

Presentation Overview

- **California's Wildfire Landscape**

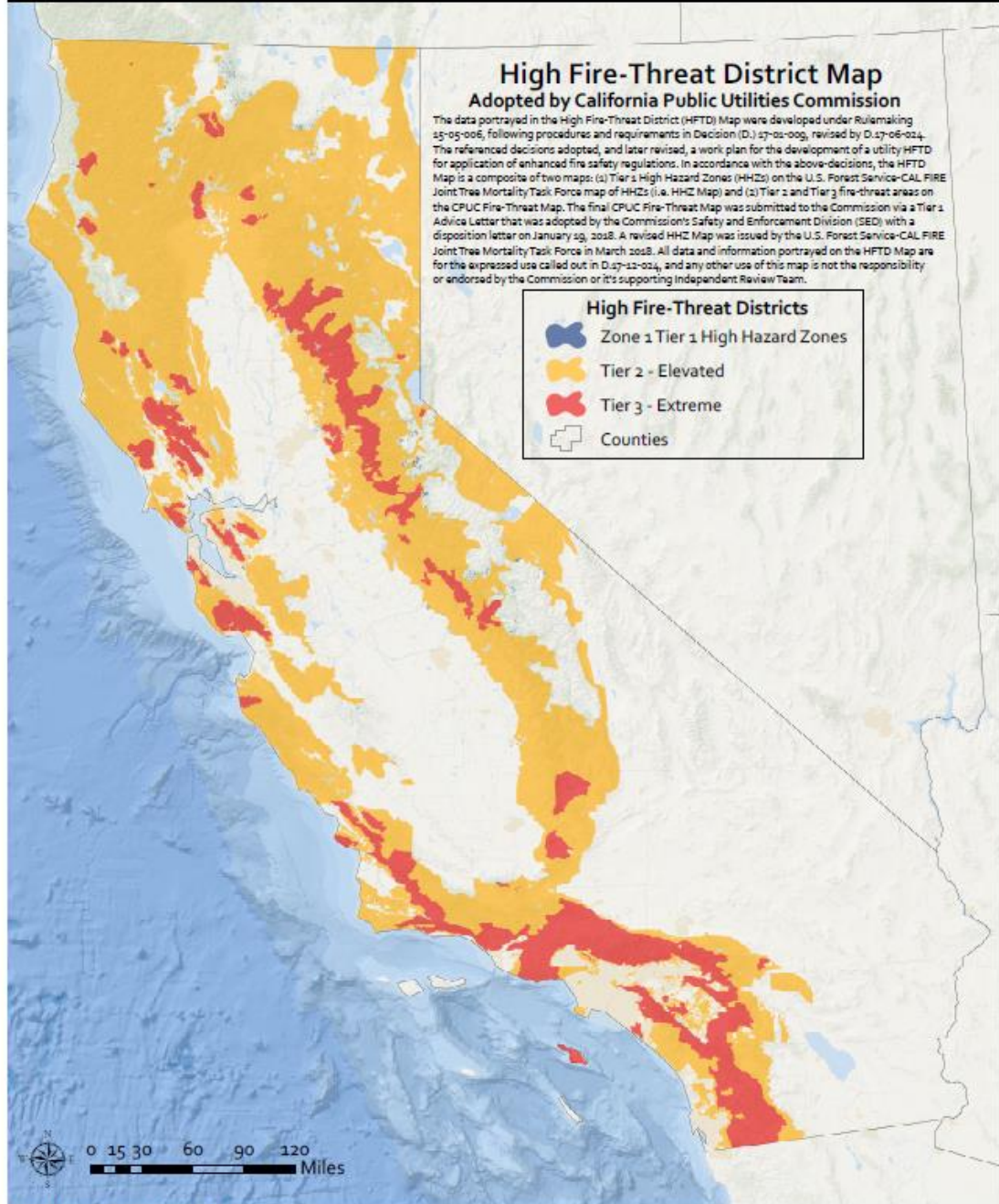- **2017 RAMP Report**

- **CPUC Review**

PG&E Risk Assessment

- **43,000 overhead distribution circuit miles (52% of total)**

- **9,000 overhead transmission miles (33% of total)**

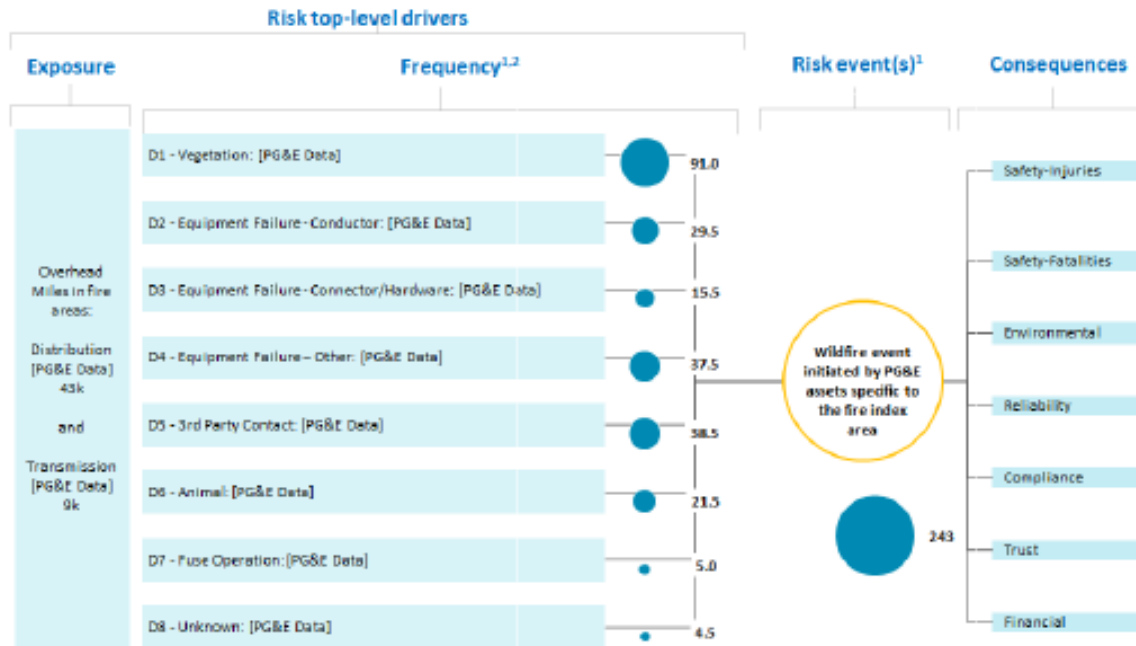- **T&D risks combined in risk modeling**

PG&E Wildfire Risk

PG&E-Defined Risk Drivers

- **Vegetation (37%)**
- **Conductor Failure (12%)**
- **Connector/Hardware Failure (6%)**
- **Other Equipment Failure (15%)**
- **Third Party Contact (16%)**
- **Animal (9%)**
- **Fuse Operation (2%)**
- **Unknown (2%)**

PG&E Wildfire Consequence Attributes

	Safety-Injuries	Safety-Fatalities	Environmental	Reliability	Compliance	Trust	Financial
Source	Calfire and NFIRS Data	Calfire and NFIRS Data	Calfire, PG&E & Pacific Union settlement Data	PG&E Data	NA	PG&E Data	PG&E and Claims Data
Consequence Distributions	Percent of wildfire events with an injury = 0.51% Percentage of events with injury or fatality = 0.62% Mean=1.14 (Poisson)	Percent of wildfire events with a fatality = 0.10% Percentage of events with injury or fatality = 0.62% Mean=0.23 (Poisson)	Ave # acres burned/wildfire event = 44 acres (exponential) x Cost per acre: Min = $855/acre Ave = $1,865/acre Max = $2,778/acre (Triangular)	Percentage of events resulting in outage = 95% Ave = 54k customer minutes (Exponential)		Dependent on Safety outcomes. If there are any fatalities= High severity brand favorability change If there are injuries without fatalities, 50/50 chance of Low or Severe High severity=12-20% Severe=5-12% Low=0-5% (Uniform)	Property: destroyed: Ave=0.392 Std Dev=1.454 Shift=0.018 (Lognormal) x Cost/property destroyed=$778k + Compensatory claims from safety events: Ave=$4.1M Std Dev=$3.3M Shift=$66k (Lognormal)
Outcome-TA-NU[1]	5.89	1.78	$27,649,728	14,791,813		18.5%	$125,436,835
Outcome-TA-MARS[2]	1.61	48.54	2.76	36.98		92.43	75.26
						MARS Total	**257.58**

[1] Ave of Year 1-6 Tail Ave outcomes in Natural units
[2] Ave of Year 1-6 Tail Ave outcomes in MARS units

PG&E Wildfire Mitigation Spending– 2016

Control	2016 Expense ($000)	2016 Capital ($000)	Total Spending($000) (% of Total)
1. Overhead Patrols & Inspections	20,521	-	20,521 (3%)
2. Veg Mgmt	435,792	-	435,792 (58%)
3. Non-Exempt Equipment Replacement	-	3,457	3,457 (<1%)
4. Overhead Conductor Replacement	-	31,858	31,858 (4%)
5. Animal Abatement	1,125	6,640	7,765 (1%)
6. Protective Equipment	-	47,744	47,744 (6%)
7. Overhead Equipment Replacement	20,084	77,717	97,801(13%)
8. Deteriorated Pole Replacement	13,964	98,693	112,657 (15%)
9. Wood Pole Bridging	46		46 (1%)
10. Design Standards	n/a	n/a	n/a
11. Restoration, Operational Procedures, Training	n/a	n/a	n/a

