2025 Risk Assessment Mitigation Phase

(Chapter RAMP-3)

Risk Quantification Framework

May 15, 2025

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CHAPTER RAMP-3: RISK QUANTIFICATION FRAMEWORK

I. INTRODUCTION

SoCalGas and SDG&E's risk quantification framework described in this chapter is designed to comply with the Commission's Risk-Based Decision-Making Framework (RDF). Chapter RAMP-1: Overview describes the procedural history of the RDF, including four decisions issued since the Companies filed their 2021 RAMP Applications and Reports – D.21-11-009, D.22-10-002, D.22-12-027 (Phase 2 Decision), and D.24-05-064 (Phase 3 Decision) – which substantially modified the RDF and adopted new regulations governing RAMP submissions.[1] The Companies' 2021 RAMP Reports implemented a Multi-Attribute Value Function (MAVF) methodology set forth in D.18-12-014. The Phase 2 Decision superseded D.18-12-014 and replaced the MAVF methodology with a Cost-Benefit Approach (CBA), which was further modified in the Phase 3 Decision and is implemented in the Companies' 2025 RAMP Reports.

SoCalGas and SDG&E's risk quantification framework accounts for applicable laws related to public safety and reliability, while building upon such requirements consistent with SoCalGas's and SDG&E's dedication to continuous improvement. The RDF has substantially increased in complexity since the Companies filed their 2021 RAMP Reports, and SoCalGas and SDG&E have evolved their data management and analytical capabilities to meet these expanded requirements.

Chapter RAMP-3 describes the components, methods, and sequencing of the quantitative framework adopted by SoCalGas and SDG&E in accordance with the following steps of the RDF:

- Step 1A: Building a Cost-Benefit Approach;
- Step 1B: Identifying Risks for the Enterprise Risk Register;
- Step 2A: Risk Assessment and Risk Ranking in Preparation for RAMP;
- Step 2B: Selecting Enterprise Risks for RAMP; and
- Step 3: Mitigation Analysis for Risks in RAMP.

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[1] Chapter RAMP-1: Overview more fully describes the procedural history of the RDF Framework, as established in Decision (D.) 14-12-025, D.16-08-018, D.18-12-014, D.20-01-002, D.21-11-009, D.22-10-002, D.22-12-027, and D.24-05-064.

The above process was used for each risk in the 2025 RAMP Reports and serves as the outline for this chapter.

The RDF incorporates various prescriptive approaches to risk and mitigation quantification, including multiple permutations of Cost-Benefit Ratios (CBRs).[2] In adopting a CBA, the Commission acknowledged that CBRs are not intended to "serve as the sole determinants of [utility] proposals or Commission decisions on risk Mitigations."[3] Instead, the Commission retained language from prior decisions explaining that a utility is not bound to select a mitigation strategy based solely on the CBRs produced under the CBA:

> In the RAMP and GRC, the utility will clearly and transparently explain its rationale for selecting Mitigations for each risk and for its selection of its overall portfolio of Mitigations. […] Mitigation selection can be influenced by other factors including, but not limited to, funding, labor resources, technology, planning and construction lead time, compliance requirements, Risk Tolerance thresholds, operational and execution considerations, and modeling limitations and/or uncertainties affecting the analysis. In the GRC, the utility will explain whether and how any such factors affected the utility's Mitigation selections.[4]

Addressing each risk thus requires a thoughtful, proactive approach that extends beyond standard quantification methods that merely consider the expected outcome of a risk event.

During preparation of the 2025 RAMP Reports, certain issues have been under consideration in Phase 4 of the Commission's Risk OIR.[5] For example, risk tolerance, which is the level of residual risk one is willing to accept, is currently under consideration in Phase 4. Accordingly, the Companies have not incorporated risk tolerance in their 2025 RAMP Reports but reserve the right to incorporate risk tolerance in future proceedings.

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[2] *See, e.g.,* D.24-05-064 at Appendix A. For example, Row 25 of the RDF provides a highly specified process for calculating CBRs, including the requirement to provide three specified discount rate scenarios. *Id.* at A-15. Rows 14 and 16 of the RDF extend the CBR requirement to provide such calculations at the tranche level. *Id.* at A-13, A-14. Row 26 of the RDF requires a presentation of CBR calculations for each GRC post-test year. *Id.* at A-17.

[3] D.22-12-027 at 26.

[4] *Id.* at 26-27; *see also, id.* at 56 (Finding of Fact (FOF) 11) (*citing* RDF Row 26).

[5] *See* R.20-07-013 (the Risk OIR), Assigned Commissioner's Phase 4 Scoping Memo and Ruling (September 13, 2024) at 2-3.

II. STEP 1A: BUILDING A COST BENEFIT APPROACH

A. CoRE Attributes

Rows 2 through 6 of the RDF's "Step 1A – Building a Cost-Benefit Approach," shown in Table 1 below, describe the determination of attributes for the quantitative framework.[6]

Table 1: Rows 2-7 of the RDF

#	RDF Element Name	Element Description & Requirements
2	Cost-Benefit Approach Principle 1 – Attribute Hierarchy	Attributes are evaluated together as a hierarchy, such that the primary Attributes are typically labels or categories and the sub-Attributes are observable and measurable.
3	Cost-Benefit Approach Principle 2 – Measured Observations	Each sub-Attribute has Levels expressed in Natural Units that are observable during ordinary operations and as a Consequence of the occurrence of a Risk Event.
4	Cost-Benefit Approach Principle 3 – Comparison	Use a measurable proxy for an Attribute that is logically necessary but not directly measurable. This principle only applies when a necessary Attribute is not directly measurable. For example, a measure of the number of complaints about service received can be used as a proxy for customer satisfaction.
5	Cost-Benefit Approach Principle 4 – Risk Assessment	When Attribute Levels that result from the occurrence of a Risk Event are uncertain, assess the uncertainty in the Attribute Levels by using expected value or percentiles, or by specifying well-defined probability distributions, from which expected values and tail values can be determined. Monte Carlo simulations or other similar simulations (including calibrated subject expertise modeling), among other tools, may be used to satisfy this principle.
6	Cost-Benefit Approach Principle 5 – Risk Assessment	Apply a monetized value to the Levels of each of the Attributes using a standard set of parameters or formulas, from other government agencies or industry sources, as determined by the Phase II Decision Adopting Modifications to the Risk-Based Decision-Making Framework Adopted in D.18-12-014 and Directing Environmental and Social Justice Pilots in Rulemaking (R.) 20-07-013. A utility may deviate from the agreed upon standard set

[6] While *Step 1A – Building a Cost Benefit Approach* of Appendix A has further elements, only the most pertinent elements are shown here.

#	RDF Element Name	Element Description & Requirements
		of parameters or formulas by submitting a detailed explanation as to why the use of a different value would be more appropriate. The use of a different set of parameters or formulas to determine the Monetized Levels of Attributes requires an analysis comparing the results of its "equivalent or better" set of parameters or formulas against the results of the agreed upon standard set of parameters or formulas.

SoCalGas and SDG&E comply with these elements by assessing the Consequence of Risk Event (CoRE) attributes shown in Table 2.

Table 2: CoRE Attributes by Company

Attribute	SDG&E	SCG
Safety	✔	✔
Electric Reliability	✔	
Gas Reliability	✔	✔
Financial	✔	✔

The attributes and their respective sub-attributes and monetized values are summarized in Table 3, and their determination is explained in the subsequent sections. While these attributes and sub-attributes serve as the general approach to consequence valuation, consequence modeling for particular risks is augmented to include risk-specific modeling consequences. This augmentation is further described below in Section VI.C.2: Consequence Modeling for Certain Risks.

Table 3: CoRE Attributes and Monetized Values (Direct, in 2024 $)

Attributes	Sub-Attributes	Monetized Value[7]
Safety	Fatality	$16.2 million per fatality
Electric Reliability (SDG&E Only)	Customer Minute Interrupted[8]	$3.76 per CMI
Gas Reliability	Gas Meter Outage	$3,868.79 per gas meter experiencing outage
Financial	US Dollar	$1

B. Valuing the CoRE Safety Attribute

The CoRE Safety Attribute estimates human injuries and fatalities resulting from a risk event. In determining the CoRE values – both Pre-Mitigation CoRE in accordance with RDF Row 18 (which, in turn, feeds into Pre-Mitigation Risk Value per RDF Row 19), and Post-Mitigation CoRE in accordance with RDF Row 21 (which, in turn, feeds into Post-Mitigation Monetized Risk Value per RDF Row 22) – are determined for each risk in this RAMP filing for which Safety is relevant. The Safety CoRE estimates the potential for a risk event to result in human injuries or fatalities. In turn, a mitigation's benefits for the Safety CoRE reflect the degree to which the mitigation is estimated to reduce the magnitude of those injuries or fatalities.

In accordance with D.24-05-064, RDF Row 6 guidance for monetized levels of attributes, SoCalGas and SDG&E use a California-adjusted VSL (VSL-CA) of $16.2 million for calculating the Safety Attribute CoRE. This value is derived by replicating the Department of Transportation's (DOT) methodology[9] as applied beginning from the 2012 DOT VSL of $9.1 million and extrapolating that methodology to 2024, with adjustments for California.

