BEFORE THE OFFICE OF ENERGY INFRASTRUCTURE SAFETY

OF THE STATE OF CALIFORNIA

OPENING COMMENTS OF THE UTILITY REFORM NETWORK ON THE 2022 WILDFIRE MITIGATION PLANS

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Regarding PG&E's proposal to significantly expand distribution system undergrounding, beginning in 2022 and accelerating in 2023-2026:

1. Energy Safety should find that no more than 17% (and likely less) of PG&E's proposed undergrounding mileage for 2022 is cost-effective. PG&E should be required to modify its Wildfire Mitigation Plan (WMP) to reduce the scope of its 2022 undergrounding proposal to 17% of the 175 miles proposed in the WMP, or 30 miles. The only exception to this limit should be for additional miles that are not cost-effective, but need to be included in a project to avoid gross inefficiency, such as undergrounding a short segment in a tranche with a Benefit/Cost (B/C) ratio below 1.0 that falls between two larger segments with B/C ratios above 1.0. PG&E should be required to justify any undergrounding of mileage that falls within a tranche with a Benefit/Cost (B/C) ratio below 1.0 by demonstrating that the work was needed to avoid gross inefficiency.

2. Energy Safety should direct PG&E, in its 2023 WMP, to demonstrate that, using a risk analysis that includes the modifications set forth in Recommendations 5 and 6 below and that otherwise meets the requirements of the CPUC's D.18-12-014 Settlement, any undergrounding work proposed for 2023 will be performed in a tranche with a B/C ratio above 1.0. If PG&E proposes to underground any mileage that falls within a tranche with a B/C ratio below 1.0, it should be required to demonstrate that such work is needed to avoid gross inefficiency.

Regarding PG&E's proposal for continued enhanced vegetation management (EVM) work in 2022, an over $900 million program:

3. Energy Safety should find that no more than 1% of PG&E's proposed EVM mileage for 2022 is cost-effective. PG&E should be required to modify its WMP to reduce the scope of its 2022 undergrounding proposal to 1% of the 1,800 miles proposed in the WMP, or 18 miles. The only exception to this limit should be for additional miles that are not cost-effective, but need to be included in a project to avoid gross inefficiency, such as performing EVM on a short segment in a tranche with a B/C ratio below 1.0 that falls between two larger segments with B/C ratios above 1.0. PG&E should be required to justify any EVM work that falls within a tranche with a B/C ratio below 1.0 by demonstrating that the work was needed to avoid gross inefficiency.

4. Energy Safety should direct PG&E, in its 2023 WMP, to demonstrate that, using a risk analysis that includes the modifications set forth in Recommendations 5 and 6 below and that otherwise meets the requirements of the CPUC's D.18-12-014 Settlement, any EVM work proposed for 2023 will be performed in a tranche with a B/C ratio above 1.0. If PG&E proposes to apply EVM to any mileage that falls

within a tranche with a B/C ratio below 1.0, it should be required to demonstrate that such work is needed to avoid gross inefficiency.

Regarding required improvements to PG&E's risk analysis for its 2023 WMP:

5. Energy Safety should require PG&E to make the following changes to its multi-attribute value function (MAVF), as described in Section III(C) of the Appendix to these comments:

    a. Adopt the attribute ranges and weights shown in the table below;

	PG&E MAVF		TURN RECOMMENDED MAVF	
Attribute	Range	Weight	Range	Weight
Safety	0 – 100 EFs	50%	0 – 500 EFs	40%
Electric Reliability	0 – 4 billion CMI	20%	0 – 4 billion CMI	24%
Gas Reliability	0 – 750,000 customers	5%	0 –750,000 customers	6%
Financial	0 – $5 billion	25%	0 – $5 billion	30%

    b. Use a linear scaling function for the Safety and Financial attributes.

6. Energy Safety should require PG&E to base its RSE analysis on tranches that are significantly more granular than the tranches used for the 2023 GRC and that meet the requirements of the CPUC's S-MAP Settlement that each tranche consist of assets with homogenous risk profiles, *i.e.*, have reasonably similar LoRE and CoRE values. TURN recommends as an initial starting point tranches with no more than 100 overhead circuit miles for the utility's HFTD, a standard already met by PG&E's risk prioritization model for risk posed by electric equipment.

Regarding requirements for future WMPs submitted by all large investor-owned utilities (IOUs):

7. With regard to Table 12 (Mitigation Initiatives Financials) of the required attachments to WMPs, Energy Safety should clarify that the IOUs shall provide the required information, including RSEs and initiative cost data, for each listed initiative in the Energy Safety template and not provide combined information that aggregates multiple rows. The only exception should be if, for a given cell in the Energy Safety template, an IOU provides an explanation demonstrating that it is unable to provide the information at the required level of specificity.

OPENING COMMENTS OF THE UTILITY REFORM NETWORK ON THE 2022 WILDFIRE MITIGATION PLANS

The Utility Reform Network ("TURN") submits these comments on the 2022 Wildfire Mitigation Plans (WMP) submitted by the large investor-owned energy utilities ("IOUs"). TURN's comments focus on the Pacific Gas and Electric Company ("PG&E") WMP but one of its recommendations applies equally to all three IOUs.

I. INTRODUCTION AND SUMMARY

Energy Safety and the California Public Utilities Commission (CPUC) have a shared responsibility to ensure that only cost-effective wildfire mitigation work is approved. Risk cannot be reduced to zero, and ratepayers should not be expected to pay even higher electric rates for programs that deliver insufficient safety benefits to justify the costs. Both Energy Safety and the CPUC must not lose sight of the fact that affordable electricity is crucial to California's urgent goal of decarbonizing our economy, particularly to electrify the transport and building sectors which today rely primarily on fossil fuels. Needless to say, if a significant portion of California's population cannot afford rapidly escalating electric rates, that transition will be defeated. If California fails to set a national and international example in achieving its greenhouse gas reduction goals, climate change will accelerate, and wildfires – whether or not ignited by utilities -- will only become more numerous, more intense and even more of a threat to California's residents and environment.

These comments will show that most of the work proposed under two of PG&E's largest and most costly wildfire mitigation programs for 2022 is not cost-effective and a poor use of limited ratepayer funding. Those two programs are: (1) PG&E's new, aggressively expanded undergrounding plan and (2) its established enhanced vegetation management (EVM) program.

Most of PG&E's proposed work in these programs is not cost-effective because, even when the full measure of anticipated risk reduction benefits from these programs are taken into account – including reduced fatalities and injuries, reduced customer outages, and reduced financial harm to ratepayers, businesses, and the general public – those benefits do not exceed the costs for a large portion of the work proposed by PG&E.[1]

These conclusions regarding the cost-effectiveness of PG&E's programs are based ***on the utility's own data*** from its General Rate Case (GRC) now pending before the CPUC. As a result of a Settlement adopted by the CPUC in Decision (D.) 18-12-014, PG&E and the other large IOUs are required to use a prescribed, rigorous methodology to quantify the risk spend efficiency (RSE) – risk reduction divided by cost – for risk mitigation initiatives proposed in their GRCs. A key element of that methodology, championed by TURN before the CPUC, is the use of a properly constructed multi-attribute value function (MAVF) to calculate the consequences of risk events. In the Appendix to these Comments, Dr. Jonathan Lesser, one of the two TURN experts who supported TURN's advocacy of the methodology adopted in D.18-12-014, explains some of the key features of the methodology, including the ability to express any RSE value as an equivalent Benefit/Cost (B/C) ratio. He also explains the importance of the D.18-12-014 Settlement's requirement that RSEs be provided at a granular "tranche" level, where tranches consist of groups of assets with homogenous risk characteristics.

The RSE-related data supporting PG&E's GRC request is far more detailed than the limited and highly aggregated RSE information that PG&E provides in its WMP. Energy Safety

[1] These conclusions assume that PG&E's programs are implemented in a risk-informed manner, which the utility failed to do in 2019 and 2020 for its costly EVM program. Despite these implementation failures, PG&E has sought to pass on exorbitant cost overruns of this program to ratepayers. *See* PG&E Wildfire Memorandum and Catastrophic Event Applications before the CPUC, A.20-09-019 and A.21-09-008.

should look closely at this data, while recognizing that PG&E's analysis has flaws that overstate the cost-effectiveness of its wildfire mitigation programs. TURN corrects some of those flaws, as explained in Appendix A, in the RSEs and B/C ratios presented in these comments, but other problems, including insufficiently granular tranches, mean that even TURN's corrected values are still likely to exaggerate the scope of PG&E's proposed mitigations that are cost-effective.

Based on PG&E's RSE data, as corrected by TURN, Section II of these Comments shows that ***only 17% of PG&E's proposed undergrounding work for 2022 would be cost-effective***. (Even without TURN's corrections, PG&E's calculations show that only one-third of its proposed undergrounding miles would be cost-effective.) The data show a similar pattern for PG&E's significantly ramped-up undergrounding proposal for the period 2023-2026. With TURN's corrections (which, as noted, still do not correct all of the flaws that overstate cost-effectiveness), only 33% of the proposed work for 2023-2026 would be cost-effective.

PG&E's proposed EVM program for 2022 has cost-effectiveness scores that are even worse than the undergrounding program. With TURN's corrections, ***less than 1% of PG&E's total proposed EVM miles for 2022 are cost-effective***. (Under PG&E's calculations without TURN's corrections, only 2.9% of the proposed work would be cost-effective.) Even though PG&E claims that it will prioritize its EVM work in high-risk areas, PG&E's RSE data shows that PG&E is now trying to push this program into relatively less risky parts of its system for which the limited risk reduction benefits do not justify the costs.

Although PG&E clearly did not find it in its interest to provide this information in its WMP, Energy Safety cannot ignore it. Now is the time for Energy Safety to make clear to PG&E and the other large IOUs that it will not allow California's affordability, equity, and climate goals to be derailed by unduly bloated programs that will not deliver sufficient risk reduction to

justify the cost. Indeed, Energy Safety must ask itself a fundamental question – how have the utilities, in particular PG&E, utilized the results of the increasingly sophisticated risk modeling to maximize safety benefits and minimize costs of WMPs? No matter the cost or performance of its system hardening and EVM programs, PG&E continues down the path of reckless spending in the name of safety. Energy Safety must call this out, and direct utilities to focus on targeted, cost-effective initiatives and limit programs such as undergrounding and EVM to only those parts of PG&E's system where the risk reduction benefits exceed the costs. TURN urges Energy Safety to adopt the recommendations presented in these Comments.

II. PG&E MUST BE DIRECTED TO FOCUS ITS COSTLY UNDERGROUNDING PROGRAM ON THE SMALL SUBSET OF MILES WHERE THIS MITIGATION WOULD BE COST-EFFECTIVE

A. PG&E's New Proposal for a Massive and Costly Undergrounding Program Needs Careful Scrutiny Before It Can Be Sanctioned by PG&E's Regulators

This is PG&E's first WMP in which it proposes a new undergrounding program that would aggressively expand the undergrounding of overhead distribution lines. PG&E proposes to complete at least 175 circuit miles of undergrounding work in 2022,[2] as the beginning of a 10-year proposal to underground 10,000 circuit miles of distribution powerlines.[3] PG&E is proposing to ramp up its undergrounding mileage quickly, with a plan to complete approximately 1,375 miles of undergrounding within 3 years,[4] and to continue steep year-to-year increases in undergrounding mileage in 2025 and 2026.[5]

[2] PG&E WMP, p. 9.
[3] PG&E WMP, p. 249.
[4] PG&E WMP, p. 250.
[5] PG&E WMP, p. 528, Figure 7.3.3-2.

PG&E does not provide a separate cost for its undergrounding proposal in Table 12 in the required attachments to its WMP,[6] even though Energy Safety's template has a separate line item for undergrounding of electric lines and/or equipment.[7] Instead, PG&E provides a combined cost for multiple grid hardening programs, including undergrounding and covered conductor, under Initiative 7.3.3.17.1. However, from PG&E's updated 2/25/22 testimony in its pending GRC, one can see how PG&E's new undergrounding proposal will increase its already high grid hardening costs, adding $100 million in 2022, $600 million in 2023, $1.7 billion in 2024, and ramping up to $2.6 billion of additional spending in 2026.[8] Furthermore, as shown in Table 2 (discussed in Section II(B) below), PG&E's Excel workpapers it its GRC show a net present value cost to ratepayers of almost $650 million, just for PG&E's comparatively modest 2022 undergrounding proposal.[9]

Now is the time for Energy Safety to provide direction to PG&E about the acceptable scope of this program. Left to its own devices, PG&E would make its 10,000 mile undergrounding idea a key part of its future planning. PG&E is clearly already devoting considerable time and resources to execution of its 10,000 mile plan well beyond 2022. However, at this point, PG&E's new undergrounding proposal is just that, a proposal, one that needs the approval of both of the relevant regulators, Energy Safety and the CPUC. While PG&E clearly views its proposal as serving the interests of the company and its shareholders, it is the responsibility of Energy Safety and the CPUC to ensure that the proposal is in the public

[6] 2022-02-25_PGE_2022_WMP-Update_R0_Section 7.3.a_Atch01_R1, tab "Table 12" (hereinafter "Table 12").