RAMP Mitigation Program 2017-2019

Four Wildfire Mitigations in RAMP Report

- **Wildfire Reclosing Operation Program in Tiers 2 & 3**
- **Replacement of Non-exempt Surge Arresters**
- **Expansion of Vegetation Management**
- **Overhang Clearing**

PG&E Wildfire Mitigation Budget 2017-2019

Control	2017-2019 Expense ($000)	2017-2019 Capital ($000)	Total Budget($000) (% of Total Budget)
Wildfire Reclosing Operation Program	1,000	50	1,050 (<1%)
Veg Mgmt	15,972	-	15,972 (11%)
Overhang Clearing	34,560	-	34,560 (24%)
Non-Exempt Surge Arrester Replacement	-	92,536	92,536 (64%)
TOTAL	**51,532**	**92,586**	**144,118**

Proposed RAMP Wildfire Mitigation 2020-2022

Continuation of 2017-2019 activities

- **Wildfire Reclosing Operation Program in Tiers 2 & 3**
- **Vegetation Management**
- **Overhang Clearing**
- **Replacement of non-exempt surge arresters**
- **Targeted Conductor Replacement**

PG&E Wildfire Mitigation Budget 2020-2022

Control	2020-2022 Expense ($000)	2020-2022 Capital ($000)	Total Budget($000) (% of Total Budget)
Wildfire Reclosing Operation Program	-	5,985 – 6,615	5,985 – 6,615 (<1%)
Veg Mgmt	19,167 – 28,749	-	19,167 – 28,749 (2 – 3%)
Overhang Clearing	41,472 - 62,208	-	41,472 - 62,208 (5 – 7%)
Non-Exempt Surge Arrester Replacement	-	131,325 – 145,149	131,325 – 145,149 (21 – 16%)
Targeted Conductor Replacement	-	571,824 – 632,016	571,824 – 632,016 (74 - 71%)
TOTAL	**60,639 – 90,957**	**709,134 – 793,780**	**769,773 – 884,737**

PG&E Wildfire Mitigation RSEs

#	Mitigation	TA RSE (Units/$M)	EV RSE (Units/$M)	Proposed Plan	Alternative 1	Alternative 2	WP #
M2	Wildfire Reclosing Operation Program	0.1007	0.0841	X	X	X	WP 11-2
M3	Fuel Reduction and Powerline Corridor Management	0.9496	0.7977	X		X	WP 11-7
M4	Overhang Clearing	0.3762	0.3160	X		X	WP 11-10
M5	Non-Exempt Surge Arrester Replacement	0.0470	0.0388	X	X	X	WP 11-13
M6	Targeted Underground Conversion	0.0058	0.0048			X	WP 11-17
M7	Targeted Conductor Replacement	0.0049	0.0041	X		X	WP 11-21
M8	Avian Mitigation for Wildfire Risk	0.0016	0.0013			X	WP 11-25
M9	Targeted Pole Replacement	0.0002	0.0002			X	WP 11-28

Cost by Plan

Proposed	76.97	NA	9.65E-08	0.0965	$ 797,683,138
Mitigation Name	MARS-TA-Risk score reduction	MARS-TA-Risk score reduction-RANK	MARS-TA-RSE (units / $) by mitigation	MARS-TA-RSE (units / $M) by mitigation	Total spend (all years)
Targeted Conductor Replacement	2.95	51	4.91E-09	0.0049	$ 601,920,000
Wildfire Reclosing Operation Program	0.63	90	1.01E-07	0.1007	$ 6,300,000
Overhang Clearing	32.50	15	3.76E-07	0.3762	$ 86,400,000
Fuel Reduction and Powerline Corridor Management	37.92	13	9.50E-07	0.9496	$ 39,930,000
Non-Exempt Surge Arrestor Replacement	2.96	50	4.70E-08	0.0470	$ 63,133,138

| Alternative 1	3.60	NA	5.18E-08	0.0518	$ 69,433,138
Mitigation Name	MARS-TA-Risk score reduction	MARS-TA-Risk score reduction-RANK	MARS-TA-RSE (units / $) by mitigation	MARS-TA-RSE (units / $M) by mitigation	Total spend (all years)
Wildfire Reclosing Operation Program	0.63	90	1.01E-07	0.1007	$ 6,300,000
Non-Exempt Surge Arrestor Replacement	2.96	50	4.70E-08	0.0470	$ 63,133,138

PG&E RAMP Review Findings

- **As noted by PG&E, Transmission and Distribution Wildfire Risks and Mitigations differ significantly, future risk assessments should separate the two asset classes**

- **Further risk model refinements should be more specific to local and regional conditions and infrastructure**
    - **Specific asset conditions should be further incorporated into risk modeling including conductor type and probability of failure, inspection results, and asset age**
    - **Specific environmental conditions including wind and location within HFTD should be incorporated into risk modeling**

- **Future risk assessments should incorporate efforts to implement new tools and mitigation techniques**

- **May be worthwhile to explore how to capture long-term benefits from mitigation measures**

- **PG&E's recently proposed Community Wildfire Safety Program will be considered as part of its GRC**

Questions?