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7 Monetized values were developed using the latest available data; through year-end 2024.

8 Customer Minute of Interruption, a standard measure for electric outages.

9 DOT, *Departmental Guidance – Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses* (March 2021), *available at:* https://www.transportation.gov/sites/dot.gov/files/2021-03/DOT%20VSL%20Guidance%20-%202021%20Update.pdf.

Methodology

The DOT VSL of $9.1 million from 2012 is scaled to the current period, consistent with the DOT's methodology, using the following formula:

$$VSL_t = VSL_0 * \left(\frac{P_t}{P_0}\right) * \left(\frac{I_t}{I_o}\right)^{\varepsilon}$$

where:

- 0 = Original Base Year
- t = Current Base Year
- P0 = Price Index in original base year
- P_t = Price Index in Year t
- I_0 = Real Incomes in original base year
- I_t = Real Incomes in Year t
- ε = Income Elasticity of VSL

The National VSL is then adjusted for California using:

$$VSL_{CA} = VSL_{USA} * \left(\frac{P_{t,CA}}{P_t}\right) * \left(\frac{I_{t,CA}}{I_t}\right)^{\varepsilon}$$

where:

- $P_{t,CA}$ = Price Index for California in Year t
- $I_{t,CA}$ = Real Incomes in California in Year t

Data Sources

- National VSL: Department of Transportation[10]
- Inflation: Bureau of Labor Statistics (CPI-U)[11]
- California CPI: Department of Industrial Relations[12]
- Earnings: Bureau of Labor Statistics[13]

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10 DOT, *Departmental Guidance on Valuation of a Statistical Life in Economic Analysis*, *available at* https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis.

11 U.S. Bureau of Labor Statistics, *Table 1. Consumer Price Index for all Urban Consumers (CPI-U) U. S. city average, by expenditure category* (March 2025), *available at:* https://www.bls.gov/news.release/cpi.t01.htm.

12 State of California – Department of Industrial Relations, *California Consumer Price Index (1955-2025)*, *available at:* https://www.dir.ca.gov/oprl/CPI/EntireCCPI.PDF.

13 U.S. Bureau of Labor Statistics, *Labor Force Statistics from the Current Population Survey - Earnings - Current Population Survey (CPS)*, *available at:* https://www.bls.gov/cps/earnings.htm.

Assumptions

Elasticity is assumed to be 1. The base VSL of $9.1 million is used for all calculations after 2012.

Table 4: VSL Values Over Time

Year	National VSL (million $)	CA VSL (million $)
2024	*13.7*[14]	16.2
2023	13.2	15.2
2022	12.5	15.0
2021	11.8	14.4
2020	11.6	13.9
2019	10.9	12.6
2018	10.5	12.0
2017	10.2	11.6
2016	9.9	11.1
2015	9.6	10.6
2014	9.4	10.2
2013	9.2	10.1
2012	9.1	10.1

The Phase 2 Decision requires, "depending on the availability of data," for the IOUs to apply "(1) a serious injury as 0.25 of a fatality, or (2) the injury severity level using DOT estimates for the value of injury prevention as indicated [in the following table]:"[15] Safety incidents resulting in non-fatal injuries are quantified using a fraction of the VSL.

Table 5: DOT Fractional VSLs – Corresponding with Injury Severity

Injury Severity	Fraction of VSL
Minor	0.003
Moderate	0.047
Serious	0.105
Severe	0.266
Critical	0.593
Unsurvivable	1.000

14 Preliminary estimate.

15 D.22-12-027 at 63-64 (Ordering Paragraph (OP) 2.).

SoCalGas and SDG&E model a serious injury as 0.25 of a fatality for asset-based risks and the workplace violence components of Employee Safety and Contractor Safety Risks. For Employee Safety and Contractor Safety Risks, where more data is available, a more granular approach is used. Prior to the issuance of the Phase 2 Decision, SoCalGas and SDG&E did not track "injury severity" data in a manner consistent with all DOT categories shown in Table 5. Therefore, SoCalGas and SDG&E cannot currently accommodate all six levels of the DOT MAIS injury severity shown in Table 5. Instead, SoCalGas and SDG&E have applied the Federal Aviation Administration's (FAA) Abbreviated Injury Scale (AIS).[16] Although the FAA AIS also includes six categories, the middle four are grouped into a "serious injury" category as a composite of the categorizations, which better aligns with SoCalGas's and SDG&E's available safety incident data. Accordingly, and as derived from the VSL-CA value of $16.2 million per fatality, serious injuries are valued at $4.10 million ($16.2 million × 0.253) and minor injuries are valued at $0.049 million ($16.2 million × 0.003).

The resulting SoCalGas and SDG&E safety sub-attribute values and monetized values are shown in Table 6 and are applied in calculating the annualized pre-mitigated risk and mitigation benefits relating to Safety Attribute CoRE.

Table 6: Safety Sub-Attributes, Values and Monetized Value (Direct, in 2024 $millions)

Safety Sub-Attributes		Relative Value	Monetized Value[17]
Fatality		1.000	16.2
Serious Injury		0.253	4.10
Minor Injury		0.003	0.049

16 The FAA's AIS categorizations of injuries are: minor, moderate, serious, severe, critical and fatal. *See* FAA, *Economic Values for FAA Investment and Regulatory Decisions, A Guide: 2024 Update – Section 2: Treatment of the Values of Life and Injury in Economic Analysis* (2024), *available at:* https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/econ-value-section-2-tx-values.pdf.

17 Monetized values were developed using the latest available data; through year-end 2024.

In the 2021 RAMP, SDG&E included Acres Burned as a sub-attribute to account for the detrimental environmental impacts of wildfire smoke.[18] During the transition to the Cost Benefit Approach, this sub-attribute was eliminated from the Safety Attribute due to several challenges, including the difficulty of accurately identifying and quantifying the potential number of SDG&E customers impacted by smoke related to utility-caused wildfires and assessing the extent of the effects on both customers and the environment. The complexity arises from several factors, including but not limited to the variability in wildfire behavior, identifying and quantifying the type of material burned, the duration of the fire, the diverse locations and existing characteristics of the customers impacted, and the difficulty in predicting long-term environmental impacts. While the removal of the Acres Burned sub-attribute may lead to an underestimation of wildfire risk in SDG&E's service territory, this change is intended to streamline the wildfire risk quantification process and improve the accuracy of SDG&E's assessments to provide a more transparent wildfire risk evaluation.

As a utility, SDG&E lacks the information necessary to adequately quantify and measure the health or overall environmental impacts of utility-related wildfire smoke. SDG&E is open to collaborating with Safety Policy Division, Energy Safety, and academia, to assess whether the potential risks of utility-related wildfire smoke on air quality and the environment can be isolated and whether this should be incorporated into future cost-benefit calculations. SDG&E's core wildfire mitigation efforts remain aimed at reducing the risk of ignition, or the incidence of ignition evolving into a catastrophic wildfire; thus, SDG&E's wildfire mitigation efforts have the simultaneous effect of reducing the impacts of wildfire smoke.

C. Valuing the CoRE Electric Reliability Attribute

The CoRE Electric Reliability Attribute estimates electric outages resulting from a risk event. In determining the CoRE values – both Pre Mitigation CoRE in accordance with RDF Row 18 (which, in turn, feeds into Pre Mitigation Risk Value per RDF Row 19), and Post Mitigation CoRE in accordance with RDF Row 21 (which, in turn feeds into Post Mitigation Monetized Risk Value per RDF Row 22) – are identified for each SDG&E Risk in this RAMP filing for which Electric Reliability is relevant. The CoRE Electric Reliability estimates the potential for a risk event to result in outages. In turn, a mitigation's benefits with respect to the

[18] *See* SoCalGas and SDG&E 2021 RAMP Report, Chapter RAMP-C at RAMP-C-5 (Table 2: Risk Quantification Framework and Safety Index).

Electric Reliability CoRE reflects the degree to which the mitigation is estimated to reduce the magnitude of those outages.

In accordance with the RDF's requirements on valuing the Electric Reliability attribute,[19] SDG&E captures electric reliability in terms of customers experiencing electric outages. In the 2021 RAMP, SDG&E quantified electric reliability value in terms of two sub-attributes: outage duration (*i.e.*, SAIDI) and outage frequency (*i.e.*, SAIFI).[20] Consistent with changes to the RDF, SDG&E has modified its Electric Reliability Attribute CoRE in the 2025 RAMP to be valued by Customer Minutes of Interruption (CMI), in alignment with PG&E, SCE, and the LBNL's ICE version 1.0.

CMI is monetized using the LBNL ICE Version 1.0,[21] calibrated with SDG&E-specific customer demographics, historical billing and load information, regional economic measures, and utility historical reliability metrics as of year-end 2023, based on data availability. The table below outlines CMI and cost per event values per sector,[22] using system-wide averages.