[7] OEIS, 2022 WMP Update Guidelines, Final Attachment 2, p. 75, item 27.

[8] GRC Ex. PG&E-4, p. 4-28, Table 4-6.

[9] Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," columns X + AF.

interest. This process will largely occur at the CPUC which will examine the merit of PG&E's proposal for the 2023-2026 timeframe. However, as a key stakeholder in an ecosystem where the regulators need to be delivering consistent messages to the utilities, Energy Safety must also signal that it will not sanction the reduction of risk at any cost and that it will carefully scrutinize the cost-effectiveness of utility wildfire mitigation proposals through rigorous processes in the coming years.

B. Even PG&E's Flawed and Exaggerated RSE Values Do Not Support PG&E's Massive Expansion of Undergrounding

As noted, PG&E's Table 12 in its WMP attachments does not provide a separate RSE for undergrounding, but rather a bundled RSE for its combined grid hardening program, including covered conductor.[10] The statistic is therefore rendered meaningless. In addition, PG&E provides this bundled RSE at a high level of aggregation, broken down only by HFTD tier (the sum of which consists of 25,500 overhead distribution miles, split mostly among Tier 2 and Tier 3)[11] shown in Table 1.

Table 1: PG&E 2022 System Hardening RSEs Reported in the WMP[12]

Initiative	Territory-wide RSE	Non-HFTD RSE	HFTD Zone 1 RSE	HFTD Tier 2 RSE	HFTD Tier 3 RSE
System Hardening – 7.3.3.17.1	5.535	0	0.062	5.800	4.146

[10] TURN notes that the OEIS template for Attachment 3, Table 12 has a separate line for undergrounding, initiative 7.3.3.16. TURN is not aware that OEIS authorized utilities to decline to provide the required RSE information for each line in the table.

[11] GRC Ex. PG&E-4, p. 3-21; PG&E WMP Attachments, Table 8.

[12] Source: 2022-02-25_PGE_2022_WMP-Update_RO_Section 7.3.a_Atch01_R1, Table 12.

However, pursuant to the CPUC's requirements for RAMP and GRC submissions under the D.18-12-014 S-MAP Settlement, PG&E has provided somewhat more detailed undergrounding-specific information in the Excel workpapers supporting its GRC request covering the years 2023-2026. PG&E has updated that RSE-related information based on its 2/25/22 WMP and revisions to its proposed wildfire mitigation strategy. TURN will present that more detailed data in these comments, with the caveat that TURN views these GRC values as flawed in a way that exaggerates the cost-effectiveness of PG&E's proposal. (As discussed below, TURN is able to correct some, but not all of these flaws.) Still, PG&E's GRC RSEs are far more useful than what PG&E has presented in its WMP.

Table 2 below summarizes the RSE information presented by PG&E in its GRC for its proposed undergrounding program for the year 2022. TURN provides the information at the level of the most granular tranches identified by PG&E, generally listing the tranche RSEs in descending order, *i.e.* from the highest-RSE tranches to the lowest. For each tranche, the table shows the total number of miles in the tranche, the miles that PG&E proposes to underground, the net present value (NPV) cost of and units of risk reduction from the proposal, and the RSE. The table also includes the Benefit/Cost (B/C) Ratios that can be readily derived from the RSEs, as explained in the Appendix A to these comments.[13] It is important to recognize, as discussed in Appendix A, that the RSEs and B/C ratios incorporate all types of risk reduction benefits identified by PG&E, including all reductions to safety, reliability and financial risks that PG&E believes the mitigation will accomplish.[14] Assuming the B/C ratios are derived from properly

[13] Appendix, pp. 15-16 and Attachment 1. As explained in the Appendix (Section IV), under PG&E's MAVF, the B/C ratio is simply the RSE divided by 5. Under the TURN MAVF, dividing by 6 provides the B/C ratio.

[14] As noted in the Appendix, p. 4, fn.3, the CPUC's risk assessment methodology does not allow utilities to include financial risks to shareholders. CPUC D.16-08-018, pp. 195-196 (Ordering Par. 6)

calculated RSEs,[15] a B/C ratio less than 1.0 indicates that the proposed activity is not cost-effective because the present value benefits of the mitigation would be less than the present value costs.

Table 2 also includes the units of risk reduction, RSE and B/C ratio under the TURN Multi-Attribute Value Function (MAVF). The TURN MAVF values correct two key flaws in PG&E's MAVF: (1) an excessive implied statistical value of life (SVL), which inflates the safety attribute scores and safety risk reduction; and (2) the use of a non-linear scaling function for the safety and financial attributes, which results in illogical preferences and contradictions. These problems and TURN's recommended corrections are discussed in detail in Appendix A, Section III. TURN's recommended corrections, particularly to address the SVL problem, generally have the effect of reducing the RSEs and resulting B/C ratios reported by PG&E for the Wildfire risk.[16]

[15] As noted above and discussed further below, TURN believes that PG&E's RSE calculations for its wildfire mitigation programs are significantly flawed in a way that likely exaggerates the RSEs and B/C ratios for those programs.

[16] The values provided under the "TURN MAVF" column in the tables in these comments are not intended to signify that TURN endorses these scores in all respects. Use of the TURN MAVF only corrects some of the problems with PG&E's analysis. As discussed below, TURN has other concerns with PG&E's analysis, particularly with insufficiently granular tranches, that tend to exaggerate the scope of PG&E's proposal that is cost-effective. In addition, TURN may identify other problems with PG&E's methodology in its upcoming testimony in PG&E's GRC.

Table 2: RSE By Tranche and Derived B/C Ratios for PG&E's 2022 Undergrounding Proposal[17]

Line No.	Tranche (Risk for Cross Cutting Programs)	Total Tranche Miles	2022 Miles to be Undergrounded	2022 NPV Cost (Millions of $)	PG&E MAVF 2022 NPV Risk Reduction	PG&E MAVF 2022 RSE	PG&E MAVF B/C Ratio	TURN MAVF 2022 NPV Risk Reduction	TURN MAVF 2022 RSE	TURN MAVF B/C Ratio
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
1	HFTD - Distribution - 1QU CoRE | 1QU LoRE	222.4	2.91	$13.07	261.34	15.300	3.060	243.01	14.23	2.37
2	HFTD - Distribution - 1QU CoRE | 2QU LoRE	510.1	7.20	$32.32	353.39	8.366	1.673	325.10	7.70	1.28
3	HFTD - Distribution - 1QU CoRE | 3QU LoRE	1,070.2	14.29	$64.10	589.01	7.030	1.406	540.57	6.45	1.08
4	HFTD - Distribution - 1QU CoRE | 4QU LoRE	1,594.3	20.72	$92.93	748.22	6.159	1.232	684.89	5.64	0.94
5	HFTD - Distribution - 1QU CoRE | 5QU LoRE	1,667.6	22.42	$100.57	601.05	4.572	0.914	549.79	4.18	0.70
6	HFTD - Distribution - 2QU CoRE | 1QU LoRE	377.9	3.19	$14.30	97.61	5.221	1.044	90.16	4.82	0.80
7	HFTD - Distribution - 2QU CoRE | 2QU LoRE	807.6	6.89	$30.92	131.87	3.262	0.652	121.09	3.00	0.50
8	HFTD - Distribution - 2QU CoRE | 3QU LoRE	1,225.9	11.80	$52.93	186.72	2.698	0.540	171.42	2.48	0.41
9	HFTD - Distribution - 2QU CoRE | 4QU LoRE	1,187.7	11.80	$52.91	144.39	2.088	0.418	132.70	1.92	0.32
10	HFTD - Distribution - 2QU CoRE | 5QU LoRE	1,487.6	15.51	$69.57	146.55	1.611	0.322	134.55	1.48	0.25
11	HFTD - Distribution - 3QU CoRE | 1QU LoRE	912.8	3.21	$14.40	42.11	2.238	0.448	38.90	2.07	0.34
12	HFTD - Distribution - 3QU CoRE | 2QU LoRE	1,386.5	4.21	$18.88	38.38	1.555	0.311	35.25	1.43	0.24
13	HFTD - Distribution - 3QU CoRE | 3QU LoRE	1,006.7	3.57	$16.00	24.92	1.192	0.238	22.95	1.10	0.18
14	HFTD - Distribution - 3QU CoRE | 4QU LoRE	964.9	2.61	$11.69	13.89	0.909	0.182	12.82	0.84	0.14
15	HFTD - Distribution - 3QU CoRE | 5QU LoRE	850.2	2.28	$10.22	8.33	0.624	0.125	7.71	0.58	0.10
16	HFTD - Distribution - 4QU CoRE | 1QU LoRE	1,379.9	1.78	$7.98	8.81	0.844	0.169	8.18	0.78	0.13
17	HFTD - Distribution - 4QU CoRE | 2QU LoRE	1,094.2	1.24	$5.57	3.57	0.489	0.098	3.30	0.45	0.08
18	HFTD - Distribution - 4QU CoRE | 3QU LoRE	1,135.0	1.33	$5.95	3.06	0.393	0.079	2.84	0.36	0.06
19	HFTD - Distribution - 4QU CoRE | 4QU LoRE	899.0	1.03	$4.62	1.91	0.316	0.063	1.78	0.29	0.05
20	HFTD - Distribution - 4QU CoRE | 5QU LoRE	588.2	0.66	$2.97	0.88	0.226	0.045	0.82	0.21	0.03
21	HFTD - Distribution - 5QU CoRE | 1QU LoRE	2,192.7	2.49	$11.18	1.57	0.107	0.021	1.53	0.10	0.02
22	HFTD - Distribution - 5QU CoRE | 2QU LoRE	1,295.6	1.49	$6.69	0.73	0.084	0.017	0.70	0.08	0.01
23	HFTD - Distribution - 5QU CoRE | 3QU LoRE	657.8	0.76	$3.40	0.29	0.064	0.013	0.28	0.06	0.01
24	HFTD - Distribution - 5QU CoRE | 4QU LoRE	442.7	0.53	$2.39	0.17	0.055	0.011	0.16	0.05	0.01
25	HFTD - Distribution - 5QU CoRE | 5QU LoRE	504.3	0.57	$2.56	0.09	0.028	0.006	0.09	0.03	0.00
	Totals	**25,461.7**	**144.5**	**$648.15**	**3,408.9**	**5.259**	**1.052**	**3,130.6**	**4.830**	**0.966**

Totals, Tranches with B/C >= 1.0, PG&E MAVF:	**48.3** / **$216.72**
Totals, Tranches with B/C >= 1.0, TURN MAVF:	**24.4** / **$109.48**

Notes

(1) Source: EO-WLDFR-1, worksheet "REF_Tranche," column C.
(2) Source: EO-WLDFR-1, worksheet "9-ProgramExposureSpend," column N.
(3) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," columns X + AF.
(4) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column G.
(5) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column Q.
(6) Equals: [3] / 5.
(7) Source: "PG&E Response to TURN_078Q02Supp01Atch02.xlsx," worksheet "RSE by Tranche," column G.
(8) Source: "PG&E Response to TURN_078Q02Supp01Atch02.xlsx," worksheet "RSE by Tranche," column Q.
(9) Equals: [3] / 6.

[17] The Excel workpapers from PG&E's GRC used as the source for this and other tables in these comments are available from TURN upon request.

The results in Table 2 show that there is a significant variation in the RSEs and B/C ratios for the various tranches in which PG&E proposes undergrounding work, which highlights the importance of granular tranches with homogenous risk profiles. Under PG&E's MAVF, the aggregate RSE for all of PG&E's undergrounding proposal for 2022 is 5.26 (similar to the "territory-wide" RSE of 5.535 PG&E reported in its WMP for *all* system hardening work, including covered conductor – see Table 1), which is equivalent to a B/C ratio of 1.052. However, at the tranche level, one can see that, even under PG&E's MAVF, most of PG&E's proposed work, 96.2[18] miles out of 144.5 total, has a B/C ratio below 1.0. Under TURN's recommended MAVF, only 24.4 miles are in tranches with B/C ratios above 1.0.

Thus, based on the RSE values presented in the GRC, with TURN's corrections to PG&E's flawed MAVF, ***only 17% of PG&E's total proposed undergrounding miles[19] for 2022 are cost-effective***. PG&E offers no explanation for why it would be sound policy and a good use of limited ratepayer funding for Energy Safety to approve its full undergrounding proposal when the RSE analysis that PG&E conducted pursuant to the CPUC's S-MAP settlement shows that most of PG&E's proposed work would not provide risk reduction benefits, *i.e.*, reduction to safety, reliability and financial risks, that exceed the costs for most of the scope of PG&E's proposal. PG&E only states that, under its proposal, it will target and prioritize the highest risk parts of its system. However, as PG&E has modeled its 2022 planned work in its RSE analysis for the GRC, the results show that the overwhelming majority of that work will not be cost-effective.