Marty Kurtovich
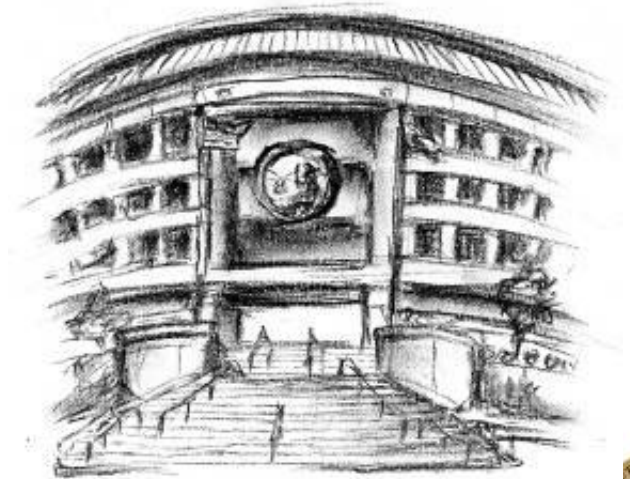
Chapter 14 – Contractor Safety

Chapter 14 - Risk

What is the Contractor safety risk?

It is "the failure to <u>identify</u> and <u>mitigate</u> occupational exposures that may result in contractor injury or illness that is fatal, life threatening or life altering."

Or it could be?

The risk event is a "Failure to fully implement pre-qualification and field oversight procedures may result in a contractor fatality, injury or illness that is life threating or life altering."

Chapter 14 - Specifics

- **MARS-EV-Overall Average-Total:**   **100.16**
- **MARS-EV-Proposed Plan-Overall Average Risk Score Reduction** **59.01 (59%)**
- **MARS-EV-Overall Average-Total-RANK:**   **5**
- **MARS-TA-Overall Average-Total:**   181.48
- **MARS-TA-Proposed Plan-Overall Average Risk Score Reduction** 86.54 (48%)
- **MARS-TA-Overall Average-Total-RANK:**   10

- **2016 Baseline Controls:**
- **Recorded control expense costs (000):**   **$952**
- **2017-2019:**
- **Current mitigation plan expenses (average) (000):** **$30**
- **2017-2019 (000):**
- **Proposed mitigation plan expense (average)(000):** **$983**
- **2020-2022 (000):**
- **Proposed mitigation plan expenses (average) (000):** **$1,778**

Chapter 14 – Specifics

Baseline (Expected Value) Injuries and Fatalities shown in the Model based on personnel count.

PGE - Time series data - expected frequency (count / year) - based on exposure						
	2017	**2018**	**2019**	**2020**	**2021**	**2022**
Personnel count	23721	23721	23721	23721	23721	23721
Total Injury Rate	**167.2**	**167.2**	**167.2**	**167.2**	**167.2**	**167.2**
Total Fatality Rate	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**

Baseline outcome determination						
Probability distribution definition - mitigations						
PGE Major incidents (count / year) - based on exposure						
Annual Reduction %	55.1%	55.1%	56.9%	64.0%	64.0%	64.0%
Total Injuries	**76.8**	**76.8**	**73.9**	**62.3**	**62.3**	**62.3**
Total Fatalities	**0.9**	**0.9**	**0.9**	**0.7**	**0.7**	**0.7**

Net Expected Injuries and Fatalities Mitigated:

Injuries	**90.4**	**90.4**	**93.3**	**104.9**	**104.9**	**104.9**
Fatalities	**1.1**	**1.1**	**1.1**	**1.3**	**1.3**	**1.3**
Proposed Plan	$ 66,829	$ 1,173,085	$ 1,709,240	$ 1,844,622	$ 1,724,386	$ 1,760,961

Chapter 14 – Controls

1. **Standardized contract terms and conditions**
2. **Pre-Qualification**
3. **Safety standards and LOB oversight procedures**
4. **Safety plans**
5. **Hazard analysis**
6. **Safety oversight**
7. **Compliance assessments (140 out of ???)**
8. **CAP for contractor issues**
9. **Post-Job safety performance review**

Chapter 14 – 2017-2019 Mitigations

1. SIF incident governance and oversight
2. Safety officer requirement criteria
3. Criteria for requiring CAP
4. Third party (ISN) analysis of contractor "rapid" growth
5. Automation of pre-qualification process
6. OSHA training – ensure employees are trained and qualified to oversee work
7. Standard safety plan and job safety analysis templates
8. Communication process for specific hazards

Chapter 14 – 2020-2022 Mitigations

1. **Governance (M9) – 46.4% Risk Reduction (RR)**

2. **Contractor Knowledge (M10) – 5.9% Risk Reduction**

3. **Contractor Process Improvements (M11 – A, B, & C):**

   A. 16% RR = a) SOW alignment, b) supplier incentives, c) MV record and Training, d) Work Permits for critical activities, and e) process for work change orders.