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19 Decision D.22-12-027 at 64, OP 2(b) requires the following:

(b) Each IOU shall use the most current version of the Lawrence Berkeley National Laboratory (LBNL) Interruption Cost Estimate (ICE) Calculator to determine a standard dollar valuation of electric reliability risk for the Reliability Attribute included in Appendix A.

i. If applicable, each IOU shall justify its choice of an alternative model by providing an analysis comparing the results of its preferred alternative model to the results using the ICE Calculator.

ii. Each IOU shall participate in the customer survey process needed to incorporate California data into the ICE 2.0 model.

iii. Each IOU is authorized to submit a Tier 1 advice letter establishing a memorandum account to track the costs of participating in ICE 2.0 Calculator development for costs up to $600,000, plus an additional 15 percent for potential incremental costs, and to seek recovery of these costs at a later date.

20 SAIDI = System Average Interruption Duration Index; SAIFI = System Average Interruption Frequency Index.

21 At the time of SDG&E's 2025 RAMP filing, ICE 1.0 was the latest known and available LBNL model. Within a reasonable timeframe and as needed, SDG&E will update its approach accordingly after the slated successor tool, ICE 2.0, becomes available.

22 C&I: Commercial and Industrial customers.

Table 7: SDG&E Monetized CMI
(Direct, in 2024 $ millions)

Sector	No. of Customers	Cost Per Event	Total CMI in 2023 (000s)	Cost Per Average kW (2024 $s)	Cost Per Unserved kWh	Total Cost of Sustained Interruptions (2024 $millions)	$/CMI
Medium and Large C&I	26,421	20,560.5	1,649	464.9	227.7	310.7	188.38
Small C&I	135,253	909.3	9,003	808.7	396.1	70.3	7.81
Residential	1,355,077	5.6	94,283	12.4	6.1	4.3	0.05
All Customers	1,516,751	444.2	104,935	349.5	171.2	385.4	$3.67

The standardized $ per CMI value is determined by dividing the Total Cost of Sustained Interruptions by the Total CMI in 2023 and then applying a 2.5% inflation rate for 2024. The resulting SDG&E Electric Reliability Attribute value produced by the LBNL ICE Version 1.0 is $3.76 per CMI, which is applied uniformly to all customer types in CoRE modeling.

D. Valuing the CoRE Gas Reliability Attribute

The CoRE Gas Reliability Attribute estimates gas outages resulting from a risk event. In determining the CoRE values – both Pre-Mitigation CoRE in accordance with RDF Row 18 (which, in turn, feeds into Pre-Mitigation Risk Value per RDF Row 19), and Post-Mitigation CoRE in accordance with RDF Row 21 (which, in turn feeds into Post-Mitigation Monetized Risk Value per RDF Row 22) – are used for each risk in this RAMP filing for which Gas Reliability is relevant. The Gas Reliability CoRE estimates the potential for a risk event to result in gas meter outages. In turn, a mitigation's benefits with respect to the Gas Reliability Attribute CoRE reflect the degree to which the mitigation is estimated to reduce the magnitude of those gas meter outages.

In accordance with the RDF's Row 6 guidance on valuing the Gas Reliability Attribute,[23] SoCalGas and SDG&E have adopted the implied monetary value of a gas meter experiencing an outage based on their respective 2021 MAVF figures. In calculating MAVF for the 2021 RAMP filings, the Meters Out sub-attribute of Gas Reliability had a scale of 0 to 100,000 or 0 to 50,000 gas meters experiencing outage, for SoCalGas and SDG&E, respectively. The number of meter outages was one of two Gas Reliability sub-attributes and was given a weight of 50% within the Reliability attribute of the MAVF for SoCalGas and 25% for SDG&E. This sub-attribute was equivalent to the Financial attribute MAVF in SoCalGas and SDG&E's 2021 RAMP filings, which had a scale of 0 to $500 million and represented 17%[24] of the overall MAVF value.[25] Using that equivalency, one gas meter experiencing an outage equates to $3,868.79 in 2024 dollars, accounting for inflation from 2021, for both Companies.[26] In the transition to the CBA, the Companies determined it was not feasible to develop a methodology for calculating a Gas Curtailment sub-attribute in the time available and only utilize meter outages as a single attribute to measure gas reliability CoRE. This decision was due to lack of data to quantify curtailment volumes as distinct impacts from meter outages during a risk event. Because gas curtailment is an important component in measuring how customers are impacted during a risk event, SoCalGas and SDG&E continue to evaluate how this sub-attribute can be accurately incorporated into the CBA in the future.

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[23] D.22-12-027 at 64-65, OP 2(c) requires the following:

(c) Each IOU shall apply a dollar value for gas reliability based on the implied value from their most recent Multi-Attribute Value Function Risk Score calculation presented in their most recent RAMP or shall justify its choice of an alternative model by providing an analysis comparing the results of its preferred alternative model to the results using the implied values. If using the implied value from its most recent RAMP: […].

ii. For SDG&E and SoCalGas, use the 2021 RAMP filings.

[24] SoCalGas and SDG&E revised the 2021 RAMP MAVF to remove the Stakeholder Satisfaction attribute in the GRC filing, per SPD's guidance in their evaluation report. As a result of removing this attribute, the weight to the financial attribute increased from 15% shown in the 2021 RAMP report to 17% in the GRC filing.

[25] *See* SoCalGas and SDG&E 2021 RAMP Report, Chapter RAMP-C at RAMP-C-6 (Table 3: Risk Quantification Framework Reliability Index for SDG&E).

[26] 1 meter experiencing outage = ($500 million / 50,000 meters out) * (23% Reliability Weighting / 17% Financial Weighting) * (1 reliability attribute / 4 reliability attributes).

As part of gas reliability quantification, SoCalGas and SDG&E's CBA currently does not quantify the value of the gas system as an integral component of California's interconnected energy system and the many functions it provides as the reliability backstop for the electric grid and broader energy system for the State as well as the region. For instance, a considerable share of the CAISO generation fleet consists of gas-fired power plants which are expected to be called upon in the foreseeable future.[27] Therefore, electric sector reliability is dependent on gas infrastructure and electric sector reliability risks can be mitigated through leveraging gas infrastructure. As the recent North American Electric Reliability Corporation (NERC) 2024 Reliability Report (NERC 2024 Reliability Report) highlights, the important role of gas pipelines to meet electric demand during peak hours complements the intermittent nature of renewable energy resources.[28] According to the Department of Energy, the grid's need for reliable dispatchable power will continue to grow as the percentage of renewables eclipses traditional fossil-fuel energy sources and projected electricity demand requires greater reliability to serve significant new demand from non-traditional users, such as increased mobility sector electrification, data centers, and generative artificial intelligence energy demands potentially reaching up to 9% of total US electricity generation by 2030.[29]

SoCalGas and SDG&E continue to explore refining the quantification of gas reliability and will consider revisions in future filings given the significant spectrum of value the gas system provides to support the State's interconnected energy system. These include as a just-in-time and seasonal reliability resource with the ability to meet increased peak daily and hourly

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27 *See* CAISO Summer Market Performance Report (September 2024) at 22, *available at* summer-market-performance-report-september-2024.pdf; *see also* California Energy Commission (CEC), *2023 Integrated Energy Policy Report* (February 2024) at 11 (Table ES-1), 27 (Table 3), *available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=254463*.

28 NERC, *2024 Long-Term Reliability Assessment,* (December 2024), *available at:* https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_Long%20Term%20Reliability%20Assessment_2024.pdf. ("Natural-gas-fired generators are a vital [bulk power system] BPS resource. They provide [essential reliability services] ERSs by ramping up and down to balance a more variable resource mix and are a dispatchable electricity supply for winter and times when wind and solar resources are less capable of serving demand. Natural gas pipeline capacity additions over the past seven years are trending downward, and some areas could experience insufficient pipeline capacity for electric generation during peak periods.").

29 Department of Energy, *Artificial Intelligence – Powering AI*, *available at:* https://www.energy.gov/topics/artificial-intelligence.

peak ramping electric sector needs which supports renewable integration and changing demand patterns.

E. Valuing the CoRE Financial Attribute

The CoRE Financial Attribute estimates both Pre-Mitigation CoRE in accordance with RDF Row 18 (which, in turn, feeds into Pre-Mitigation Risk Value per RDF Row 19), and Post-Mitigation CoRE in accordance with RDF Row 21 (which, in turn feeds into a Post-Mitigation Monetized Risk Value per RDF Row 22) to estimate the financial impacts resulting from a risk event. The Financial CoRE estimates the magnitude of financial impact that could result from a risk event. In turn, any mitigation that has a benefit with respect to the Financial CoRE reflects the degree to which the mitigation is estimated to reduce the magnitude of those financial consequences. Unlike the other CoRE valuations, the Financial CoRE attribute is inherently dollar-denominated and no conversion is necessary.[30]

In accordance with the RDF's guidance on valuing the Financial Attribute, financial risk is captured in a similar fashion to the 2021 RAMP filings. The Financial Attribute has no sub-attributes or index and is measured in dollars. Like the other attributes, the Financial Attribute is used to estimate aspects of the impact from risk events. Unlike the other attributes, however, different types of costs are measured in the attribute. The two general types of costs measured include: societal damage (including physical damage, lost wages, relocation costs, etc.) and utility service restoration and repair costs (labor, materials). The Financial Attribute focuses on impact to the public and does not include any impacts related to shareholder financial interests.