Because PG&E's WMP touts 2022 as the beginning of a steep ramp-up of proposed undergrounding work over the next several years, it is instructive to review the RSE-related data

[18] Calculated as 144.5 total miles (col. 2) minus 48.3 miles in tranches with a B/C ratio above 1.0.
[19] 17% = 24.4/144.5.

PG&E has provided in its GRC for its *2023-2026* undergrounding proposal. Table 3 provides the same information as Table 2, for the 2023-2026 period.

Table 3: RSE By Tranche and Derived B/C Ratios for PG&E's 2022 Undergrounding Proposal

Line No.	Tranche (Risk for Cross Cutting Programs)	Total Tranche Miles	2023-2026 Miles to be Undergrounded	2023-2026 NPV Cost (Millions of $)	PG&E MAVF 2023-2026 NPV Risk Reduction	PG&E MAVF 2023-2026 RSE	PG&E MAVF B/C Ratio	TURN MAVF 2023-2026 NPV Risk Reduction	TURN MAVF 2023-2026 RSE	TURN MAVF B/C Ratio
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
1	HFTD - Distribution - 1QU CoRE | 1QU LoRE	222.4	54.0	$211.40	4,277.74	20.236	4.047	3,968.92	18.77	3.13
2	HFTD - Distribution - 1QU CoRE | 2QU LoRE	510.1	133.5	$522.80	5,784.97	11.065	2.213	5,309.87	10.16	1.69
3	HFTD - Distribution - 1QU CoRE | 3QU LoRE	1,070.2	264.7	$1,036.92	9,641.46	9.298	1.860	8,828.72	8.51	1.42
4	HFTD - Distribution - 1QU CoRE | 4QU LoRE	1,594.3	383.8	$1,503.40	12,247.79	8.147	1.629	11,186.02	7.44	1.24
5	HFTD - Distribution - 1QU CoRE | 5QU LoRE	1,667.6	415.3	$1,626.99	9,839.00	6.047	1.209	8,979.78	5.52	0.92
6	HFTD - Distribution - 2QU CoRE | 1QU LoRE	377.9	59.1	$231.40	1,597.65	6.904	1.381	1,472.36	6.36	1.06
7	HFTD - Distribution - 2QU CoRE | 2QU LoRE	807.6	127.7	$500.27	2,158.43	4.315	0.863	1,977.48	3.95	0.66
8	HFTD - Distribution - 2QU CoRE | 3QU LoRE	1,225.9	218.6	$856.34	3,056.16	3.569	0.714	2,799.51	3.27	0.54
9	HFTD - Distribution - 2QU CoRE | 4QU LoRE	1,187.7	218.5	$855.93	2,363.40	2.761	0.552	2,167.14	2.53	0.42
10	HFTD - Distribution - 2QU CoRE | 5QU LoRE	1,487.6	287.3	$1,125.55	2,398.78	2.131	0.426	2,197.42	1.95	0.33
11	HFTD - Distribution - 3QU CoRE | 1QU LoRE	912.8	59.5	$232.90	689.24	2.959	0.592	635.21	2.73	0.45
12	HFTD - Distribution - 3QU CoRE | 2QU LoRE	1,386.5	78.0	$305.45	628.12	2.056	0.411	575.60	1.88	0.31
13	HFTD - Distribution - 3QU CoRE | 3QU LoRE	1,006.7	66.1	$258.86	407.88	1.576	0.315	374.69	1.45	0.24
14	HFTD - Distribution - 3QU CoRE | 4QU LoRE	964.9	48.3	$189.17	227.34	1.202	0.240	209.27	1.11	0.18
15	HFTD - Distribution - 3QU CoRE | 5QU LoRE	850.2	42.2	$165.26	136.34	0.825	0.165	125.83	0.76	0.13
16	HFTD - Distribution - 4QU CoRE | 1QU LoRE	1,379.9	33.0	$129.14	144.16	1.116	0.223	133.56	1.03	0.17
17	HFTD - Distribution - 4QU CoRE | 2QU LoRE	1,094.2	23.0	$90.15	58.35	0.647	0.129	53.92	0.60	0.10
18	HFTD - Distribution - 4QU CoRE | 3QU LoRE	1,135.0	24.6	$96.32	50.11	0.520	0.104	46.36	0.48	0.08
19	HFTD - Distribution - 4QU CoRE | 4QU LoRE	899.0	19.1	$74.75	31.23	0.418	0.084	29.01	0.39	0.06
20	HFTD - Distribution - 4QU CoRE | 5QU LoRE	588.2	12.3	$48.13	14.37	0.299	0.060	13.33	0.28	0.05
21	HFTD - Distribution - 5QU CoRE | 1QU LoRE	2,192.7	46.2	$180.89	25.66	0.142	0.028	25.01	0.14	0.02
22	HFTD - Distribution - 5QU CoRE | 2QU LoRE	1,295.6	27.6	$108.27	11.98	0.111	0.022	11.49	0.11	0.02
23	HFTD - Distribution - 5QU CoRE | 3QU LoRE	657.8	14.1	$55.07	4.69	0.085	0.017	4.51	0.08	0.01
24	HFTD - Distribution - 5QU CoRE | 4QU LoRE	442.7	9.9	$38.67	2.81	0.073	0.015	2.69	0.07	0.01
25	HFTD - Distribution - 5QU CoRE | 5QU LoRE	504.3	10.6	$41.45	1.54	0.037	0.007	1.49	0.04	0.01
	Totals	**25,461.7**	**2,676.7**	**$10,485.50**	**55,799.2**	**5.322**	**1.064**	**51,129.2**	**4.876**	**0.975**

Totals, Tranches with B/C >= 1.0, PG&E MAVF:	**1,310.3**	**$5,132.91**
Totals, Tranches with B/C >= 1.0, TURN MAVF:	**895.0**	**$3,505.92**

Notes

(1) Source: EO-WLDFR-1, worksheet "REF_Tranche," column C.

(2) Source: EO-WLDFR-1, worksheet "9-ProgramExposureSpend," sum of columns O - R.

(3) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," columns AD + AK.

(4) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column O.

(5) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column V.

(6) Equals: [3] / 5.

(7) Source: "PG&E Response to TURN_078Q02Supp01Atch02.xlsx," worksheet "RSE by Tranche," column O.

(8) Source: "PG&E Response to TURN_078Q02Supp01Atch02.xlsx," worksheet "RSE by Tranche," column V.

(9) Equals: [3] / 6.

The findings from Table 3 are similar to those from Table 2. Even though at the overall program level, the B/C ratios are at or near 1.0 (1.064 under PG&E's MAVF and 0.975 under TURN's MAVF), the large majority of the undergrounding that PG&E is proposing in the GRC for 2023-2026 is not cost-effective. Under TURN's MAVF, only 33% of PG&E's proposed undergrounding miles for 2023-2026 are in tranches with B/C ratios above 1.0. To be clear, TURN does not necessarily support this level of undergrounding both for the reasons cited below but also because we will scrutinize the basis of PG&E's proposal in the GRC, which will be litigated over the coming months.

Indeed, there is good reason to believe that the RSEs and B/C ratios shown in Table 2 and 3 overstate the percentage of PG&E's undergrounding proposal that is cost-effective. As previously noted, the degree of granularity of PG&E's tranches for its GRC analysis, while certainly better than the extremely aggregated tranche RSEs it has provided in its WMP, still falls short of the homogenous risk profile requirement of the S-MAP settlement. As shown by column 1 in Tables 2 and 3 above, PG&E has several relatively high risk tranches that include more than 1,000 miles of distribution lines -- with, *e.g.* one tranche (line 5) with 1,668 miles and another (line 4) with 1,594 miles. PG&E's own risk prioritization model that was used as the basis of these tranches demonstrates that these miles have significantly different risk profiles.[20] With more granular tranches, we would expect to find (just as we found when comparing PG&E's total program average RSE and B/C values to its tranche values) that the majority of the miles in each tranche would have lower RSEs and B/C ratios than shown for PG&E's insufficiently granular tranches.[21]

[20] PG&E WMP, p. 89, "Equipment Probability of Ignition Model," provided to TURN in response to Data Request TURN-18, Question 1, in the GRC.

[21] *See* Appendix, Section V.

Thus, a more granular tranche analysis would likely show that even less of PG&E's proposed undergrounding mileage is cost-effective than is reflected in Tables 2 and 3.

In addition, PG&E's risk modeling fails to sufficiently reflect the full extent to which PG&E operational failure – such as poor performance in facility inspection and vegetation management -- is a major driver of catastrophic wildfires. If PG&E correctly modeled the contribution of operational failure to catastrophic wildfire ignitions, its RSE and B/C results would show that mitigations such as undergrounding contribute less risk reduction than shown by PG&E's analysis. Correcting this error would instead show that, compared to the results the company reports, PG&E would obtain more risk reduction from improved quality assurance and quality control and less risk reduction from costly grid hardening programs and enhanced vegetation management.

C. Energy Safety Should Limit the Amount of Undergrounding Work that is Approved for 2022 and Direct PG&E's 2023 WMP to Demonstrate, at a Highly Granular Level, that PG&E's Proposed Undergrounding Work Is Cost-Effective

Table 2 shows that the vast majority of PG&E's undergrounding proposal for 2022 does not deliver risk reduction benefits that exceed the considerable cost of undergrounding. And Table 3 demonstrates that PG&E's undergrounding plans for 2023-2026, as described in its pending GRC, suffer from the same problem. This information, derived from PG&E's own quantitative risk assessment, should sound loud alarms for the regulators responsible for reviewing and approving PG&E's proposals, both Energy Safety and the CPUC. PG&E's new undergrounding strategy may promote its shareholders' interest in growing rate base (upon which profits are collected) at unprecedented levels. But there is a serious question whether the *public* interest is served by such heavy reliance on a costly program that PG&E's own analysis shows not to be cost-effective for most of the proposed mileage. Both Energy Safety and the CPUC need to follow the facts where they lead and direct PG&E to limit undergrounding to the highest risk areas where it is a cost-

effective mitigation and to rely on other less costly and more cost-effective mitigations in other areas where the wildfire risk needs to be mitigated.

Accordingly, TURN urges Energy Safety to adopt the following recommendations regarding PG&E's new proposal to dramatically expand its undergrounding program:

First, based on Table 2, Energy Safety should find that no more than 17% of PG&E's proposed undergrounding mileage for 2022 is cost-effective. PG&E should be required to modify its WMP to reduce the scope of its 2022 undergrounding proposal to 17% of the 175 miles proposed in the WMP, or 30 miles. The only exception to this limit should be for additional miles that are not cost-effective, but need to be included in a project to avoid gross inefficiency, such as undergrounding a short segment in a tranche with a B/C ratio below 1.0 that falls between two larger segments with B/C ratios above 1.0. PG&E should be required to justify any undergrounding of mileage that falls within a tranche with a B/C ratio below 1.0 by demonstrating that the work was needed to avoid gross inefficiency.

Second, Energy Safety should state its expectations for PG&E's 2023 WMP regarding the analysis that will be needed to justify its proposed wildfire mitigation programs. In particular, Energy Safety should direct PG&E to adopt the changes to its MAVF recommended and explained by TURN in the Appendix to these comments, Section III(C), namely: (a) adopting the attribute ranges and weights shown in Table 4 below; and (b) using linear scaling functions for the safety and financial attributes.

Table 4: TURN's Recommended Changes to PG&E's MAVF

	PG&E MAVF		TURN RECOMMENDED MAVF	
Attribute	Range	Weight	Range	Weight
Safety	0 – 100 EFs	50%	0 – 500 EFs	40%
Electric Reliability	0 – 4 billion CMI	20%	0 – 4 billion CMI	24%
Gas Reliability	0 – 750,000 customers	5%	0 –750,000 customers	6%
Financial	0 – $5 billion	25%	0 – $5 billion	30%

In addition, PG&E should be required to base its RSE analysis on tranches that are significantly more granular than the tranches used for the 2023 GRC and that meet the requirements of the CPUC's S-MAP Settlement that each tranche consist of assets with homogenous risk profiles, *i.e.*, have reasonably similar LoRE and CoRE values. TURN recommends as an initial starting point tranches with no more than 100 overhead circuit miles for the utility's HFTD, a standard already met by PG&E's risk prioritization model for risk posed by electric equipment.[22]

Third, for its 2023 WMP, PG&E should be directed to demonstrate that, using an analysis that is modified as described in the preceding paragraph and otherwise meets the requirements of the S-MAP Settlement, any undergrounding work proposed for 2023 will be performed in a tranche with a B/C ratio above 1.0. If PG&E proposes to underground any mileage that falls within a tranche with a B/C ratio below 1.0, it should be required to demonstrate that such work is needed to avoid gross inefficiency.