   B. 2% RR = a) ~~SOW alignment~~, b) supplier incentives, c) MV record and Training, d) Work Permits for critical activities, and e) process for work change orders.

   C. 2% RR = a) ~~SOW alignment~~, b) supplier incentives, c) ~~MV record and Training~~, d) Work Permits for critical activities, ~~and e) process for work change orders.~~

4. **Tools and Tech (M12) – 11% risk reduction**

Chapter 14 - Strengths

Mitigations intuitively make sense and focus on:

- **Governance – standardization, procedural framework, processes improvement, safety/work planning, oversight, and contractor feedback.**
- **Improve contractor work methods and work planning, and evaluating contractors;**
- **Contractor training and education.**

The model appears to work as intended.

Chapter 14 – Areas for Improvement

2. A general lack of transparency

3. Modeling input assumptions appear to inflate the output

- – Combining different data sets which increase the average injuries used in the model
- – Lack of explanation for these choices which impact model outputs.

Chapter 14 – Areas for Improvement

4. Data not properly vetted.

– Inaccurate data used in model due to undetected source errors.

– 23,721 vs. 22,701; 10 vs 12 month's average hours.

5. Choice of data sets not explained.

– Use of a 2-year data set when it appears a 5-year set was available.

- Chapter narrative says: 2 fatality and 149 injuries average 2012-2016 (5-year span).
- Model used 1-year contractor only plus 1-year contractor and subcontractor data. A 2-year average of disparate data.

– Lack of explanation for these choices which impact model outputs.

Chapter 14 – Areas for Improvement

6. Lack of context and frame of reference to controls and existing mitigations.

– PG&E explicitly noted that it had not scored the controls within the RAMP report.

– There may be similar issues to scoring the controls as with mitigations et al.

– Without a frame of reference understanding the relevance of mitigation scores becomes difficult.

7. Secondary impacts from subcontractor performance.

– Trust & Environmental - No impacts included in the data set of past incidents.

– Financial - Costs associated with injuries/fatalities subsumed by contractor.

Chapter 14 – Areas for Improvement

9. Confusing mitigation cost presentation.

- – M9-M12 Costs apparently missing from Table 14-2.
- – Model shows active mitigations during 2017-2022.

Frequency Mitigation						
Start year	2017	2017	2017	2020	2019	2019
Duration	6	6	6	3	4	4
Final effectiveness percentage	100%	100%	100%	100%	100%	100%

These appear to Equate to M9-M12:

	Contractor Governance	Tools and Technology	Contractor Knowledge	Contractor Process Improvements-A	Contractor Process Improvements-B	Contractor Process Improvements-C	Total
O&M	$5,931,604.0	$245,895.0	$109,725.0	$762,936.0	$533,150.0	$695,813.0	$ 8,279,123
2017	$66,829.0	$0.0	$0.0	$0.0	$0.0	$0.0	$ 66,829
2018	$1,087,331.0	$49,179.0	$36,575.0	$0.0	$0.0	$0.0	$ 1,173,085
2019	$1,178,961.0	$49,179.0	$0.0	$0.0	$209,750.0	$271,350.0	$ 1,709,240
2020	$1,240,561.0	$49,179.0	$36,575.0	$255,544.0	$107,800.0	$154,963.0	$ 1,844,622
2021	$1,178,961.0	$49,179.0	$0.0	$253,696.0	$107,800.0	$134,750.0	$ 1,724,386
2022	$1,178,961.0	$49,179.0	$36,575.0	$253,696.0	$107,800.0	$134,750.0	$ 1,760,961

|	Contractor Governance	Tools and Technology	Contractor Knowledge	Contractor Process Improvements-A	Contractor Process Improvements-B	Contractor Process Improvements-C	2017-2019 Average
Check	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	$ 983,051

Chapter 14 – Conclusion

- **Heavy influence of SME judgement in each chapter make it difficult to compare risk scores because the risks are not scored on the same footing.**

- **An objective review of chapter inputs and outputs should be performed to ensure integrity of assumptions and data.**

- **Strive for narrative consistency to reduce confusion.**

- **Undertake scoring the controls and existing mitigations acting on the risks to better understand the iterative impact of proposed mitigations.**

Questions?