The quantitative approach used by SoCalGas and SDG&E primarily utilizes historical events as a guide for possible future impacts. Precision for the Financial Attribute is difficult to achieve, however, as risk events are rarely reported with a single summation of all financial impacts. Depending on the risk event, differing approaches were therefore used to estimate the financial impacts. For example, for pipeline risks, Pipeline and Hazardous Materials Safety Administration (PHMSA) data was used in combination with internal data; however, the financial values provided by PHMSA do not necessarily include all societal financial impacts. For electrical outages, subject-matter expert estimates were used for the cost of repairs. Additional information can be found in the individual risk chapters and Attachment B.

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[30] Except for time value of money considerations that apply to all aspects of monetized benefits, as discussed *infra* Section VI.E (which addresses discounting).

III. STEP 1B: IDENTIFYING RISKS FOR THE ENTERPRISE RISK REGISTER

Row 8 of the RDF's "Step 1B – Identifying Risks for the Enterprise Risk Register" describes the method for identifying risks to be assessed by the quantitative framework.

Table 8: Row 8 of the RDF

#	RDF Element Name	Element Description & Requirements
8	Risk Identification and Definition	Utilities' risks are defined in their respective Enterprise Risk Registers. The Enterprise Risk Register is the starting point for identifying the risks that will be included in the RAMP. The process for determining these risks will be described in the RAMP. The RAMP will consider risks using the same risk definitions as in the ERR. Each RAMP filing will highlight any changes to the ERR from the previous RAMP or GRC filings.

The starting point for determining if a risk is to be included in the RAMP filing is to review the risks contained in SoCalGas's and SDG&E's respective 2024 enterprise risk registers (ERRs). Each applicable enterprise risk is then assessed in accordance with RDF Step 2A, as described in the next section, to determine if it is to be included in the RAMP filing.

IV. STEP 2A: RISK ASSESSMENT AND RISK RANKING IN PREPARATION FOR RAMP

Rows 9-11 of the RDF's "Step 2A – Risk Assessment and Risk Ranking in Preparation for RAMP" describe the method for initial assessment and risk ranking of risks via the quantitative framework.

Table 9: Rows 9-11 of the RDF

#	RDF Element Name	Element Description & Requirements
9	Risk Assessment	Using the Cost-Benefit Approach developed in accordance with Step 1A, for each Risk included in the Enterprise Risk Register, the utility will compute a monetized Safety Risk Value using only the Safety Attribute. The utility will sort its ERR Risks in descending order by the monetized Safety Risk Value. For the top 40% of ERR risks with a Safety Risk Value greater than zero dollars, the utility will compute a monetized Risk Value using at least the Safety, Reliability and Financial Attributes to determine the output for Step 2A. The output of Step 2A, along with the input from stakeholders described in Row 12 below, will be used to decide which risks will be addressed in the RAMP.

#	RDF Element Name	Element Description & Requirements
		The Risk Assessment in preparation for RAMP will follow the steps in Rows 10 and 11.
10	Identification of Potential Consequences of Risk Event	The identified potential Consequences of a Risk Event should reflect the unique characteristics of the utility. For each enterprise risk, the utility will use actual results, available and appropriate data (*e.g*., Pipeline and Hazardous Materials Safety Administration data), and/or Subject Matter Experts (SMEs) to identify potential Consequences of the Risk Event, consistent with the Cost-Benefit Approach developed in Step 1A. The utility should use utility specific data, if available. If data that is specific to the utility is not available, the utility must supplement its analysis with subject matter expertise. Similarly, if data reflecting past results are used, that data must be supplemented by SME judgment that takes into account the Benefits of any Mitigations that are expected to be implemented prior to the GRC period under review in the RAMP submission.
11	Identification of the Frequency of the Risk Event	The identified Frequency of a Risk Event should reflect the unique characteristics of the utility. For each enterprise risk, the utility will use actual results and/or SME input to determine the annual Frequency of the Risk Event. The utility should use utility specific data, if available. If data that is specific to the utility is not available, the utility must supplement its analysis with subject matter expertise. In addition, if data reflecting past results are used, that data must be supplemented by SME judgment that takes into account the Benefits of any Mitigations that are expected to be implemented prior to the GRC period under review in the RAMP submission. The utility will take into account all known relevant Drivers when specifying the Frequency of a Risk Event. Drivers should reflect current and/or forecasted conditions and may include both external actions as well as characteristics inherent to the asset. For example, where applicable, Drivers may include: the presence of corrosion, vegetation, dig-ins, earthquakes, windstorms or the location of a pipe in an area with a higher likelihood of dig-ins.

Starting with their respective 2024 ERR risks, pursuant to RDF Row 9, SoCalGas and SDG&E computed a monetized Safety Risk Value using only the Safety Attribute. The pre-mitigated Safety Risk Value (SRV) for each risk is estimated as the product of the Risk's Likelihood of a Risk Event (LoRE) and Expected Value[31] of the risk's (unscaled) Safety Consequence of a Risk Event (CoRE). The Companies then sorted these ERR risks in descending order by the monetized SRVs. Applying a 2023 VSL[32] of $15.2 million, the Companies used estimated LoREs and unscaled safety CoRE estimates for the safety calculation. For the top 40% of risks that had SRV's greater than $0, SoCalGas and SDG&E computed the risk values for Reliability and Financial Attributes to determine the total monetized risk values for the preliminary RAMP Risks.

At their discretion, the Companies elected to present an additional risk, Cybersecurity, which did not meet the RDF's 40% threshold. For SDG&E, Employee Safety-related risks, including Motor Vehicle Incident and Workplace Violence, were consolidated in a single RAMP risk. Similarly, Electric Infrastructure Integrity was consolidated with Customer & Public Safety – Contact with Electric Equipment, and SDG&E selected Medium Pressure Gas as an additional RAMP Risk.

In accordance with the RDF, and as described in detail in the sections that follow, the analysis performed produces CBRs for all selected RAMP risks for the GRC cycle (2028 through 2031) on the basis of the residual risk as of the "baseline" year (2028, the start of the GRC period), after taking into account all risk reduction benefits from all mitigation activities projected to have been performed by the start of 2028.[33] Please refer to Chapter 2 for additional information regarding the Companies' selection of RAMP risks.

V. STEP 2B: SELECTING ENTERPRISE RISKS FOR RAMP

Row 12 of the RDF's "Step 2B – Selecting Enterprise Risks for RAMP" describes the method for selecting risks for RAMP.

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31 "Expected Value" is the probability-weighted sum of all possible risk outcomes.

32 At the time the Safety Risk Assessment was performed and presented during the December 17, 2024 pre-filing risk selection workshop, the 2023 VSL value was the best available information.

33 *See* "Baseline Risk" in RDF Lexicon.

Table 10: Row 12 of the RDF

#	RDF Element Name	Element Description & Requirements
12	Risk Selection Process for RAMP	Using the analysis performed in Step 2A, the utility will preliminarily select risks to be included in the RAMP. The utility will host a publicly noticed workshop, to be appropriately communicated to interested parties and at a minimum, should include the CPUC's Safety Policy Division (SPD), to gather input from SPD, other interested CPUC staff, and interested parties to inform the determination of the final list of risks to be included in the RAMP. At least 14 days in advance of the workshop, the utility will provide to SPD and interested parties at least the following information: (1) its preliminary list of RAMP risks; and (2) the monetized Safety Risk Value for each risk in the ERR and the monetized Risk Value for the top ERR risks identified through the process in Row 9. The utility will make its best effort to timely respond to reasonable requests for additional information prior to the workshop. Based on input received from SPD, other interested CPUC staff, and interested parties, the utility will make its determination of the final list of risks to be addressed in its RAMP. The rationale for taking or disregarding input during the workshop will be addressed in the utility's RAMP.

SoCalGas and SDG&E's selected RAMP risks were presented informally to the CPUC's Safety Policy Division (SPD) for review on October 14, 2024, and formally to SPD and interested parties during the December 17, 2024 RAMP pre-filing risk selection public workshop. Following the workshop, based on feedback provided by stakeholders, SoCalGas elected to present Underground Storage as an additional RAMP risk.

VI. STEP 3: MITIGATION ANALYSIS FOR RAMP RISKS

Rows 13-25 of the RDF's "Step 3 – Mitigation Analysis for Risks in RAMP" describes the method for analyzing risks per the quantitative framework.