Energy Safety should adopt these recommendations to ensure that PG&E is focused on the optimal and most cost-effective strategies for reducing the Wildfire risk to acceptable levels. With

[22] PG&E WMP, p. 89, "Equipment Probability of Ignition Model," provided to TURN in response to Data Request TURN-18, Question 1, in the GRC.

affordable electricity for all at the heart of California's greenhouse gas reduction goals, California cannot afford to saddle ratepayers with the costs of programs that deliver insufficient risk reduction to justify the cost.

III. PG&E MUST LIKEWISE BE DIRECTED TO FOCUS ITS 2022 ENHANCED VEGETATION MANAGEMENT (EVM) PROGRAM ON THE EXTREMELY SMALL SUBSET OF MILES WHERE THIS MITIGATION WOULD BE COST-EFFECTIVE

A. EVM Work Comprises More than Half of the Cost of PG&E's Proposed Vegetation Management Work in 2022

Table 3.1-2 in PG&E's WMP reports that under the broad category of Vegetation Management, PG&E proposes to spend $1.98 billion in 2022. This is the second largest cost category in that table, surpassed only by the $3.13 billion that PG&E proposes to spend for Grid Design and System Hardening. PG&E's WMP differentiates among various activities that fall under the Vegetation Management heading, foremost among them being Routine Vegetation Management, which is designed to meet compliance obligations, and Enhanced Vegetation Management, which PG&E states "is designed to go above and beyond compliance requirements."[23] PG&E's WMP states that PG&E intends to perform 1,800 miles of EVM work in 2022.[24] However, Table 12 in PG&E's WMP attachments[25] does not give a breakdown of the proposed cost of the EVM program for 2022 (or any other year) between Routine VM and EVM. Instead, those costs are combined under WMP Initiative 7.3.5.2, even though PG&E's Table 12 recognizes that Energy Safety's template has a separate line item (numbered 7.3.5.20, in PG&E's Table 12) called "Additional vegetation management practices beyond regulatory requirements and

[23] PG&E WMP, p. 636; *see also*, p. 10.

[24] PG&E WMP, p. 277, Table PG&E 5.3-1(A).

[25] 2022-02-25_PGE_2022_WMP-Update_R0_Section 7.3.a_Atch01_R1, tab "Table 12" (hereinafter "Table 12").

recommendations" that would seem to apply specifically to EVM. As a result, the contribution of EVM to PG&E's total Vegetation Management proposed spending in 2022 is masked by PG&E's WMP presentation. (As discussed below, PG&E's presentation also masks the extremely low RSE for EVM compared to Routine VM.)

However, PG&E's 2023 GRC testimony, updated as of 2/25/22, does provide a breakdown of its forecast 2022 Vegetation Management costs for its distribution system,[26] as shown in Table 5.

Table 5: PG&E GRC Forecast Vegetation Management Expense[27]

Activity	2022 Forecast Cost (Thousands of Nominal Dollars)
Routine VM	$711,007
Enhanced VM	***$916,600***
Tree Mortality Work	$144,000
Total	$1,771,608

This breakdown shows that the EVM program makes up more than half, 52%, of PG&E's proposed spending for Vegetation Management activities in 2022. Because EVM comprises such a large share of total VM spending and because it is discretionary work, it is appropriate for Energy Safety to examine the cost-effectiveness of PG&E's proposed EVM program for 2022. Now is a particularly opportune time to engage in such scrutiny because this is an established program that has already addressed over 6,300 miles (over 25% of the approximately 25,000 distribution miles in PG&E's HFTD areas) from 2019 through 2021.[28] As a result, at this point, the EVM program should already have addressed the highest risk parts of the system. PG&E now seeks to extend the

[26] Unlike its WMP, PG&E's GRC does not address its transmission system programs and costs, as those are regulated by FERC.

[27] Source: A.20-06-021, PG&E 2/25/22 Updated Testimony, Ex. PG&E-4, p. 9-69, Table 9-17.

[28] PG&E WMP, p. 277, Table PG&E 5.3-1(A).

program to relatively lower risk areas where reduced risk reduction benefits may not justify the cost.

B. The RSE Data Presented in PG&E's GRC Shows that Almost None of PG&E's Proposed EVM Work for 2022 is Cost-Effective

In TURN's comments on PG&E's 2021 WMP, TURN pointed out that the RSEs for EVM activities were dramatically lower than for other compliance-related VM work.[29] TURN used data from PG&E's 2020 RAMP submission to the CPUC to document TURN's point. In this WMP, PG&E has again chosen not to present separate RSE information for its discretionary EVM work, electing instead to provide a combined RSE for its compliance and discretionary activities under initiative 7.3.5.2 in PG&E's Table 12. PG&E followed this approach even though, as noted above, Energy Safety's template has separate lines, calling for separate financial and RSE information for various different vegetation management activities, including a distinct line item for discretionary vegetation management work. PG&E's combined RSE reported in Table 12 for this undifferentiated VM work (under initiative 7.3.5.2) shows high RSE values: 4,763 territory-wide: 3,507 in HFTD Tier 3; 11,253 in HFTD Tier 2 and 54 in non-HFTD areas. This data gives the misleading impression that PG&E's proposed EVM work is highly cost-effective.

However, when EVM is addressed separately, as PG&E did in its Excel workpapers for the GRC, the RSE data tell a very different story. Table 6 presents the same types of RSE-related information presented in Tables 2 and 3 for PG&E's undergrounding program. (See Section II(B) above for an explanation of the data presented in these tables.) As in Tables 2 and 3, the data in Table 6 is broken down at the level of the tranches identified by PG&E.[30]

[29] Comments of TURN on 2021 Wildfire Mitigation Plan Updates (Corrected 3/30/21), pp. 20-24.

[30] As discussed in Section II(B) above, PG&E's Wildfire risk tranches are not sufficiently granular to meet the homogenous risk profile requirement of the CPUC's S-MAP settlement.

Table 6: RSE By Tranche and Derived B/C Ratios for PG&E's 2022 EVM Proposal

Line No.	Tranche (Risk for Cross Cutting Programs)	Total Tranche Miles	2022 Miles	2022 NPV Cost (Millions of $)	PG&E MAVF 2022 NPV Risk Reduction	PG&E MAVF 2022 RSE	PG&E MAVF B/C Ratio	TURN MAVF 2022 NPV Risk Reduction	TURN MAVF 2022 RSE	TURN MAVF B/C Ratio
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
1	HFTD - Distribution - 1QU CoRE | 1QU LoRE	222.4	16.5	$8.01	73.15	9.78	1.956	66.63	8.91	1.48
2	HFTD - Distribution - 1QU CoRE | 2QU LoRE	510.1	37.9	$18.36	107.95	6.29	1.258	98.23	5.72	0.95
3	HFTD - Distribution - 1QU CoRE | 3QU LoRE	1,070.2	79.4	$38.53	177.45	4.93	0.986	161.48	4.48	0.75
4	HFTD - Distribution - 1QU CoRE | 4QU LoRE	1,594.3	118.4	$57.39	253.91	4.73	0.947	230.94	4.31	0.72
5	HFTD - Distribution - 1QU CoRE | 5QU LoRE	1,667.6	123.8	$60.03	184.90	3.30	0.659	168.06	3.00	0.50
6	HFTD - Distribution - 2QU CoRE | 1QU LoRE	377.9	28.1	$13.60	61.30	4.82	0.964	55.91	4.40	0.73
7	HFTD - Distribution - 2QU CoRE | 2QU LoRE	807.6	59.9	$29.07	80.76	2.97	0.594	73.61	2.71	0.45
8	HFTD - Distribution - 2QU CoRE | 3QU LoRE	1,225.9	91.0	$44.13	101.96	2.47	0.494	92.89	2.25	0.38
9	HFTD - Distribution - 2QU CoRE | 4QU LoRE	1,187.7	88.2	$42.76	71.18	1.78	0.356	64.86	1.62	0.27
10	HFTD - Distribution - 2QU CoRE | 5QU LoRE	1,487.6	110.4	$53.55	56.10	1.12	0.224	51.11	1.02	0.17
11	HFTD - Distribution - 3QU CoRE | 1QU LoRE	912.8	67.8	$32.86	83.82	2.73	0.546	76.64	2.50	0.42
12	HFTD - Distribution - 3QU CoRE | 2QU LoRE	1,386.5	102.9	$49.91	85.08	1.82	0.365	77.69	1.67	0.28
13	HFTD - Distribution - 3QU CoRE | 3QU LoRE	1,006.7	74.7	$36.24	47.62	1.41	0.281	43.52	1.28	0.21
14	HFTD - Distribution - 3QU CoRE | 4QU LoRE	964.9	71.6	$34.74	27.89	0.86	0.172	25.49	0.79	0.13
15	HFTD - Distribution - 3QU CoRE | 5QU LoRE	850.2	63.1	$30.61	16.88	0.59	0.118	15.45	0.54	0.09
16	HFTD - Distribution - 4QU CoRE | 1QU LoRE	1,379.9	102.4	$49.67	48.77	1.05	0.210	44.85	0.97	0.16
17	HFTD - Distribution - 4QU CoRE | 2QU LoRE	1,094.2	81.2	$39.39	21.60	0.59	0.117	19.86	0.54	0.09
18	HFTD - Distribution - 4QU CoRE | 3QU LoRE	1,135.0	84.3	$40.86	17.10	0.45	0.090	15.73	0.41	0.07
19	HFTD - Distribution - 4QU CoRE | 4QU LoRE	899.0	66.7	$32.36	8.58	0.28	0.057	7.90	0.26	0.04
20	HFTD - Distribution - 4QU CoRE | 5QU LoRE	588.2	43.7	$21.17	4.87	0.25	0.049	4.48	0.23	0.04
21	HFTD - Distribution - 5QU CoRE | 1QU LoRE	2,192.7	162.8	$78.94	9.39	0.13	0.025	8.92	0.12	0.02
22	HFTD - Distribution - 5QU CoRE | 2QU LoRE	1,295.6	96.2	$46.64	4.48	0.10	0.021	4.22	0.10	0.02
23	HFTD - Distribution - 5QU CoRE | 3QU LoRE	657.8	48.8	$23.68	1.45	0.07	0.013	1.37	0.06	0.01
24	HFTD - Distribution - 5QU CoRE | 4QU LoRE	442.7	32.9	$15.94	0.90	0.06	0.012	0.85	0.06	0.01
25	HFTD - Distribution - 5QU CoRE | 5QU LoRE	504.3	37.4	$18.15	0.40	0.02	0.005	0.38	0.02	0.00
	Totals	**25,461.7**	**1,890.1**	**$916.62**	**1,547.5**	**1.688**	**0.281**	**1,411.1**	**1.539**	**0.257**

Totals, Tranches with B/C >= 1.0, PG&E MAVF:	**54.37**	**$26.37**
Totals, Tranches with B/C >= 1.0, TURN MAVF:	**16.51**	**$8.01**

Notes

(1) Source: EO-WLDFR-1, worksheet "REF_Tranche," column C.
(2) Source: EO-WLDFR-1, worksheet "9-ProgramExposureSpend," column N.
(3) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column AF.
(4) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column G.
(5) Source: "PG&E GRC RSEs Feb 2022_Fixed 4-4-2022.xlsx," worksheet "RSE by Tranche," column Q.
(6) Equals: [3] / 5.
(7) Source: "PG&E Response to TURN_078Q02Supp01Atch02.xlsx," worksheet "RSE by Tranche," column G.
(8) Source: "PG&E Response to TURN_078Q02Supp01Atch02.xlsx," worksheet "RSE by Tranche," column Q.
(9) Equals: [3] / 6.

The results in Table 6 are striking. In the aggregate, the RSE for the entire program under PG&E's MAVF is 1.688, which corresponds to a very low B/C ratio of 0.281. Under TURN's MAVF, the numbers are even lower: the aggregate RSE is 1.539 and the B/C ratio is 0.257. At the tranche level, one can see that, even under PG&E's MAVF, only a small portion of PG&E's proposed work, 54.4 miles out of 1,890 total, has a B/C ratio above 1.0. Under TURN's recommended MAVF, only 16.5 miles are in tranches with B/C ratios above 1.0.