Ed Charkowicz
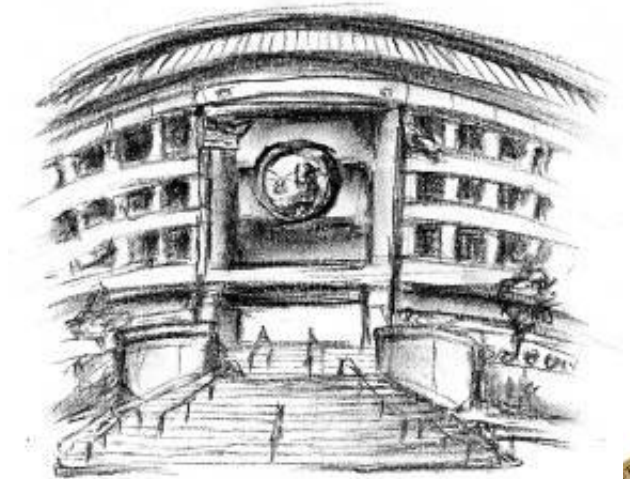
Motor Vehicle Safety
Chapter 16

Amy Chamarty

Motor Vehicle Safety

MARS Expected Value Rank: 4
MARS Tail Average Rank: 8

In the past 3 years PG&E has experienced 1 death and 87 serious injuries due to motor vehicle incidents.

January 2018 – A white minivan pulled in front of this PG&E truck. To avoid a head-on collision with a semi-truck the driver collided with a PG&E pole.

Motor Vehicle Safety

What is Motor Vehicle Safety Risk?

The failure to identify and mitigate motor vehicle incident exposures that may result in serious injuries or fatalities for employees or the public, property damage, and other consequences.

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Motor Vehicle Safety

What is an incident?

TRAFFIC SAFETY FACTS
Crash • Stats

U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
www.nhtsa.gov

DOT HS 812 115   A Brief Statistical Summary   February 2015

Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey

Summary

The National Motor Vehicle Crash Causation Survey (NMVCCS), conducted from 2005 to 2007, was aimed at collecting on-scene information about the events and associated factors leading up to crashes involving light vehicles. Several facets of crash occurrence were investigated during data collection, namely the pre-crash movement, critical pre-crash event, critical reason, and the associated factors. A weighted sample of 5,470 crashes was investigated over a period of two and a half years, which represents an estimated 2,189,000 crashes nationwide. About 4,031,000 vehicles, 3,945,000 drivers, and 1,982,000 passengers were estimated to have been involved in these crashes. The critical reason, which is the last event in the crash causal chain, was assigned to the driver in 94 percent (±2.2%)[†] of the crashes. In about 2 percent (±0.7%) of the crashes, the critical reason was assigned to a vehicle component's failure or degradation, and in 2 percent (±1.3%) of crashes, it was attributed to the environment (slick roads, weather, etc.). Among an estimated 2,046,000 drivers who were assigned critical reasons,

crash envelope that comprises of a sequence of events, referring to the above data elements, which eventually led to the crash.

This Crash•Stats presents some statistics related to one of the four data elements, namely "critical reason for the critical pre-crash event." The data obtained through the sample of 5,470 NMVCCS crashes and the weights associated with them were used to obtain national estimates of frequencies and percentages along with their 95-percent confidence limits, as presented in the following sections.

Critical Reasons for the Critical Pre-Crash Event

The critical reason is the immediate reason for the critical pre-crash event and is often the last failure in the causal chain of events leading up to the crash. Although the critical reason is an important part of the description of events leading up to the crash, it is not intended to be interpreted as the cause of the crash nor as the assignment of the fault to the driver, vehicle, or environment.

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Motor Vehicle Safety

Getting back to the definition…

> The failure to identify and mitigate motor vehicle ~~incident~~ crash exposures that may result in serious injuries or fatalities for employees or the public, property damage, and other consequences.

The definition is still hard to follow.

Motor Vehicle Safety

PG&E should define risks in a more straightforward, easy to understand way, such as:

Motor vehicle accidents that may result in serious injuries or fatalities for employees or the public, property damage, and other consequences.

Motor Vehicle Safety – Risk Drivers

- **D1 – Equipment: Equipment failures are incidents due to the failure of the**

vehicle, or part of the vehicle such as, flat tires and brake failures.

  - 2 percent of incidents resulting in an estimate of 45 events.

- **D2 – Human Errors: Human errors are incidents resulting from human**

mistakes for reasons such as internal and external distractions, driving too fast, overcompensation, and non-performance errors such as sleep.

  - 94 percent of MVS incidents resulting in an estimate of 2,121 events.

- **D3 – Outside Forces: Outside forces are incidents related to factors**

outside the driver's control such as roadway design, and atmospheric conditions such as slick roads.

  - 4 percent of incidents are caused by outside forces resulting in an estimate of 90 events.

Motor Vehicle Safety – Risk Drivers

- **Strengths:**
    - Risk driver data is drawn from a large, publicly available data set. It includes data from over 2 million crashes over two years.
    - The drivers are clearly described and easy to understand. They don't match the Department of Transportation descriptions, but PG&E simplified them in a way that makes sense.

Motor Vehicle Safety – Areas for Improvement

Alternatives:

- **M11 – Emerging Incident Reduction Technology: This technology is focused on human error and is similar to back-up cameras and lane drift detection.**

- **M12 – Emerging Impact Reduction Technology: This technology is similar to airbags and would reduce the severity of injuries.**

These technologies do not exist yet, so PG&E did not select them as part of their mitigation plan.