Table 11: Rows 13-25 of the RDF

#	RDF Element Name	Element Description & Requirements
13	Calculation of Risk	For purposes of the Step 3 analysis, pre- and post-mitigation risk will be calculated by multiplying the Likelihood of a Risk Event (LoRE) by the Consequences of a Risk Event (CoRE). The CoRE is the sum of each of the Risk-Adjusted Attribute Values using the utility's full Cost-Benefit Approach.
14	Definition of Risk Events and Tranches	Detailed pre- and post-mitigation analysis of Mitigations will be performed for each risk selected for inclusion in the RAMP. The utility will endeavor to identify all asset groups or systems subject to the risk and each Risk Event associated with the risk. For example, if Steps 2A and 2B identify wildfires associated with utility facilities as a RAMP Risk Event, the utility will identify all Drivers that could cause a wildfire and each group of assets or systems that could be associated with the wildfire risk, such as overhead wires and transformers. For each Risk Event, the utility will subdivide the group of assets, or the system associated with the risk into Tranches. Risk reductions from Mitigations and Risk Spend Efficiencies will be determined at the Tranche level, which gives a more granular view of how Mitigations will reduce Risk. The determination of Tranches will be based on how the risks and assets are managed by each utility, data availability and model maturity, and strive to achieve as deep a level of granularity as reasonably possible. The rationale for the determination of Tranches, or for a utility's judgment that no Tranches are appropriate for a given Risk Event, will be presented in the utility's RAMP submission. For the purposes of the risk analysis, each element (*i.e.*, asset or system) contained in the identified Tranche would be considered to have homogeneous risk profiles (*i.e.*, considered to have the same LoRE and CoRE).
15	Bow Tie	For each risk included in the RAMP, the utility will include a Bow Tie illustration. For each Mitigation presented in the RAMP, the utility will identify which element(s) of its associated Bow Tie the Mitigation addresses.
16	Expressing Effects of a Mitigation	The effects of a Mitigation on a Tranche will be expressed as a change to the Tranche-specific pre-mitigation values for LoRE and/or CoRE. The utility will provide the pre- and post-mitigation values for LoRE and CoRE determined in

#	RDF Element Name	Element Description & Requirements
		accordance with this Step 3 for all Mitigations subject to this Step 3 analysis.
17	Determination of PreMitigation LoRE by Tranche	The pre-mitigation LoRE is the probability that a given Risk Event will occur with respect to a single element of a specified Tranche over a specified period of time (typically a year) in the planning period, before a future Mitigation is in place.
18	Determination of PreMitigation CoRE	The pre-mitigation CoRE is the sum of each of the pre-mitigation Risk Adjusted Attribute Values using the utility's full Cost-Benefit Approach. The CoRE is calculated using the full Cost-Benefit Approach tool constructed consistent with Step 1A above.
19	Measurement of PreMitigation Risk Value	The monetized pre-mitigation risk value will be calculated as the product of the pre-mitigation LoRE and the pre-mitigation CoRE for each Tranche subject to the identified Risk Event.
20	Determination of PostMitigation LoRE	The post-mitigation LoRE calculation will be conducted at the same level of granularity as the pre-mitigation risk analysis within Step 3. The calculated value is the probability of occurrence of a Risk Event after the future Mitigation is in place.
21	Determination of PostMitigation CoRE	The post-mitigation CoRE calculation will be conducted at the same level of granularity as the pre-mitigation risk analysis. The post-mitigation CoRE is the sum of each of the post-mitigation Risk-Adjusted Attribute Values using the utility's full Cost-Benefit Approach.
22	Measurement of PostMitigation Monetized Risk Value	The monetized post-mitigation risk value will be calculated as the product of the post-mitigation LoRE and post-mitigation CoRE for each Tranche subject to the identified Risk Event.
23	Measurement of Risk Reduction Provided by a Mitigation	The risk reduction provided by a risk mitigation will be measured as the difference between the values of the monetized pre-mitigation risk value and the monetized post-mitigation risk value.
24	Use of Expected Value for CoRE; Supplemental Calculations	The utility will use expected value for the Cost-Benefit Approach-based measurements and calculations of CoRE in Rows 13, 18, 19, 21, 22, and 23. If a utility chooses to present Alternative Analysis of monetized pre- and post-

#	RDF Element Name	Element Description & Requirements
		mitigation CoRE using a computation in addition to the expected value of the Cost-Benefit Approach, such as tail value, it does so without prejudice to the right of parties to the RAMP or GRC to challenge such Alternative Analysis.
25	Cost-Benefit Ratios Calculation	The Cost-Benefit Ratio calculation should be calculated by dividing the dollar value of Mitigation Benefit by the Mitigation cost estimate. The values in the numerator and denominator should be present values to ensure the use of comparable measurements of Benefits and costs. The Benefits should reflect the full set of Benefits that are the results of the incurred costs. For capital programs, the costs in the denominator should include incremental expenses made necessary by the capital investment.

F. Estimating LoRE and CoRE

For each RAMP risk, the RDF directs utilities to assess each mitigation's prospective benefits (monetized, over the mitigation's life, and discounted to present value in accordance with RDF requirements) in relation to the mitigation's cost (likewise discounted to present value). In this section, SoCalGas and SDG&E present their methodology for estimating mitigation benefits in accordance with RDF guidance.

The RDF defines mitigation benefits as the difference between the Pre-Mitigation Risk Value (per RDF Row 19) and the Post-Mitigation Monetized Risk Value (per Row 22). SoCalGas and SDG&E note, however, that Pre-Mitigation Risk Values are time specific. That is, the underlying Pre-Mitigation LoRE and/or Pre-Mitigation CoRE can change over time, owing to the presence or removal of existing mitigations, as well as ongoing system deterioration and inflation. For example, in meeting the requirement to provide CBRs for each GRC Post-Test Year (per RDF Row 26), the Pre-Mitigation Risk Value for a RAMP risk for 2029 may be different than for 2030. As such, in SoCalGas and SDG&E's modeling, the Pre-Mitigation Risk Value is not a singular, unchanging value.

Further to this point, there are certain mitigations that have the effect of "preserving" the risk profile (*i.e.*, maintaining the Pre-Mitigation Risk Value over time). That is, absent the presence of such mitigations (which are typically ongoing mitigations or controls), the Pre-

Mitigation Risk Value would be greater, all other things being held constant. The modeling of such effect, referred to as "preservation," is discussed in detail in Section VI.D.3 below.

To distinguish between the computed Pre-Mitigation Risk Value for a RAMP risk for which "preservation" mitigations remain in place (and new mitigations have yet to be considered), and the Pre-Mitigation Risk Value absent ongoing "preservation" mitigations, in the methodology presented in this chapter, SoCalGas and SDG&E refer to the former value as the "Risk Value" while reserving the term Pre-Mitigation Risk Value for the final calculations of CBRs. For the final calculations of CBRs for the Test Year 2028 and each of the Post-Test Years 2029, 2030, and 2031, the benefit is the difference between the Pre-Mitigation Risk Value and the Post-Mitigation Risk Value specific to the year for which the CBRs are calculated.

Calculating a Risk Value for each RAMP risk involves estimating the LoRE and the three attributes comprising the CoRE before applying any mitigations and continuing current risk-treatment activities. The LoRE is calculated by multiplying the annual probability of a risk event per unit of exposure (*e.g.*, per mile of pipe) by the total number of units. This method allows for the calculation of LoRE at both the tranche and system levels.

When the probability of a risk event is multiplied by the number of units, the resulting value is a rate or frequency and hence can exceed 1, especially at the system level. Thus, the LoRE is a frequency or rate, indicating the number of times the risk event is expected to occur per year. This behavior is expected, as risk is additive, but probabilities are not.

The CoRE is estimated by modeling the range of possible outcomes resulting from a risk event. For each CoRE attribute (Safety, Reliability, and Financial), possible outcomes[34] are modeled independently. Each CoRE attribute is then scaled in accordance with Row 7 of the RDF; and, as described in the next section, the expected value (EV) of the scaled distribution of outcomes for that attribute represents the attribute's CoRE value. As shown in Equation 3.1, the expected values of the three CoRE attributes—Safety, Reliability, and Financial—are summed to comprise the total CoRE expected value.

$$\mathrm{EV}\left(\mathrm{CoRE}^{\mathrm{Total}}\right) = \mathrm{EV}\left(\mathrm{CoRE}^{\mathrm{safety}}\right) + \mathrm{EV}\left(\mathrm{CoRE}^{\mathrm{reliability}}\right) + \mathrm{EV}\left(\mathrm{CoRE}^{\mathrm{financial}}\right) \qquad 3.1$$

34 Outcomes are derived from: (i) direct observations, (ii) random sampling from known or constructed distributions fit to observations, or (iii) Monte Carlo simulations on failure consequence models (*e.g.*, safety CoRE modeling of high-pressure gas).

Table 12: Row 7 of the RDF

7	Cost-Benefit Approach Principle 6 – Risk-Adjusted Attribute Levels	Apply a Risk Scaling Function to the Monetized Levels of an Attribute or Attributes (from Row 6) to obtain Risk-Adjusted Attribute Levels. The Risk Scaling Function is an adjustment made in the risk model due to different magnitudes of Outcomes, which can capture aversion or indifference towards those Outcomes. The Risk Scaling Function can be linear or convexly non-linear. For example, the Risk Scaling Function is linear to express indifference if avoiding a given change in the Monetized Attribute Level does not depend on the Attribute Level. Alternatively, the Risk Scaling Function is convexly non-linear to express aversion if a change in the Attribute level results in an increasing rate of change in the Risk-Adjusted Monetized Attribute Level as the Level of the Attribute increases. When completing Rows 5 and 24 in the RDF, if a utility chooses to address tail risk using the power law or other statistical approach and chooses to present Risk-Adjusted Attribute Levels by relying on a convex scaling function, then it must supplement its analysis by also presenting Risk-Adjusted Attribute Levels by relying on a linear scaling function.