Thus, based on the RSE values presented in the GRC, with TURN's corrections to PG&E's flawed MAVF, ***less than 1% of PG&E's total proposed EVM miles[31] for 2022 are cost-effective***. Even under PG&E's MAVF, only 2.9% of the proposed work would be cost-effective. PG&E offers no explanation for why it would be sound policy and a good use of limited ratepayer funding for Energy Safety to approve anything but the small percentage of its EVM that would provide risk reduction benefits, *i.e.*, reduction to safety, reliability and financial risks, that exceed the costs. In fact, as noted, PG&E's WMP presentation does not disclose the very low RSEs for this program, despite the line item in Energy Safety's template that called for separate RSEs for discretionary vegetation management work. PG&E claims that it will prioritize EVM activities to the highest risk areas. But PG&E's own RSE data shows that, even so, at this point in the roll-out of a multi-year program, PG&E is proposing to apply EVM where the costs are high and risks relatively low such that this work is no longer cost-effective.

[31] 16.51 divided by 1,890.1 = 0.87%

C. Energy Safety Should Sharply Limit the Amount of EVM Work that is Approved for 2022 and Direct PG&E's 2023 WMP to Demonstrate, at a Granular Level, that PG&E's Proposed EVM Work Is Cost-Effective

Table 6 shows that almost none of PG&E's EVM proposal for 2022 delivers risk reduction benefits that exceed the costs. Energy Safety should find this information both eye-opening and troubling, in that the separate RSE for a $900 million program was not disclosed in PG&E's WMP. This extensive multi-year program has clearly reached a point of maturity, where it is only cost-effective for the few remaining portions of its system where the risk reduction justifies the costs. Moreover, with PG&E's increased reliance on the Enhanced Powerline Safety Setting (EPSS) program, the risk reduction benefits of EVM should be even lower than the standalone RSE values for EVM that PG&E has modeled in its GRC workpapers and that are presented in Table 6 above.

Accordingly, TURN urges Energy Safety to adopt the following recommendations regarding PG&E's EVM proposal:

First, based on Table 6, Energy Safety should find that no more than 1% of PG&E's proposed EVM mileage for 2022 is cost-effective. PG&E should be required to modify its WMP to reduce the scope of its 2022 undergrounding proposal to 1% of the 1,800 miles proposed in the WMP, or 18 miles. The only exception to this limit should be for additional miles that are not cost-effective, but need to be included in a project to avoid gross inefficiency, such as performing EVM on a short segment in a tranche with a B/C ratio below 1.0 that falls between two larger segments with B/C ratios above 1.0. PG&E should be required to justify any EVM work that falls within a tranche with a B/C ratio below 1.0 by demonstrating that the work was needed to avoid gross inefficiency.

Second, Energy Safety should state its expectations for PG&E's 2023 WMP regarding the analysis that will be needed to justify any continuation of EVM work. In particular,

PG&E should be directed to demonstrate that, using the modified RSE analysis described in Section II(C) above for undergrounding, any EVM work proposed for 2023 will be performed in a tranche with a B/C ratio above 1.0. If PG&E proposes to apply EVM to any mileage that falls within a tranche with a B/C ratio below 1.0, it should be required to demonstrate that such work is needed to avoid gross inefficiency.

Energy Safety should adopt these recommendations to ensure that PG&E is not unduly driving up electricity rates and impeding achievement of California's urgent greenhouse gas reduction goals.

IV. CONCLUSION

For the reasons set forth above, TURN urges Energy Safety to adopt the recommendations in these Comments.

Date: April 11, 2022

Respectfully submitted,

By: _____/s/_____
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APPENDIX TO

COMMENTS OF THE UTILITY REFORM NETWORK ON THE 2022 WILDFIRE MITIGATION PLANS

ADDRESSING

THE USE OF MULTI-ATTRIBUTE VALUE FUNCTIONS (MAVF) FOR RISK ASSESSMENT, EXPRESSING RISK SPEND EFFICIENCY VALUES AS BENEFIT-COST RATIOS, AND PROBLEMS WITH PG&E'S MAVF

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I. INTRODUCTION AND SUMMARY

This Appendix provides support for the foregoing Comments of The Utility Reform Network (TURN) on the 2022 Wildfire Mitigation Plans (WMP). Its purpose is to assist in understanding the basis of the risk spend efficiency (RSE) and Benefit/Cost (B/C) ratios that are presented in TURN's comments.

The risk assessment methodology discussed in this Appendix was mandated by the Safety Model Assessment Proceeding (S-MAP) Settlement adopted by the California Public Utilities Commission (CPUC) in Decision (D.) 18-12-014 (S-MAP Settlement). That methodology, which PG&E and California's other large utilities agreed to adopt in that Settlement, relies on the use of a multi-attribute value function (MAVF) to estimate the full range of consequences from the occurrence of a risk event, such as the ignition of a wildfire. This MAVF-based methodology enables utilities to determine and compare RSE values for all of their proposed risk mitigation initiatives, including wildfire risk mitigations. As explained in this Appendix, the MAVF methodology also allows RSE values to be expressed as B/C ratios, providing a direct means to assess the cost-effectiveness of any risk mitigation program, or portion thereof.

Section II of these comments first provides a brief discussion of the nature of MAVFs and the reason for their development. It then explains the various aspects of a MAVF, including the selection of attributes, their ranges in natural units, and how attribute weights are determined. Next, Section II discusses PG&E's MAVF and why it is problematic, followed by a discussion of TURN's recommended improvements to PG&E's MAVF.

Section III explains how RSEs can be expressed as traditional benefit-cost ("B/C") ratios, which often are used to select among competing programs where money and resources are constrained. It discuses how B/C ratios can be used to inform approval or disapproval of specific risk mitigation programs and explain the advantages of doing so in light of the importance of customer affordability of the rates to be charged by utilities.

Section IV discusses the importance of ensuring that RSEs and B/C ratios are calculated at the level of granularity required by the S-MAP Settlement by performing the risk analysis at the "tranche" level. The S-MAP Settlement adopted in D.18-12-014 requires PG&E to calculate RSEs for each tranche. Because RSEs at the aggregate program level simply are averages of the RSEs for individual tranches within a given program, relatively high aggregate RSE values for a given program do not mean that the entire program is cost-effective and warrants adoption. Conversely, relatively low programmatic RSEs do not necessarily mean that applying mitigations to specific, properly constructed tranches is not warranted. Appropriately granular tranche-level RSEs and B/C ratios provide the most useful information for determining which of a utility's proposed programs warrant funding and at what scope.

This Appendix is prepared by Jonathan A. Lesser, expert consultant to TURN on quantitative risk assessment issues. Dr. Lesser, the President of Continental Economics, Inc., is an economist with significant experience with multi-attribute models such as what PG&E and other utilities have used to estimate RSE values. With his colleague, Dr. Charles D. Feinstein (who also consults for TURN), Dr. Lesser has developed multi-attribute value functions for

various utilities and performed a number of research projects for the Electric Power Research Institute ("EPRI") to develop methodologies for utilities to select and prioritize projects. Dr. Lesser also participated in the initial Safety Model Assessment Proceeding ("S-MAP"), A.15-05-002 et al, where they advocated on behalf of TURN for the MAVF methodology that ultimately was adopted by the Commission in Decisions ("D.") 16-08-018 and 18-12-014 for use by the state's large investor-owned utilities ("IOUs") in their Risk Assessment and Mitigation Phase (RAMP) and General Rate Case ("GRC") filings for calculating risk scores and risk-spend efficiencies ("RSEs") for proposed programs to mitigate various risks. In that same S-MAP proceeding, as part of the CPUC-required "test drive" of different methodologies, they facilitated creation of an illustrative MAVF based on the preferences of the participants, including the investor-owned utilities, CPUC Safety staff, and consumer organizations.

II. THE NATURE OF A MAVF

A. Purpose and Value of a MAVF

As its name implies, a MAVF combines multiple factors that contribute to economic value (or loss). For example, when consumers shop for automobiles, they typically value and trade off different combinations of multiple factors or *attributes* of an automobile, including price, fuel efficiency, color, comfort, and reliability. Because it can be difficult to express directly the value of each of these attributes in monetary terms (e.g., a consumer values an increased level of comfort at $X or increased level of reliability at $Y), a MAVF provides a convenient and transparent way to express numerically the values of various levels of these non-monetary attributes and rank different combinations of levels of the attributes. Specifically, a MAVF expresses the value of any combination of levels of a collection of attributes as a single number.

In addition to expressing the value of a set of desirable attributes, a MAVF can measure the consequences of an adverse event that individuals or companies seek to avoid. Gas and electric utilities measure the benefits of their risk reduction actions with respect to multiple objectives. In effect, these objectives are designed to capture the benefits of improved performance with respect to impact dimensions including, but not limited to, safety, system reliability, customer satisfaction, regulatory compliance, environmental consequences, and financial consequences. When an adverse event occurs, the normal operating levels of these impact dimensions (or attributes) change: injuries and deaths may take place, electricity and natural gas service may be disrupted, consumers and businesses may suffer financial losses, and so forth. The MAVF measures the cost (or value) of those changes. When the level of an attribute is improved (more safety, improved reliability, greater customer satisfaction), the MAVF measures the benefit of those changes.

To summarize, because it is inconvenient to consider multiple dimensions separately, economists created what are known as *multi-attribute value functions*.[32] Multi-attribute value

[32] More formally, economists call MAVFs multi-attribute utility functions, where *utility* means an economic quantity, not a regulated entity that provides electricity or natural gas service. The foundational textbook is Keeney, R.L, and H. Raiffa, *Decisions with Multiple Objectives,* New York: Wiley (1976). A

functions combine the impacts in each consequence dimension into a single numerical value, measured in some type of unit (e.g., risk units), or just treated as a number with no unit attached to it.

B. Using a MAVF to Measure the Consequences of a Risk Event

An event is risky if: (i) the occurrence of the event is uncertain; (ii) the consequences of the event, given that it has occurred, are uncertain; and (iii) if the risky event occurs, at least one of the adverse attributes will increase in a way that one would be willing to pay to avoid. Therefore, the MAVF is designed to capture the effects of uncertainty in the level of the attributes. As agreed to in the S-MAP Settlement adopted in D.18-12-014, the term "risk event" is used to describe an uncertain event that can have adverse consequences. Often, the term "risk event" is, in many cases, just a euphemism for an asset failure, such as a gas transmission pipe that ruptures or a distribution circuit that fails.

A risk management action or strategy will be aimed at either reducing the likelihood of occurrence of the risk event or the expected consequences of the risk event, as measured by the MAVF, or both. A risk management action may achieve risk reduction benefits with respect to any or all of the attributes. For example, deciding to add a safety awareness training class for field employees may have risk reduction benefits with respect to customer and employee safety, service reliability, regulatory compliance, and financial consequences.

MAVFs avoid the need to measure all consequence impacts directly in dollar terms. There are several reasons why individuals and companies may not wish to measure all consequence impacts in dollar terms. First, doing so may be difficult. For example, most of us cannot provide a direct monetary value on many environmental attributes, such as cleaner air and water, or avoiding species loss. Although economists have developed empirical techniques to elicit values for environmental attributes, those techniques are not simple to employ.[33]

Another reason for using a MAVF is that individuals may be uncomfortable directly expressing the value of certain attributes in dollar terms. For example, many individuals are uncomfortable placing a dollar value on human life. Although economists have developed estimates of the statistical value of life ("SVL"), which is discussed in more detail below, those estimates are not the equivalent of asking, "How much is a person's life worth?"

Nevertheless, both society and individuals make implicit tradeoffs between reducing the risk of death and other attributes we value. For example, vigorously enforcing speed limits to no more than 10 miles per hour on all roads would provide benefits in terms of reduced traffic deaths, but the cost in terms of lost time to travel likely would be unacceptable for most of us. A MAVF can be used to elicit these types of tradeoffs without forcing individuals to specify the value of attributes directly in dollar terms. Moreover, a MAVF provides a single numerical

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popular reference is R.L. Keeney, *Value-Focused Thinking: A Path to Creative Decision-Making,* Harvard (1992).

[33] For a comprehensive discussion, see A. Myrick Freeman, et al., *The Measurement of Environmental and Resource Values: Theory and Methods*, 3rd ed. (Washington, DC: Resources for the Future, 2014).

measure associated with the joint occurrences of different levels of the attributes selected. For example, a wildfire that resulted in pole failures could cause safety, environmental, reliability, and financial consequences. The MAVF determines an overall consequence value by converting the levels of these different attributes associated with the wildfire into a single numerical score.

C. Steps in Constructing a MAVF

1. Identifying the Risks

The first step in constructing a MAVF is to identify the risks that are present. Then, it is natural to consider the mitigation actions that can address those risks. An important question is "Why are you considering undertaking these particular mitigation actions?" Given the risks and the actions, the next question is how the actions will change the system in order to mitigate the risk.

Answering this question naturally leads to identifying and defining attributes because changes in the levels of the attributes that result as a consequence of the occurrence of the adverse event will determine how costly that adverse event can be. In other words, the definition of the attributes follows from consideration of risks and actions and requires specifying the following: (i) How is the attribute measured (natural units)? (ii) What levels can the attribute take on (attribute range)? and (iii) Are there subordinate attributes (attribute structure)? The structure of an attribute is presented as a hierarchy, such that the lowest-level sub-attributes are directly observable and measurable.