Describing alternatives that are completely infeasible is not meeting the spirit of the decision.

Motor Vehicle Safety – Areas for Improvement

Comparing Risk Spend Efficiencies:

Mitigation	TA RSE	Cost (000s) Over RAMP Time Period	Reduction in Human Error Incidents
Deploy Vehicle Safety Technology in Personal Vehicles	6.5	$487-539 (capital) $1,962-2,170 (expense)	25%
Driver Selection Program	277.8	$231-255 (expense)	25%

The model reveals that the RSE differences are driven by miles driven.

Mitigation

Mitigation List*
Mitigation active?

TRUE	TRUE

Exposure this applies to (miles) in the first year?

34730000	138920000

Percent of base year mileage

23.0%	92.0%
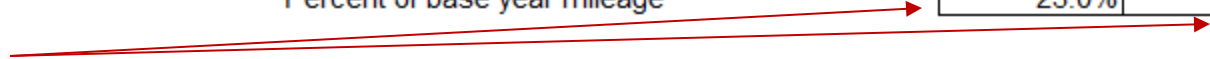
	Deploy Vehicle Safety Technology in Personal Vehicles	Driver Selection Program
Left hand side of bow tie		
Incidents attributable to equipment		
Incidents attributable to human error	25.00%	25.00%
Incidents attributable to outside forces		
Right hand side of bow tie		
Safety1_Injury		
Safety1_Fatality		
Environmental		
Reliability		
Compliance		
Trust		
Financial		

Time series data for mitigation

| Cover | Globals | **MVSInput** | MVSCalc | ManualRiskCompound | O |

Motor Vehicle Safety - Conclusions

- Risk definitions should be straightforward and easy to understand. Any terms within the risk should be defined.

- The risk drivers were easy to understand and drew from a large dataset. From this data, we could see where mitigations would have the most impact.

- PG&E should include alternatives that are feasible, not technologies that don't exist today.

- PG&E should include more data in the report or in the workpapers to clearly indicate why certain RSEs are higher or lower.

Questions?

Amy Chamarty
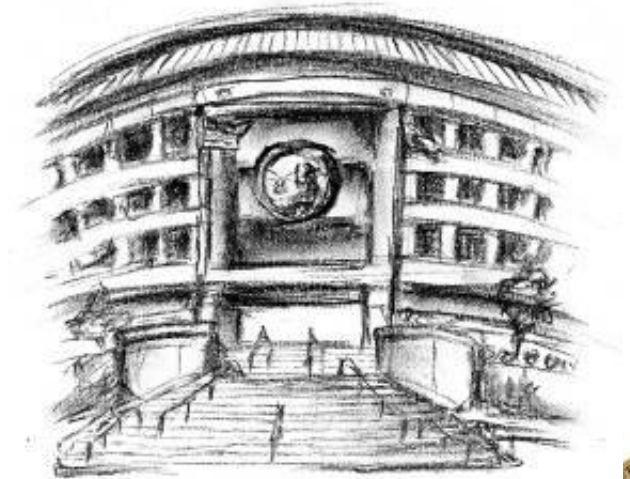
Chapter 22 – Climate Resilience

Arthur O'Donnell

Climate Resilience

PG&E defines Resilience as: "actions to be taken related to infrastructure, operations, employees and customers to mitigate against the potential consequences of and adapt to a changing climate and associated weather patterns."

In effect, this is both defined and treated differently than other RAMP risks and in a different manner than other utilities.

Each utility has a distinguishable set of adaptation actions and strategies which lead to very different proposals for potential mitigations and expected costs.

Climate Resilience

Six Drivers - Multipliers

- Rising Sea Levels
- Major Storm Events
- Increased Temperatures and Heatwaves
- Wildfires
- Drought
- Subsidence

Other weather events (e.g.. Ice storms, noted by less confidence in impacts.)

11 Related Risks/Exposures

- Distribution Overhead Conductors
- Transmission Overhead Conductors
- Gas Storage Wells Failure
- Failure to Meet Capacity Needs
- Gas C&P Failure
- Gas M&C Failure
- Transmission Pipe Rupture/Ignition
- **Hydro System Safety**
- Motor Vehicle Safety
- Employee Safety
- Contractor Safety

Climate Resilience

In contrast to other Risks identified for this GRC cycle, PG&E conducted analysis for two differing time periods and two scenarios for each:

- Near Term 2022

- Longer Term 2050

This approach successfully addresses SED's previously expressed concerns that utilities should begin to address potential climate impacts now, rather than view it as a long-term issue. However, it must be recognized that there is a great deal of uncertainty about changes in likelihood of events or consequences. One way PG&E tried to deal with this was using 25,000 Monte Carlo runs instead of 10,000.