G. Risk-Averse Scaling of CoRE

An additional consideration in developing the CoRE expected value is the application of societal risk-averse scaling to the CoRE outcomes. Row 7 of the RDF provides for convex non-linear (risk-averse) risk scaling, which SoCalGas and SDG&E applied to risk-scale CoRE estimates for all RAMP Risks. This approach recognizes that an increasing aversion to progressively larger CoRE outcomes aligns with societal preferences.[35]

For certain asset-based risks such as High Pressure Gas and Wildfire & PSPS, Monte Carlo simulation is used to produce a scaled CoRE distribution for each attribute by applying a convex risk-averse scaling function, described in the following section, at the trial (event) level. The scaled expected value of the CoRE is equivalent to the expected value of the scaled distribution, estimated by computing the average outcome from all the scaled trials. The scaled

[35] *See*, *e.g.*, UCLA School of Engineering and Applied Sciences, *The Use of Risk Aversion in Risk Acceptance Criteria?* (June 1980), *available at:* https://www.osti.gov/servlets/purl/5230500.

expected value is calculated at the attribute level, and then all the attributes are summed (as shown in Equation 3.1) to determine the total scaled expected value CoRE.

1. Risk-Averse Scaling Function

One commonly-used convex risk-averse scaling function is the Power Law function,[36] as shown in Equation 3.6, where the risk aversion factor, $\alpha > 1$, is determined from the relationship between the number of fatalities (N) and the frequency (f) of those events across a wide range of occurrences (such relationship is termed an "$f - N$ curve").

The Power Law function can be derived from the regression line of an $f - N$ curve with a negative slope of $-\alpha$, as shown in the Gas Research Institute (GRI)[37] study. In the GRI study's Figure 3.8, the log-fatalities (N) of events are plotted against the log-likelihoods (p) of those events. The Power Law equation, Equation 3.6, is derived from the regression line in Equations 3.2-3.5.

$$\log_{10} p = -\alpha \cdot \log_{10} N + C \tag{3.2}$$

$$\Rightarrow 10^{\log_{10} p} = 10^{\log_{10} N^{-\alpha}} 10^{C} \tag{3.3}$$

$$\Rightarrow p = k\, N^{-\alpha} \tag{3.4}$$

$$\Rightarrow pN^{\alpha} = k \tag{3.5}$$

$$f(N) = N^{\alpha} \tag{3.6}$$

Equation 3.5 shows the concept of risk neutral versus risk-averse well. Note that when $\alpha = 1$, the product of the likelihood and its corresponding fatalities are always constant (*i.e.*, "risk neutral"). This implies that rare catastrophic events are treated the same as more frequent, less catastrophic events, which is the concept of risk neutrality. Hence, in the case of societal risk-aversion, α is greater than 1, leading to increased scaling of consequences as the severity of catastrophic events rises.

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36 The power law function describes a relationship where a relative change in one variable results in a proportional relative change in another variable, raised to a constant exponent. For risk-averse scaling, the constant exponent term is $\alpha > 1$. Note that this should not be confused with the power law or other statistical methods used to address tail risk, which specifically refers to the Probability Density Function of the Pareto distribution with a negative exponent.

37 Journal of Pressure Vessel Technology, Transactions of the ASME, *Target Reliability Levels for Design and Assessment of Onshore Natural Gas Pipelines* (December 2009), *available at*: https://www.researchgate.net/publication/245365044_Target_Reliability_Levels_for_Design_and_Assessment_of_Onshore_Natural_Gas_Pipelines.

To determine an appropriate value for α, SoCalGas and SDG&E conducted an analysis based on independent and peer-reviewed empirical studies that quantify risk aversion in similar industries. These studies provide a suitable proxy for societal risk aversion with respect to SoCalGas's and SDG&E's operations. Specifically, two studies of $f - N$ and $F - N$ curves, commonly used to estimate risk aversion in infrastructure-intensive industries with potential for catastrophic injury or fatality events, were utilized. SoCalGas and SDG&E leveraged studies from the Department of Energy (DOE)[38] and the GRI to identify the risk scaling factor. The DOE and GRI studies determined implied risk aversion coefficients of 1.34 for natural catastrophic events and 1.6 for North American pipeline standards, respectively. SoCalGas and SDG&E adopted the average of these two implied factors, resulting in a risk scaling factor α of 1.47.[39] A PHMSA study[40] on risk tolerance across various industries globally focused on $F - N$ curves and lines with slopes of $-\alpha$ for risk tolerance. As demonstrated in the GRI study, this can be translated to a risk-averse function (Equation 3.6). The PHMSA study found slopes of -1, -1.5, and -2, corresponding to α values of 1, 1.5, and 2, respectively. This indicates that the value of 1.47 is consistent with other risk-aversion practices across industries and around the world.

2. Implied Thresholds and the Application of the Scaling Function

Since fatalities in the $f - N$ and $F - N$ curves start at 1, the scaling function in Equation 3.6 is defined for $N \geq 1$. In SoCalGas and SDG&E's Fractional VSL framework (described in Section II B. above), equivalence of fatalities are represented as fractions (*e.g.*, 0.25 for serious injuries). Therefore, for purpose of the RAMP Reports, SoCalGas and SDG&E define the risk-averse scaling function in Equation 3.7, to be applicable for all values of equivalent fatalities:

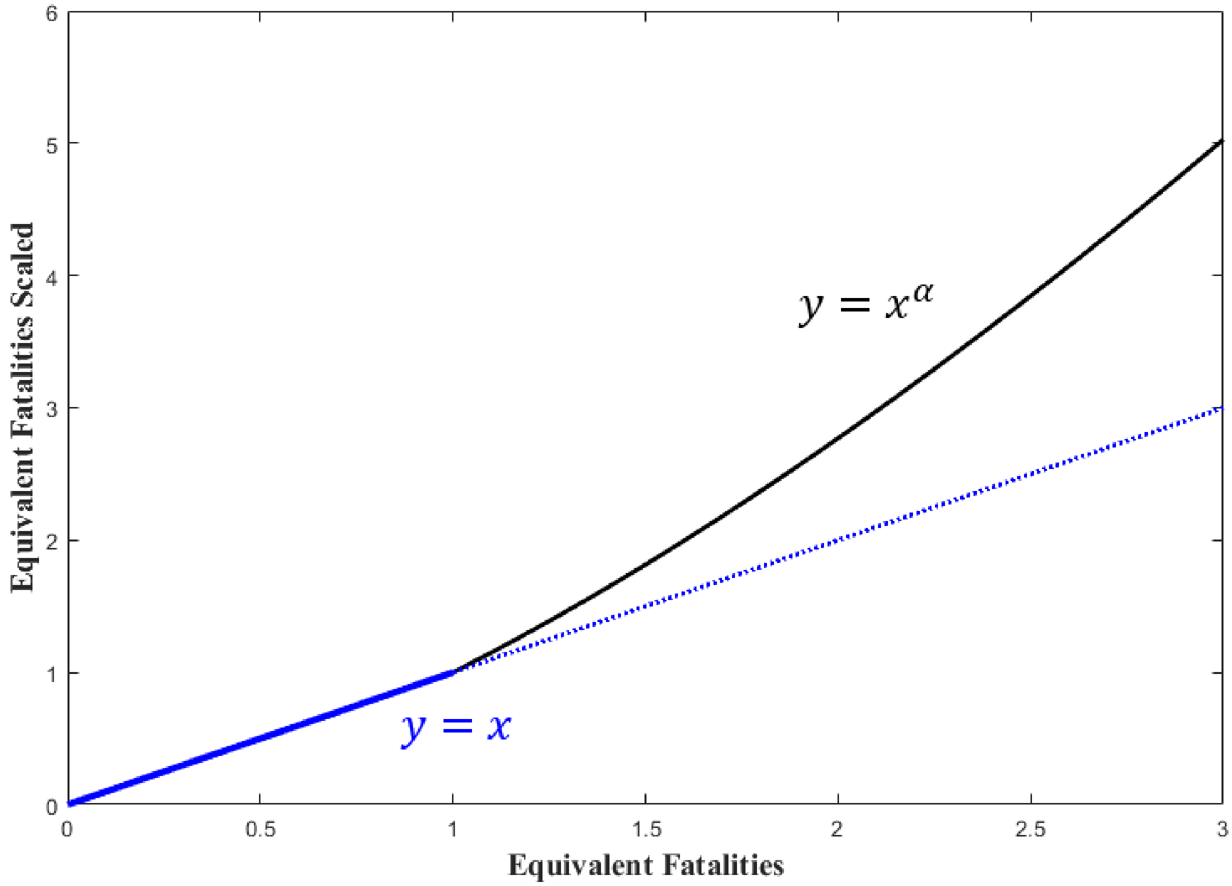
$$f(x) = \begin{cases} x & 0 \leq x < 1 \\ x^{\alpha} & x \geq 1 \end{cases} \tag{3.7}$$

[38] UCLA School of Engineering and Applied Sciences, *The Use of Risk Aversion in Risk Acceptance Criteria?* (June 1980), *available at:* https://www.osti.gov/servlets/purl/5230500.

[39] This is consistent with PHMSA and other global and local risk aversion practices (*i.e.*, 1.0-2.0 range).