For example, the attribute *Reliability* might have two sub-attributes, *Electric Reliability* and *Gas Reliability.* The sub-attribute *Electric Reliability* itself could have two sub-attributes: *SAIDI* and *SAIFI.* Because *SAIDI* and *SAIFI* are directly computable, they are the lowest level attributes in this *Reliability* hierarchy.

2. Selecting Attributes

Attributes measure important characteristics of a situation. In the case of a MAVF used to measure the consequences of an adverse event, the attributes should cover all of the possible adverse consequences.[34] This requirement is reflected in the S-MAP Settlement, which states in the definition of "Attribute" that "[t]he attributes in an MAVF should cover the reasons that a utility would undertake risk mitigation."[35] The fundamental objectives will be reducing or avoiding those consequences. Using a MAVF that ignores important consequences associated with a risk event can result in decisions that are distorted and economically inefficient.

Desirable properties of attributes include the following:[36]

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[34] The CPUC has determined that adverse financial consequences to utility shareholders cannot be included as an attribute. D.16-08-018, pp. 195-196.

[35] S-MAP Settlement, App. A, p. A-2.

[36] For a more detailed discussion, see Ralph Keeney, *Value-Focused Thinking* (Cambridge, MA: Harvard University Press, 1988, pp. 82-86.

Complete: as noted, the attributes should cover all the consequences of the event or decision to be made. For example, a wildfire can cause loss of life, damage to homes and businesses, loss of income, destruction of agricultural land, pollution, and loss of species. A complete MAVF would include attributes that can measure all of these impacts.

Measurable: the attributes should be defined precisely so that changes in attribute levels that arise from decisions (e.g., selecting risk mitigation programs) can be evaluated. In some cases this means beginning with a fundamental attribute such as safety and then defining sub-attributes that can be observed directly and measured numerically, such as deaths and injuries.

Value-Independent: Attributes should not overlap, so as to avoid double-counting impacts from an event or action. This means that the contribution of a single attribute (e.g., reliability) to the overall score does not depend on the level of any other attribute (e.g., customer satisfaction). Conversely, the customer satisfaction consequences of a power outage should not depend on the amount of money required to settle any lawsuits resulting from the failure.

Controllable: the attributes selected can be affected by the decisions made.

Concise: the attributes selected should be the minimum number that are nevertheless complete.

3. Determining Attribute Ranges

Consistent with Row 3 of the S-MAP Settlement,[37] an attribute range should include both the most benign level of the attribute and the most harmful level of the attribute. For example, a financial consequence range would reasonably start at $0 (because there is no financial loss if there is no adverse event) and might extend to billions of dollars in damages, depending on the type of risk envisioned. Constructing the attribute range is important because the potential outcomes of all possible failure events should be included in the range.

The range of an attribute need not be bounded by any past observable outcomes. In other words, one can extrapolate from an attribute's observed historical range to include a prospective outcome that has not been observed previously, but could occur in the future. The range of an attribute plays an essential role in specifying the tradeoffs between and among attributes. Therefore, the range should be selected both to include the anticipated possible outcomes and to facilitate tradeoffs. Defining the lower- and upper-bound levels of each attribute typically is done by taking input from subject matter experts ("SMEs"), utility management, regulators, and other stakeholders.

[37] Row 3 of the Appendix to the S-MAP Settlement states: "Each lower-level Attribute has its own range (minimum and maximum) expressed in natural units that are observable during ordinary operations and as a consequence of the occurrence of a risk event."

4. Determining Attribute Scales

The next step is determining the attribute scales. This is noted in Row 6 of the Appendix to the S-MAP Settlement.[38] Each attribute has a scale, measured on a common range, typically from 0 to 100. As stated in row 6, these scales measure the relative value of the levels of each attribute, by converting an attribute measured in its *natural units* (e.g., outages per year, lives lost per year) into a scaled numerical value. The scale measures the relative value of changes of attribute level, described in natural units, within the range of the attribute.

The scaled value itself is dimensionless and can be called anything (e.g., "scaled risk units" or "scaled units"). For example, 10 outages per year might have a scaled value of 25 scaled units, based on a scale range from zero to 100, where zero represents the best level of the attribute (in this case, zero outages) and 100 represents the worst level (say), 50 outages per year. An intermediate number of outages, say 25 per year, might have a value of 40 scaled units. If that were the case, then reducing the number of outages by 25 per year, from 50 to 25, would have a scaled value of 100 – 40 = 60 scaled units, while a reduction from 25 outages to zero would have a scaled value of 40 – 0 = 40 scaled units. Hence, in this example, reducing the number of outages by 25 per year would be 50 percent more valuable if the reduction were from 50 to 25, than from 25 to zero.

The scale is itself arbitrary, although scales of 0 – 100, such as what PG&E has used, are commonly employed. Each attribute's scaling range must have the same limits, *i.e.*, if one attribute has a scaling range of 0 – 100, then all attributes in the MAVF must use that scale. The term *scaling function* is used to refer to the way an attribute level in natural units is assigned a scaled value, measured in scaled units.

Scaling functions are often linear, but do not have to be so, depending on the attribute. The scales can differ depending on the nature of the attributes and the tradeoffs determined by the stakeholders. In the example above relating to outages, the scaling is not linear. However, some attribute scales should always be linear. For example, financial impacts, which are measured in dollars, must use a linear scale because "a dollar is a dollar." In other words, the change in the scaled value of an additional one dollar loss, say from $1,000 to $1,001, must be the same as the change in the scaled value of an additional one dollar loss from $1,000,000 to $1,000,001. (As discussed below, the non-linear nature of PG&E's attribute scales, including its Financial attribute, are problematic and imply tradeoffs that are not logical.)

5. Determining Attribute Weights

Consistent with Row 7 of the Appendix to the S-MAP Settlement, the "Principle of Relative Importance" determines the weights for the attributes. As this principle states, "Weights are assigned based on actual Attribute measurement ranges, not a fixed weight arbitrarily assigned to an Attribute." The attribute weights measure the relative importance of the

[38] Row 6 of the Appendix to the S-MAP Settlement directs the utility to "[c]onstruct a scale the converts the range of natural units (from Row 3) to scaled units to specify the relative value of changes within the range, including capturing aversion to extreme outcomes or indifference over a range of outcomes."

attributes as compared to one another. This is different than the scaling functions, which measure the relative importance of the levels of a single attribute. The attribute weights must sum to 100 percent.

The attribute weights complete the MAVF structure. To summarize, each attribute has a level that is expressed in natural units. The scaling function converts the attribute level in natural units to a scaled value in scaled units. The attribute weight multiplies the scaled value and converts scaled units to weighted units. The sum of the weighted units for all the attribute levels is the total MAVF score for the collection of attribute levels. This score is referred to as the risk score for the attribute levels. Therefore risk score and risk reduction are measured in weighted units.

Unlike the ranges and scales of the attributes themselves, which are determined without reference to any other attribute, weights require comparisons and direct tradeoffs among attribute levels for different attributes. As Row 7 of the Appendix to the S-MAP Settlement states, "each Attribute . . . should be assigned a weight reflecting its relative importance to other Attributes in the MAVF."[39] These comparisons provide ratios that can be converted into a set of attribute weights (which are all greater than zero) and which sum to 100 percent. Setting attribute weights independently of such comparisons (e.g., Safety = 50 percent, Reliability = 25 percent, etc.) will result in attribute weights that do not reflect actual tradeoffs. This can result in attribute values that, contrary to the S-MAP Settlement, are arbitrary and inconsistent with one another or inconsistent with established values, such as published SVL values.

Specifically, the attribute weights reflect the relative importance of moving the attribute levels from the least to the most desirable levels. That is why the bounds of the attribute ranges are important: they facilitate assigning weights to the attributes. Weights should only be set by tradeoffs, typically made pairwise, between two attributes. Setting weights arbitrarily can lead to contradictions or implicit values that are inconsistent with published or accepted values.

For example, as discussed below, statistical value of life ("SVL") estimates used by the U.S. government to evaluate safety measures, such as for automobiles and environmental regulations, are all around $10 - $12 million. If a MAVF has a Safety attribute measured in lives lost and a Financial attribute measured in dollars, then arbitrarily setting the weights for these two attributes without regard to comparisons between changes to each can lead to implicit SVL values that are inconsistent with commonly accepted values and thus can lead to inappropriate valuations. (In fact, as discussed below, this is the case with PG&E's MAVF, which has an implied SVL of $100 million.)

Notably, having a financial attribute measured in dollars and a financial attribute weight allow one to assign dollar values to other attributes. As discussed below, the presence of a financial attribute and its weight allows one to assign a monetary value to changes in all non-

[39] Row 7 continues: "Weights are assigned based on the relative value of moving each Attribute from it least desirable to its most desirable level, considering the entire range of the Attribute." Row 7 also provides an example: "For example, the Attribute weights will reflect the relative importance of moving the safety outcomes from the least to the most desirable levels, as compare with moving financial outcomes from the least to the most desirable levels in a risky situation."

monetary attributes. It also allows us to express weighted units mitigated in dollar terms. As shown below, this, in turn, allows us to express RSEs as a ratio of dollar benefits divided by dollar costs, which is the familiar benefit-cost ("B/C") ratio.

6. Assessing the Reasonableness of a Utility MAVF

One way to determine whether a specific MAVF is reasonable is to convert the attributes to known dollar values. For example, if one of the attributes measures safety, in terms of loss of life, the dollar value of that attribute can be compared to published values of the SVL that are viewed as reasonable. Similarly, the monetary value of a loss in electric reliability can be compared to published value of lost load ("VOLL") estimates that are considered reasonable. Even environmental attributes, such as species loss, often can be compared to reasonable published estimates.

III. PG&E'S MAVF

A. The Structure of PG&E's MAVF

As described in PG&E's 2020 Risk Mitigation and Mitigation Phase ("RAMP") report, the company's MAVF consists of four attributes: (i) Safety; (ii) Electric Reliability; (iii) Gas Reliability; and (iv) Financial. The weights assigned to these four attributes are: Safety – 50 percent; Electric Reliability – 20 percent; Gas Reliability – 5 percent; and Financial – 25 percent.[40] Based on the implied SVL resulting from the attribute ranges and these weights, as discussed below, it appears these attribute weights were not determined consistent with Row 7 of the S-MAP Settlement, but instead were set arbitrarily by PG&E.

PG&E measures Safety in terms of what it calls "equivalent fatalities" ("EF") which the company defines as, "the sum of fatalities and serious injury equivalents per event occurrence."[41] Specifically, PG&E uses the formula:

$$EF = \text{Fatalities} + [0.25 \times (\text{Serious Injuries})]$$

In other words, four serious injuries are equivalent to one fatality. (According to PG&E, a serious injury is one that requires hospitalization.)[42]

PG&E measures the Electric Reliability attribute in terms of customer minutes interrupted ("CMI"). The company measures Gas Reliability as the number of customers affected. Finally, PG&E measures the Financial attribute in dollars.[43]

The attribute ranges are shown in Table 3-2 of PG&E's 2020 RAMP filing. For Safety, the range for EF is between 0 and 100. Hence, the company is assuming that the worst outcome of a risk event could be 100 fatalities, 400 serious injuries, or some combination of both

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40 GRC Ex. PG&E-2, p. WP 1-149.

41 *Id.*, p. WP 1-183.

42 *Id.*, pp. WP 1-183 to 1-184.

43 *Id.*, p. WP 1-182.

(although it is possible that these upper bounds, like the upper bounds for any attribute, can be exceeded by either forecast or actual events). The range for Electric Reliability is between 0 and four billion minutes interrupted. The range for Gas Reliability is between 0 and 750,000 customers affected. The range for Financial is between $0 and $5 billion.[44]

B. Flaws in PG&E's MAVF

There are two important empirical flaws in PG&E's MAVF, which affect the company's calculation of Risk-Spend Efficiency ("RSE") values and, presumably, the company's choice of proposed mitigation programs and expenditures on those programs. First, the company's MAVF implies a SVL that is $100 million, which is far in excess of accepted SVL estimates used by the U.S. government. As a consequence of PG&E's SVL, all else being equal, the company overestimates the value of reducing safety-related impacts of risk events, which means that mitigation programs primarily designed to reduce safety-related impacts will be ranked more highly than otherwise. Second, PG&E's nonlinear scaling functions are problematic because they lead to irrational preferences.