Climate Resilience

There is a fairly wide range of MARS scoring attributable:

- 19.08 to 80.41 Mean in 2022

- 592.43 – 665.33 Tail Average in 2022

- 76.06 – 226.57 Mean in 2050

- 658.8 – 845.01 TA in 2050

A surprising result in an assessment of safety consequences, even in the near-term of 2022:

- *"PG&E could experience … an additional 25 – 129 injuries and 1 -3 fatalities per year due to climate change impacts, and in 2050, as additional 66 – 173 injuries and 2 -3 fatalities…."*

Climate Resilience

Mitigations

In the near term, PG&E's mitigation plan has to be considered "foundational", focused on improving analytical capabilities rather than altering operations or increasing capital expenditures to harden systems against climate impacts.

Current controls are mainly about emergency response and developing measurement tools.

This continues in the 2020-2022 period "to create knowledge, tools and a platform" to apply mitigations to lines of business in the future.

Projections are for expenditures of less than $1 million per year though 2022.

Climate Resilience

Alternatives

Alternatives are largely "More of or Less of" in terms of accelerating or slowing down responses – no real alternative options were presented.

Climate Resilience

Risk Spend Efficiency – PG&E can discern no expected quantifiable risk reduction in the foreseeable future, so it did not compute RSE.

Climate Resilience

Areas for Improvement

There could be a better understanding of how Climate risks contribute to the 11 other risk areas identified by PG&E. The concept of Climate Change as a "force multiplier" is well accepted (even by the US Military), but it could use additional fleshing out as it pertains to utility systems.

PG&E promised additional "deep dive" analysis of areas including sea-level rise, which could be important for better analyzing issues related to substations near coastal areas, undergrounded facilities and possibly pipeline networks.
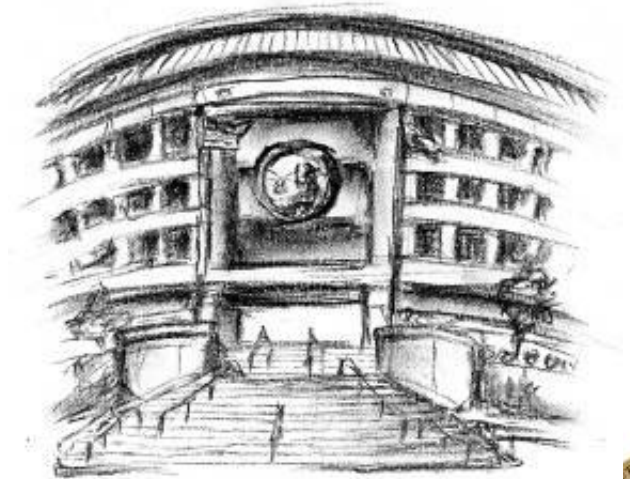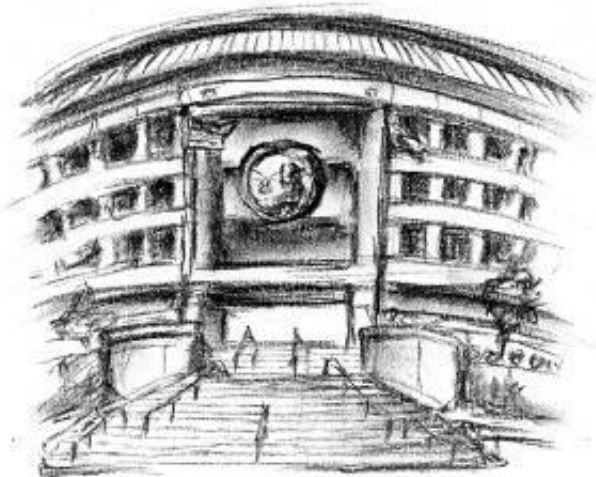
Questions?
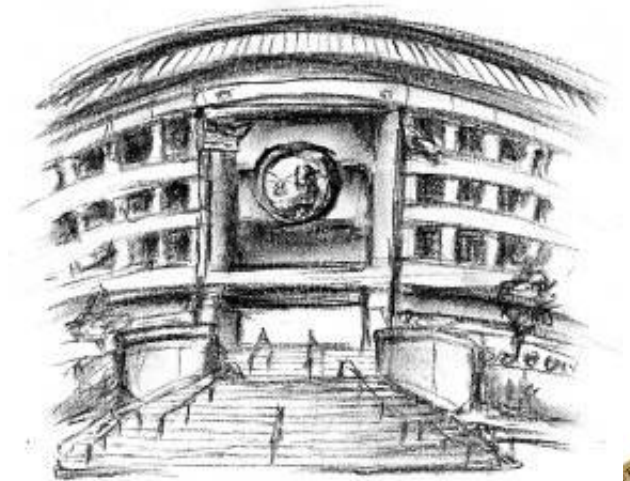
Arthur O'Donnell

PG&E Response

Janaize Markland

Next Steps

Arthur O'Donnell

Thank You

For Additional Information:

www.cpuc.ca.gov/RiskAssessment