[40] PHMSA, *Final Report on Paper Study on Risk Tolerance* (June 30, 2016), *available at:* https://primis.phmsa.dot.gov/matrix/FilGet.rdm?fil=10733.

Figure 1: Risk-Averse Scaling Function Equation 3.7



This produces an implied transition from linear scaling to convex scaling at one equivalent fatality. This transition threshold is applied consistently for all CoRE attributes.[41] The monetized scaling function for any attribute will be the composition of Equations 3.7, 3.8 and its inverse 3.9, as seen in Equation 3.10:

$$g(x) = \frac{x}{VSL} \qquad 3.8$$

$$g^{-1}(x) = VSL \cdot x \qquad 3.9$$

$$s(x) = g^{-1} \circ f \circ g(x) = g^{-1}\Big(f\big(g(x)\big)\Big) \qquad 3.10$$

Note that any monetized CoRE will first transform into equivalent fatalities using Equation 3.8, then be scaled by Equation 3.7, and finally be transformed back to monetized scaled CoRE.

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41 Note that the implied transition point of one equivalent fatality is not indicative of a risk tolerance threshold for either company and is presented here solely for purposes of risk-averse scaling for SoCalGas's and SDG&E's 2025 RAMP presentations, which are submitted in compliance with the Commission's RDF.

Consistent with the Commission's shift to monetization in the Phase 2 Decision, SoCalGas and SDG&E's adoption of Equation 3.10 produces a consistent implied threshold for Safety, Reliability, and Financial attributes. Specifically, the Companies apply the risk scaling factor on a trial-by-trial basis to each CoRE attribute, starting at the monetized equivalent of the VSL dollar value for one fatality. This process is applied to each attribute using Monte Carlo sampling from the CoRE distribution. The expected value of the resulting scaled CoRE distribution represents the scaled CoRE for each attribute, and using Equation 3.1, SoCalGas and SDG&E derive the total scaled CoRE. Table 13 below illustrates the application of both the implied threshold and the step-by-step application of Equations 3.8, 3.7, and 3.9, culminating in Equation 3.10.

Table 13: Illustrative Risk Aversion Function Applied to CoRE Distribution for each Attribute through the VSL

Simulation	Unscaled CoRE ($) x	Unscaled CoRE (Fatality-equivalent) $y = g(x) = \frac{x}{VSL}$	Scaled CoRE (Fatality-equivalent) $z = f(y) = \begin{cases} y & y < 1 \\ y^{1.47} & y \geq 1 \end{cases}$	Scaled CoRE ($) $w = g^{-1}(z) = z \cdot VSL$
Trial 1	$200,000	0.012	0.012	$200,000
Trial 2	$12,000,000	0.741	0.741	$12,000,000
Trial 3	$50,000	0.003	0.003	$50,000
Trial 4	$27,000,000	1.667	2.119	$34,326,749
Trial 5	$100,000	0.006	0.006	$100,000
Trial 6	$55,000,000	3.395	6.030	$97,692,471
Trial 7	$250,000	0.015	0.015	$250,000
Trial 8	$1,200,000	0.074	0.074	$1,200,000
Trial 9	$8,000,000	0.494	0.494	$8,000,000
Trial 10	$25,000	0.002	0.002	$25,000
Expected Value ($) =	$10,382,500			$15,384,422
If LoRE = 0.1, then Risk ($) =	$103,825			$153,844

VSL: $16.2M ($2024)

H. Deriving Risk Values

Consistent with the RDF, the Risk Value is the product of LoRE and the scaled expected value of CoRE (denoted hereinafter as CoRE):

$$\text{Risk Value} = \text{LoRE} \times \text{CoRE} \quad 3.11$$

1. Data Sources Used in Estimating Risk Values

SoCalGas and SDG&E applied the RDF's analytical requirements by leveraging internal and external historical data, external research, simulations, and subject matter expertise (SME) to assess the range of potential risk event impacts to inform the CoRE attributes. Probabilistic distributions of consequence outcomes are developed where sufficient data exists. The data for such analyses are derived from internal historical records, external sources, or SME estimates, as needed.

The distribution for each consequence outcome is determined based on the properties of the consequence and the available data. The expected values of consequences, as well as other relevant values (*i.e.*, tail outcome values), are derived from the probabilistic range of outcomes presented in the distributions. A non-exhaustive list of potential distributions used, sometimes in combination, for 2025 RAMP calculations includes:

- Lognormal
- Poisson
- Bernoulli
- Generalized Pareto Distribution
- Truncated Pareto
- Capped discrete Pareto
- Truncated Normal
- Uniform
- Kernal Density Estimation
- Beta
- PERT

Data to assess risk and mitigation value comes from various sources, such as internal data at SoCalGas and SDG&E, publicly available data, external research, and historical utility datasets. A non-exhaustive list of examples includes the following:

A. Electric outage data – SAIDIDAT [2014-23]
B. Circuit customer count [2014-23]
C. PHMSA Reportable Incident and Annual Data
D. Damage Information Reporting Tool (DIRT) data
E. Other SoCalGas and SDG&E Internal Data
F. Other Industry Reports, Studies, Papers
G. Field-Based Safety Management System (SMS) data [2016-24]

H. CPUC-reportable fire incident data[42]

Table 14: Sample Data Sources Used in Estimating Risk Value

RAMP Risk	Data Source(s)
HP Gas	C, E, F
MP Gas	C, E, F
Excavation Damage	C, D, E, F
Gas Storage	C, E, F
Employee Safety	F, G
Contractor Safety	F, G
EII	A, B, E, F
Cybersecurity	F, G
Wildfire	A, B, E, F, H (*see* section 2.i)

2. Consequence Modeling for Certain Risks

Special consequence modeling is administered for certain risks, as described below, which supersedes the analyses described above.

i. Consequence Modeling for Wildfire Risk

The unique nature of Wildfire Risk has garnered specialized methodologies, as described in the section below. The prevalence and complexity of wildfire risk has garnered heightened attention and analyses from SDG&E, as exemplified in the Wildfire Mitigation Plan (WMP) filings and prior RAMP reports. Consequence modeling for wildfire risk include modeling for the risk itself as well as Public Safety Power Shutoff (PSPS) and Protective Equipment and Device Settings (PEDS) considerations. Each are described below, and additional details can be found in SDG&E's 2026-2028 WMP.[43]

Wildfire consequence estimations are derived from Technosylva's FireSight™ simulations (also known as WFA-E WRRM). These simulations assess fire behavior at each asset location under historical worst-case fire weather conditions. Currently, SDG&E evaluates fire behavior scenarios for 125 days, spanning from 2013 to 2021, which represent the worst fire

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42 CPUC, *Wildfire and Wildfire Safety*, *available at:* https://www.cpuc.ca.gov/industries-and-topics/wildfires.

43 State of California – Office of Energy Infrastructure and Safety, *2026-28 Base Wildfire Mitigation Plans (WMP)*, *available at:* https://energysafety.ca.gov/what-we-do/electrical-infrastructure-safety/wildfire-mitigation-and-safety/wildfire-mitigation-plans/2026-28-base-wildfire-mitigation-plans/.

weather days in its service area. These days are selected and reviewed by experts from the Meteorology, Fire Science, Engineering, and Risk Analytics groups to properly account for the most critical fire weather conditions in SDG&E's service territory and promote accurate risk assessments. SDG&E subject matter experts are collaborating with the Technosylva team to reevaluate and expand the selection of these critical fire weather days to include the latest fire weather events that occurred in California from November 2024 to January 2025, including the Palisades and Eaton fires.

Technosylva's advanced and proprietary wildfire modeling incorporates weather variables, detailed fuel layers, and a 24-hour unsuppressed fire spread model to estimate potential ignition size (acres burned) and impact (buildings destroyed), both at and around asset locations within SDG&E's service territory.

Table 15: Attributes for Wildfire Consequence

Risk Attribute	Wildfire Consequence
Safety	Equivalent Safety Serious Injuries and Fatalities are calculated based on Technosylva estimates of structures destroyed. Assumption: To estimate the total number of equivalent fatalities per structure destroyed a 0.00617 factor is assumed. This factor is estimated based on an internal analysis conducted on the CALFIRE dataset.
Reliability	Subject matter expert assumption to estimate Customer Minutes Interrupted (CMI) values based on estimates of outage duration and assumed restoration duration. These CMI estimates are subsequently monetized using the $/CMI value provided in this chapter. Assumption: Restoration time is 24h
Financial	Subject matter expert conservative assumption to translate buildings destroyed and acres impacted estimated by Technosylva simulations to financial dollars. Assumptions: - Suppression and restoration cost: $2,350/acres burned[44] - Structure Destroyed cost: $1,000,000/structure destroyed[45]

44 SME assumption based on a review of CALFIRE suppression costs incurred from 2000 to 2023. Data for 2024 and 2025, which should include the devastating fires in Los Angeles, is not included as suppression costs for these incidents are not available as of February 2025.

45 SME assumption based on a review of publicly available data on the median listing home price in San Diego County as of February 2025.

To calculate the potential impacts of PSPS de-energizations, the duration of de-energization by feeder segment and the number of downstream customers affected by de-energization on each feeder segment are considered. These values are used to determine natural unit values for the three consequence components.