1. The Implied Statistical Value of Life of PG&E's MAVF Is Unreasonable

The statistical value of life ("SVL") is a measurement of the value of mitigating the risk of death. Importantly, SVL is <u>not</u> a valuation of any individual life. Instead, it is a measure of how much society is willing to pay for marginal reductions in the risk of dying across a broad population. For example, if the likelihood of death is reduced by one percent, then society should be willing to pay (0.01) × SVL for that reduction. If the SVL is $100 million, then society would be willing to pay $1 million for that reduction. However, as I discuss below, that SVL is almost 10 times greater than the actual SVL values used by U.S. government agencies to evaluate the costs and benefits of different regulations affecting safety, health, and environmental quality.

To determine the implied SVL of PG&E's MAVF, one calculates the monetary value of a weighted unit and the number of weighted units per EF, the natural unit for the Safety attribute. PG&E's Financial attribute has a range between $0 and $5 billion, and a weight of 25 percent. In other words, the Financial attribute contributes a maximum of 25 weighted units (100 scaled units × 0.25) if the level of the Financial attribute moves from $0 to $5 billion. Therefore, one weighted unit has a value of ($5 billion – $0) / 25 = $200 million.

The EF range for PG&E's MAVF is between 0 and 100, and has a weight of 50 percent. Therefore, the maximum Safety impact is equal to 50 weighted units (100 scaled units × 0.50), which is equivalent to changing the level of Safety from 0 to 100 EFs. Because 100 EFs are equivalent to 50 weighted units, then 1 EF is equivalent to 0.5 weighted units. This is the statistical value of life expressed in weighted units. Because PG&E's MAVF values one weighted unit at $200 million, the SVL is one-half of that dollar amount, or $100 million.

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[44] *Id.*, p. WP 1-182.

PG&E's SVL of $100 million is not consistent with values used by the U.S. Government for evaluating safety-related regulations. The most recent values used by the U.S. Environmental Protection Agency ("US EPA") and U.S. Dept. of Transportation ("US DOT") are based on studies from the academic literature. The US EPA uses a value of $7.4 million in 2006$, which is approximately $10 million in 2020$.[45] The most recent US DOT updates use a value of $11.8 million in 2021$.[46]

PG&E's SVL of $100 million is problematic for valuing risk mitigations. Using a SVL of $100 million will overvalue risk reduction from safety-related risk mitigations by as much as a factor of ten. (The exact overvaluation depends on whether and how a particular risk mitigation affects the other MAVF attributes.) By overvaluing safety-related mitigations, the ranking of risk mitigations by their RSEs will be skewed. This skewing of RSEs can justify forcing PG&E customers to pay for risk mitigations that would otherwise not be selected and to justify PG&E not pursuing risk mitigation measures that would otherwise be seen as more valuable.

The CPUC's Safety Policy Division (SPD) raised issues about PG&E's SVL in its report evaluating PG&E's RAMP. SPD observed that PG&E's implied VSL is approximately ten times larger than the estimates used by U.S. federal agencies.[47] In addition, in its discussion of certain PG&E RAMP report risk chapters, SPD pointed out that the outcome of PG&E's analysis could be significantly affected by using an implied VSL at odds with "broadly accepted" federal figures and recommended that "PG&E should revisit the MAVF calculations based on intervenor recommendations, which would produce a new set of risk scores, risk reductions, and RSEs.[48]

2. PG&E's Nonlinear Attribute Scales are Problematic

PG&E's use of non-linear scales for the Safety and Financial attributes is not appropriate. As discussed below, PG&E's use of non-linear scaling functions for the Safety and Financial attributes results in illogical preferences and contradictions. (However, the concerns described below do not apply to PG&E's use of non-linear scaling functions for the gas and electric reliability attributes.)

For all of its attributes, PG&E uses a scaling function with three segments, as shown in Figure 3-3 on page 3-12 of PG&E's 2020 RAMP.[49] The first segment, which lies in what PG&E calls "Minor/Moderate" in the figure, extends from a zero impact to an impact that is one percent

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[45] US EPA, "What Value of a Statistical Life Does EPA Use." U.S. Dept. of Transportation, "2016 Revised Value of a Statistical Life Guide," August 8, 2016.

[46] US DOT, "Departmental Guidance on Valuation of a Statistical Life in Economic Analysis", found at: https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis

[47] SPD's Evaluation Report on PG&E's RAMP (SPD Report), A.20-06-012, Nov. 25, 2020, p. 17.

[48] *Id.*, pp. 28, 36, 41, 43.

[49] GRC Ex. PG&E-2, p. WP 1-190. For its GRC, PG&E no longer caps its scaling functions at 100 risk units, as was shown in Figure 3-3 of PG&E's 2020 RAMP. *See* GRC Ex. PG&E-2, p. 1-54, Line 130. *See also* PG&E WP-1, Enterprise Risk Model Documentation and User Guide, June 30, 2021, at 10, Figure 1-3.

of the maximum natural unit range. In this range, the scaling function is linear and natural unit attribute levels are assigned scaled values equal to one-tenth of those levels. For example, moving from zero EFs to one EF is assigned a scaled value of 0.1 scaled units.[50]

The second segment, which lies in what PG&E describes as the "Critical Region," extends from one percent of the natural unit range to 10 percent of that range. In this region, the scaled units are determined by a non-linear, quadratic function, such that when the attribute reaches 10 percent of the natural unit range, the scaled value is 5 scaled units.

The third segment, which lies in what PG&E describes as the "Catastrophic Region" extends from 10 percent of the natural unit range to the maximum value of the range. In this range, the scaling function is linear. In this region, each increase of 1% in the level of the attribute measured in natural units has a scaled value of approximately 1.056 scaled units.[51]

PG&E's nonlinear scaling function means that avoiding an increase in an attribute level of 10 percent to 11 percent (e.g., in terms of the safety attribute 10 EFs to 11 EFs, or $500 million financial loss to $550 million financial loss) will have a change in consequence value measured in scaled units that is over 10 times larger than the scaled units associated with avoiding an attribute increase from 0 percent to 1 percent (e.g., 0 EFs to 1 EF, $0 financial loss to $50 million financial loss). The scaled values are 1.056 scaled units for the change from 10% to 11%, an increase of 1% of the natural unit range, and 0.1 scaled units for the change from 0% to 1%, which is also an increase of 1% of the natural unit range.

The nonlinear scaling functions lead to preferences that defy common sense. PG&E's nonlinear scaling functions decrease the relative value of mitigating the risk of less consequential, but more frequently occurring, events compared with the value of mitigating the risk of more consequential, but less frequently occurring, events. This is not reasonable because the repeated occurrence of a more frequently occurring, relatively low-risk event can inflict more damage, measured in dollars or fatalities, over a fixed time period, say a year, than the infrequent occurrence of a more consequential event, such as a wildfire.

For example, as discussed above, using PG&E's nonlinear scaling function for the Safety attribute, the value of reducing the expected number of equivalent fatalities caused by a risk event from 11 EFs to 10 EFs is 1.056 scaled units. The value of reducing the expected number of EFs from 1 EF to zero is 0.10 scaled units, less than one-tenth the former amount.

Suppose that risky event A is expected to occur once per year and result in 11 fatalities, which PG&E considers to be in the "Catastrophic Region." Suppose that risky event B is

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[50] Figure 3-4 of PG&E's 2020 RAMP (GRC Ex. PG&E-2, p. WP 1-190) is incorrect. In the first region, the scaling function should be 0.1r, not 10r, as shown. Similarly, in the second region, the scaling function incorrectly shows an initial value of 10r, not the correct 0.1r.

[51] The 1.056 value in the "catastrophic range" is derived from PG&E's scaling function in that region, as shown in Figure 3-3 of PG&E's RAMP (GRC Ex. PG&E-2, p. WP 1-189; *see also* Figure 1-4 in PG&E WP-1, Enterprise Risk Model Documentation and User Guide). Specifically, the line connects the points (5, 10%) and (100, 100%), slope of the scaling function in this range is: (100 – 5) / (100% - 10%) = 95 / 90% = 1.056/1%, or the value of each increase of 1% is 1.056 scaled units.

expected to occur 10 times per year and result in one fatality each time it occurs, which PG&E considers to be in the "Minor/Moderate Region." Next, suppose a mitigation program can reduce the expected number of EFs from event A by one, from 11 to 10. Even with the mitigation, event A will still have "catastrophic" damages.

Suppose another mitigation program can reduce the expected number of EFs from event B from one to zero for each occurrence of event B. This means the expected number of deaths is reduced by 10. The scaled value of this mitigation program will be $10 \times 0.1 = 1.0$ scaled units. By comparison, the mitigation program for event A, which reduces the consequences by only one death, would have a scaled value of 1.056 scaled units.

Hence, based on its nonlinear scaling function, PG&E will prefer to implement the event A mitigation, which reduces the expected number of deaths by only one, from 11 to 10, to the mitigation that reduces a total of 10 deaths from 10 occurrences of event B. In other words, PG&E would prefer to accept 10 additional deaths from 10 separate events to reducing the number of expected deaths in the Catastrophic event by one, from 11 to 10. This is not a rational preference.

This problem also applies to PG&E's nonlinear scaling function for financial impacts. Here again, the nonlinear scaling function means that PG&E would prefer to accept $500 million in additional financial damages to the public from 10 separate risk events, each having a financial cost of $50 million, compared to reducing the financial impacts to the public of a single catastrophic risk event by $50 million, from $550 million to $500 million. Such a tradeoff defies economic logic. The nonlinear scaling function means PG&E believes that the value of a dollar changes, depending on how many dollars are involved. But the value of one dollar is always … one dollar.

C. TURN's Recommended Improvements to the PG&E MAVF

TURN recommends two types of changes to PG&E's MAVF. First, TURN recommends that PG&E adopt linear scaling functions for the Safety and Financial attributes. Second, TURN recommends that PG&E adopt the changes shown below to attribute ranges and weights.

	PG&E MAVF		**TURN RECOMMENDED MAVF**	
Attribute	Range	Weight	Range	Weight
Safety	0 – 100 EFs	50%	0 – 500 EFs	40%
Electric Reliability	0 – 4 billion CMI	20%	0 – 4 billion CMI	24%
Gas Reliability	0 – 750,000 customers	5%	0 –750,000 customers	6%
Financial	0 – $5 billion	25%	0 – $5 billion	30%

TURN proposes changes to the Safety range, Safety weight, and Financial weight in order to change the SVL to a more reasonable value of $13 million. With a Financial attribute weight of 30 percent, the value of one weighted unit becomes $5 billion / 30 = $166.67 million.

Similarly, one EF is equivalent to (100 × 0.40) / 500 = 0.08 weighted units. This implies a SVL of 0.08 × $166.67 million = $13.33 million. TURN considers this SVL to be much more reasonable for purposes of calculating program RSEs. Although TURN's MAVF changes the pairwise relationship between the Safety and Financial attributes, TURN has attempted to maintain the same or similar relationships as in PG&E's MAVF between the Reliability and Financial attributes, while meeting the Commission's requirement that Safety have a weight of no less than 40%. In particular, the total weight of the Reliability attributes in the original MAVF is 20% + 5% = 25%, and that is equal to the weight of the Financial attribute and therefore equivalent to $5 billion. In the TURN MAVF, the total weight of the reliability attributes is 24% + 6% = 30%, and that is equal to the weight of the financial attribute and therefore again equivalent to $5 billion. Notice also that the ratio of the reliability weights is preserved at 4:1, and the relative weights of both reliability attributes to the Financial attribute are both preserved at 1:5. Hence, the relative dollar equivalences of each of the attribute ranges are preserved.

Unfortunately, it is foreseeable that a risk event in PG&E's territory could cause 500 EFs. Before the Camp Fire, the most deaths from a wildfire in PG&E's service territory was the Tubbs Fire, which killed 22 people.[52] The Camp Fire, which was caused by PG&E's admitted negligence, killed almost four times more people. Therefore, it is not inconceivable that another risk event caused by PG&E equipment and/or negligence in the wildland-urban interface could result in 500 EFs.

Such a Safety range with 500 EFs is consistent with the S-MAP Settlement. As discussed previously, and as PG&E itself has interpreted in the GRC, Principle 2 (S-MAP Settlement Appendix Row 3) of the S-MAP Settlement does not limit attribute ranges to include only *historically* observable levels, but instead allows them to include potentially observable impacts from a future risk event. Given PG&E's admitted criminal negligence in the Camp Fire and the difficult-to-predict behavior of wildfires, a Safety Range upper bound of 100 EFs does not represent an absolute limit on the potential consequences from future risk events caused by the company's equipment or negligence, Adjusting the upper bound is particularly warranted when the combination of PG&E's limit and Safety weight results in an excessive SVL. Finally, it is notable that PG&E uses 625 as its maximum value for EF in its distribution of potential consequences from a catastrophic wildfire.[53]

The changes to the attribute ranges and weights made by TURN, which are designed to yield a more reasonable SVL, reduce the Safety attribute consequence values and reduce the Safety impacts of risk mitigation measures. On the other hand, adopting linear scaling functions for the Safety and Financial attributes: (i) increases the attribute levels for all risks having Safety and Financial impacts, because the linear scaling function always lies above PG&E's non-linear scaling function; (ii) increases the relative risk mitigation of low consequence events; and (iii) reduces the relative risk mitigation of high consequence events.

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[52] Source: PG&E GRC workpaper "EO-WLDFR-4_Wildfire Bowtie Analysis.xlsx," worksheet "Large Fires (PGETerritory)," cell O169.

[53] Source: PG&E GRC workpaper, "EO-WLDFR-1_Risk Model Input File.xlsm," worksheet "REF_Conseq" row 7.

In Data Requests in PG&E's GRC, TURN asked PG&E to run a sensitivity analysis to compare the results using TURN's recommended MAVF compared to PG&E's MAVF. TURN asked PG&E to isolate the impacts of each of TURN's two recommended changes and to provide a third analysis showing the aggregate impact of applying both changes, which is TURN's recommendation. In PG&E's responses, the impact of extending the Safety range to 500 EFs reduced RSEs for mitigations having safety impacts, as expected.[54] Similarly, the effect of adopting linear scales tended to increase RSE values, again as expected.[55], [56]

As for the combined impact of applying both of TURN's recommended changes, for Wildfire-related programs, the TURN MAVF generally results in lower RSE values and B/C ratios. This is because the Safety attribute comprises a significant portion of the overall Wildfire risk score, and the effect of the more reasonable SVL in TURN's MAVF is greater than the offsetting effect of using a linear scaling function for the Safety and Financial attributes.

IV. EXPRESSING RSE VALUES AS BENEFIT-COST RATIOS

RSE values are not the same as benefit-cost ratios, in the way that benefit-cost ratios are commonly understood and used. PG&E states in its GRC that, "RSE is a metric for representing the benefit to cost ratio of a mitigation, *where benefit is described in terms of risk reduction*."[57] As PG&E's statement recognizes, benefit-cost ratios are highly desirable in deciding whether a proposed program to mitigate risk would be cost effective. However, as the italicized language indicates, the numerator of an RSE, reflecting the benefit from a mitigation, is expressed in units of risk reduction. In contrast, the numerator in traditional benefit-cost ratios is expressed in financial terms, *i.e.*, dollars, in the United States. Without expressing risk reduction units in dollars, one cannot reach a conclusion about whether the benefits of a mitigation exceed the costs, which is the typical purpose of a benefit-cost ratio.

For example, suppose a specific mitigation program has a planned expenditure of $500 million and an RSE of 2.5. Because an RSE is expressed as the present value of risk mitigated, measured in weighted units per present value dollar expenditure, an RSE expressed that way can only provide an ordinal ranking of the cost-effectiveness of risk mitigations. In other words, if we know that the RSE for program A is greater than the RSE for program B, then we can conclude that program A is more cost-effective than program B. However, we cannot determine whether the economic value of the risk reduction for either or both programs is greater than their respective costs. For this, we need a different measure. The most common and, as demonstrated below, easily calculated measure, is the standard benefit-cost ("B/C") ratio. A B/C ratio divides the present value of the benefits measured in dollars by the present value of the costs measured in dollars. B/C ratios greater than 1.00 indicate cost-effectiveness because the present value benefits exceed the present value costs.

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54 PG&E response to TURN DR 78-1.

55 PG&E response to TURN DR 37-2.

56 Furthermore, as explained in Attachment 1, because the TURN MAVF reduces the value of one weighted unit from $200 million to $166.67 million, expressing RSEs calculated using the TURN MAVF requires dividing the RSEs by six, rather than by five.

57 Ex. PG&E-2, p. 1-12, lines 11-12 (emphasis added).

It is important to express RSEs as B/C ratios for several reasons. First, the information provided by B/C ratios provides additional information regarding which programs will spend ratepayer dollars most efficiently. Second, by indicating which expenditures are cost-effective in financial terms, B/C ratios provides useful information to help keep rates affordable by ensuring that the financial benefits of a mitigation exceed the cost paid by ratepayers.

It is straightforward to express the present value of weighted risk units mitigated into a present value in dollar terms for any MAVF that includes a Financial attribute. As was shown previously, under PG&E's MAVF, the company values one weighted unit at $200 million. Using this value, the RSEs PG&E has calculated for its risk mitigation programs can be easily expressed as B/C ratios. In fact, as shown in Attachment 1 to this Appendix, ***PG&E's RSEs can be expressed as B/C ratios simply by dividing the RSE by five***.

For example, consider the values shown in the table in GRC Exhibit PG&E-2, WP 1-68 – WP 1-69. Line (2) on page WP 1-68 presents RSEs for the risk mitigation identified as "3A and 4C Line Recloser Replacement [3A]," which is part of the program "DOVHD-M010" meaning mitigation number 10 for the risk "Failure of Electric Distribution Overhead Assets." As shown on line (2), PG&E reports a PV sum of risk reduction for this specific program ID of 0.47 weighted units and a PV cost of $5.72 million.[58] PG&E expresses the RSE for its programs in weighted units per million dollars. Hence, for this specific program, the RSE is 0.47 / 5.72 = 0.08, as shown in the rightmost column of line (2). The corresponding B/C ratio is just 0.08 / 5 = 0.016. Thus, based on PG&E's analysis, the present value cost of the program is 62.5 times greater than the present value benefit.[59] Put another way, PG&E's calculations show that this mitigation provides 1.6 cents of benefits for every dollar spent.

Importantly, the fact that the present value benefits of an investment exceed its present value costs is not a sufficient condition for an investment or expenditure to be undertaken by a utility. Electric utilities, like all companies, face budget constraints. If there are only so many dollars available to spend, then it may be the case that not all investments with B/C ratios greater than one can be funded. In the case of an electric utility, which collects funding from its ratepayers, the budget constraint will be determined, in part, by the need to ensure rates remain affordable. In addition, if utility regulators authorize measures with B/C ratios less than one -- in other words, with present value costs that exceed their present value benefits because, for example, such measures are required by law -- then it may be necessary to reject some measures with B/C ratios above 1.0 in order to preserve affordability.

V. THE VALUE OF USING APPROPRIATELY GRANULAR TRANCHES IN USING RSEs AND B/C RATIOS FOR DECISION MAKING

It is important to consider tranche-level RSEs, not aggregate, program-level RSEs, when evaluating the cost-effectiveness of specific risk mitigation program. PG&E calculates program-level RSEs by summing up the NPV risk reductions and NPV costs of the individual

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[58] On November 1, 2021, in its GRC PG&E issued updated RSE values for its mitigation programs. The values for this specific program did not change. In addition, PG&E's February 25, 2022 revisions did not include revisions to the workpapers for GRC Ex. PG&E-2.

[59] Calculated as 1 / 0.016 = 62.5.

tranches and then dividing the overall NPV risk reduction by the overall cost. Thus, a program-level RSE can be thought of as a weighted average of individual tranche RSEs within that program. The weight of each individual tranche RSE is the cost of the individual tranche relative to the cost of the entire program.

Consequently, the program-level RSEs mask variations in the individual tranche RSEs: some of the tranche RSEs will be greater than the program average RSE and the others will be below the average. Hence, at the tranche level, some RSEs within a given program may demonstrate that applying the program to that tranche is cost-effective, while applying it to other tranches is not. Understanding the differences in tranche-level RSEs is important to ensure that (i) the most cost-effective risk mitigations are pursued, and (ii) rates remain affordable.

Tranche-level RSEs are particularly important for large-scale multi-year programs where work is targeted to the highest risk elements of the system first and then proceeds to decreasingly risky system elements. Tranche-level RSEs provide the utility, regulators and parties important information to determine the point at which such a program is no longer cost-effective and no longer a good use of limited ratepayer funds.

The S-MAP Settlement adopted in D.18-12-014 requires that investor-owned utilities calculate RSE values at the tranche level. Row 14 of the Appendix to the S-MAP Settlement states that the utility is required to calculate "[r]isk reductions from mitigations and risk spend efficiencies at the Tranche level" in order to "give[] a more granular view of how mitigations will reduce risk."

In particular, Row 14 requires, "for each Risk Event, the utility [to] subdivide the group of assets or the system associated with the risk into tranches." The last paragraph of Row 14 provides the principal that the utility is to use in determining the composition of the tranches. Each element in an identified tranche is to "have homogeneous risk profiles (i.e., considered to have the same LoRE and CoRE)." In other words, to comply with the Settlement, all of the assets in each tranche should be grouped so that there are no significant differences in either the LoRE or the CoRE of those assets. This means that, if there is a meaningful difference, the asset group needs to be broken out into more granular tranches.

In addition, Row 14 requires the determination of tranches to be "based on how the risks and assets are managed by each utility, data availability and model maturity." This requirement means that data that the utility uses to manage the risk and prioritize the execution of mitigations must be used in the determination of the tranches. As Row 14 states, the utility must strive to achieve as deep a level of granularity as reasonably possible.

Also, Row 14 includes a requirement for the utility to explain for each risk how the utility determined the tranches. Specifically, in its RAMP submission, the utility must provide its "rationale for the determination of Tranches, or for a utility's determination that no Tranches are appropriate for a given Risk Event."

Using insufficiently granular tranches creates the same problem as using program-level RSEs. If tranches are not sufficiently granular and include assets with widely varying LoRE and CoRE values, then a tranche-level RSE will reflect an average over disparate assets.

VI. CONCLUSION

TURN hopes this Appendix assists Energy Safety in understanding the basis of the risk spend efficiency (RSE) and Benefit/Cost (B/C) ratios that are presented in TURN's comments.

Attachment 1: B/C RATIO DERIVATION

Recall that an RSE for a risk mitigation program equals the present value ("PV") of the weighted units mitigated by the program divided by the present value of the dollar expenditure on the risk mitigation program. PG&E expresses the RSE for its programs in risk units per million dollars.

To express the weighted units of risk reduction as a dollar value and, hence, express a RSE as a B/C ratio, we must account for both the scaling factor applied to the CoRE values and program costs that are reported in millions of dollars. Hence, PG&E's reported RSEs are expressed as:

$$\text{RSE}_{\text{REPORTED}} = \frac{[\text{PV Weighted Risk Units Mitigated} \times 1{,}000]}{[\text{PV Cost} / 1{,}000{,}000]}. \quad (1)$$

This is equivalent to:

$$\text{RSE}_{\text{REPORTED}} = \frac{[\text{PV Weighted Risk Units Mitigated}]}{[\text{PV Cost}]} \times (1{,}000{,}000) \times (1{,}000). \quad (2)$$

Hence,

$$\frac{[\text{PV Weighted Risk Units Mitigated}]}{[\text{PV Cost}]} = \frac{\text{RSE}_{\text{REPORTED}}}{(1{,}000{,}000) \times (1{,}000)}. \quad (3)$$

The left-hand side of equation (3) is risk-spend efficiency expressed as the ratio of weighted units to dollars. The right-hand side is the required conversion of the RSE reported by PG&E.

Next, we express the RSE reported by PG&E as the ratio of dollars to dollars. As discussed in my testimony, using PG&E's MAVF, one weighted unit has a dollar value of $200 million. Therefore, we multiply both sides of equation (3) by $200 million to express weighted units mitigated by their dollar value:

$$\frac{[\text{PV Weighted Risk Units Mitigated}]\times(\$200,000,000)}{[\text{PV Cost}]} = \frac{\text{RSE}_{\text{REPORTED}}}{(1,000,000)\times(1,000)}\times(\$200,000,000) = \text{RSE}_{\text{REPORTED}}\times\left[\frac{\$200,000,000}{\$1,000,000,000}\right] \quad (4)$$

The resulting ratio on the left-hand side is now the present dollar value of the risk reduction divided by the present value of the cost. In other words, it is the B/C ratio for the mitigation. The right-hand side is the B/C ratio expressed in terms of the RSE reported by PG&E. Thus, we can rewrite equation (4) as:

$$\text{B/C Ratio} = \frac{\text{RSE}_{\text{REPORTED}}}{5}$$

Using the TURN MAVF, the value of one weighted unit is \$5 billion / 30 weighted units ≈ \$166.67 million. Therefore, we modify equation (4) as

$$\frac{[\text{PV Weighted Risk Units Mitigated}]\times(\$5\times10^{9}/30)}{[\text{PV Cost}]} = \frac{\text{RSE}_{\text{REPORTED}}}{(1,000,000)\times(1,000)}\times(\$5\times10^{9}/30) = \text{RSE}_{\text{REPORTED}}\times\left[\frac{\$5\times10^{9}/30}{\$10^{9}}\right] \quad (5)$$

Hence, for the TURN MAVF:

$$\text{B/C Ratio} = \frac{\text{RSE}_{\text{REPORTED}}}{6}$$