Table 16: Attributes for PSPS Consequence

Risk Attribute	PSPS Consequence
Safety	Subject matter expert conservative assumption to estimate the potential number of Serious Injuries and Fatalities created by a PSPS de-energization event. Assumption: 1 fatality per 10 billion customer minutes de-energized. This assumption is estimated based on a review of historical PSPS events in California (2018-2021).[46,47,48]
Reliability	Customer Minutes Interrupted (CMI) estimates are calculated directly from the number of customers impacted at each feeder segment with varying event durations based on historical and projected PSPS event durations. Assumption: These CMI estimates are subsequently monetized using the $/CMI value provided in this chapter.
Financial	Subject matter expert conservative assumption to estimate the potential financial loss experienced by customers affected by a PSPS de-energization event. Assumption: For Residential customers a $482 cost per event is calculated using the per diem rates applicable to San Diego, CA, as of September 2024 with the assumption of accommodating four family members per customer meter. For C&I customers, a $1,446 cost per event is estimated.[49]

[46] CPUC, *Utility PSPS Reports: Post-Event, Pre-Season and Post-Season*, *available at*: https://www.cpuc.ca.gov/consumer-support/psps/utility-company-psps-reports-post-event-and-post-season.

[47] SCE, *PSPS Reports to the CPUC*, *available at:* https://www.sce.com/outage-center/outage-information/psps.

[48] PG&E, *Public Safety Power Shutoffs*, *available at:* https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program/public-safety-power-shutoffs.html.

[49] For FY 2025 per diem rates for San Diego, California refer to: U.S. General Services Administration (GSA), *FY 2025 per diem rates for ZIP Code. Financial values as of February 2025. A factor of three is assumed for C, available at:* https://www.gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-results?action=perdiems_report&city=San%20Diego&fiscal_year=2025&state=CA&zip=.Financial%20values%20as%20of%20February%202025.%20A%20factor%20of%20three%20is%20assumed%20for%20C&I%20customers.

To align the risk quantification requirements between this RAMP filing and WMP filings,[50] SDG&E includes risks associated with Protective Equipment Device Settings (PEDS). This PEDS model follows a similar approach to PSPS as it is modeled as a reliability outage. The following assumptions are considered to establish PEDS consequences.

Table 17: Attributes for PSPS Consequence

Risk Attribute	PEDS Consequence
Safety	The same assumption as in the PSPS consequence model is used for PEDS. Subject matter expert conservative assumption to estimate the potential number of Serious Injuries and Fatalities created by a PEDS reliability outage event. Assumption: 1 fatality per 10 billion customer minutes de-energized. This assumption is estimated based on a review of historical PSPS events in California (2018-2021).[51,52,53]
Reliability	Customer Minutes Interrupted (CMI) estimates are calculated directly from the number of customers impacted at each feeder segment, with varying event durations based on historical and projected PEDS event durations. These CMI estimates are subsequently monetized using the $/CMI value provided in of this chapter.
Financial	Subject matter expert conservative assumption to estimate the potential financial loss by a PEDS de-energization event. Assumption: Based on historical overhead line patrol costs during elevated or extreme fire weather conditions, whether conducted on foot or by helicopter, a 10% ratio of the expected reliability cost is assumed to model this impact.

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50 State of California – Office of Energy Infrastructure Safety, *Wildfire Mitigation Plans Guidelines* (February 24, 2025), *available at:* https://efiling.energysafety.ca.gov/eFiling/Getfile.aspx?fileid=58026&shareable=true.

51 CPUC, *Utility PSPS Reports: Post-Event, Pre-Season and Post-Season*, *available at*: https://www.cpuc.ca.gov/consumer-support/psps/utility-company-psps-reports-post-event-and-post-season.

52 SCE, *PSPS Reports to the CPUC*, *available at:* https://www.sce.com/outage-center/outage-information/psps.

53 PG&E, *Public Safety Power Shutoffs*, *available at:* https://www.pge.com/en/outages-and-safety/safety/community-wildfire-safety-program/public-safety-power-shutoffs.html.

ii. Modeling Safety Consequences for High-Pressure, Above-Ground Gas Facilities and Storage

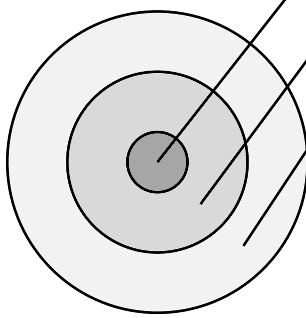
Due to the lack of historical high-pressure gas risk events resulting in fatalities or serious injuries, SoCalGas and SDG&E have relied on national natural gas pipeline incident data provided by PHMSA to quantify the potential safety impacts of such events. This approach takes into account pipeline specifications, such as operating pressure and pipe diameter, as well as service territory characteristics like population density, which may differ from national data. This is done using mathematics and physical principles, based on an equation provided in the Gas Research Institute (GRI),[54] which is based on the same physical model as the Potential Impact Radius (PIR) model used for natural gas pipelines in the U.S. Code of Federal Regulations (49 CFR § 192). The general form of the equation is the following:

$$N = p_i \cdot a_h \cdot \rho \cdot \tau \qquad 3.12$$

where p_i is the probability of ignition, a_h is the size of the hazard area, ρ is the population density, and τ is the probability of an occupant being present at the time of the incident. The probability of ignition p_i is calculated as a function of pipe diameter and a_h is assumed to be a circle with radius r_i, within which the heat intensity exceeds a certain threshold that results in certain fatality or possible fatality depending on the threshold. The study depicts the hazard area and potential safety consequences in Figure 2 below:

54 Journal of Pressure Vessel Technology, Transactions of the ASME, *Target Reliability Levels for Design and Assessment of Onshore Natural Gas Pipelines* (December 2009), *available at*: https://www.researchgate.net/publication/245365044_Target_Reliability_Levels_for_Design_and_Assessment_of_Onshore_Natural_Gas_Pipelines.

Figure 2: **Hazard Areas**



For the outcome rupture, Nessim et al. (2009) shows Equation 3.12 can be expanded to:

$$N = p_i \cdot \rho \cdot \tau \cdot \pi \cdot [P_{in} \cdot (0.25 \cdot (r_{i-0}^2 - r_{i-100}^2) + \ r_{i-100}^2) + P_{out} \cdot (0.5 \cdot (r_{o-0}^2 - r_{o-100}^2) + \ r_{o-100}^2)] \quad 3.13$$

where r_{i-0} and r_{i-100} are the radii of the hazard area when indoors, and similarly r_{o-0} and r_{o-100} describe the hazard radii for outdoor exposure. The study also makes assumptions that τ is 40%, the probability of being indoor P_{in} is 90%, and the probability of being outdoors P_{out} is 10%. Large leaks are also modeled using Equation 3.13 with different radii and a probability of ignition accounting for the differences between a rupture and a large leak.

Using these assumptions SoCalGas and SDG&E adopted the approach presented in the GRI study in Monte Carlo simulation to estimate the average number of fatalities per rupture and large leak. Since the equation only predicts fatalities, PHMSA data was used to estimate how many serious injuries would occur given a rupture or large leak. This approach using heat thresholds and hazard radii was also applied to High-Pressure facilities and Underground Storage, with different assumptions based on the type of asset.

Additionally, the Monte Carlo simulations for the Safety CoRE distributions included distributions for Class locations for transmission and Zone locations for High-Pressure distribution infrastructure. These Class/Zone distributions were constructed using internal sliding miles data and the latest available California and US census data.

This comprehensive approach enhances the modeling of the safety consequences of high-pressure risk events, taking into account specific pipeline and service territory characteristics.

iii. Safety Consequence Modeling for Medium-Pressure Gas Risk including Excavation

Consequence modeling for Medium Pressure risk involves assessing the probability that a leak results in a serious incident (a serious injury or fatality or SIF), the expected number of SIFs, and the proportion of those SIFs that are fatalities versus serious injuries. Equation 3.13 discussed above applies only to high-pressure assets and cannot be used to estimate safety consequences for the medium pressure system, as safety incidents associated with the Medium Pressure Gas Risk typically occur due to gas migration and accumulation into a structure.

Where possible, internal data was leveraged, such as the probability of a serious incident, which is an output of the Companies' Integrity Management Quantitative Risk Analytics (QRA) model. Where internal data was unavailable, national PHMSA incident data was used. The total number of SIFs expected per incident and the proportion of those SIFs expected to be fatalities were determined using PHMSA data. For risk-averse scaling, probability distributions calibrated to PHMSA data were used to perform Monte Carlo simulations.

SoCalGas and SDG&E recognize potential drawbacks to using national data, such as varying levels of population density nationwide that may not reflect the service territory population density and thus may not entirely reflect potential safety outcomes. To address this, SoCalGas and SDG&E categorized the locations of the national incident data into one of four types: Business District High Population, Business District Low Population, Non-Business District High Population, and Non-Business District Low Population.

Considering business districts and population density as two different dimensions allows for different location types to be considered, which may have varying amounts of traffic. For example, an area may have low population density because it is commercial and lacks many homes. It would not be accurate, however, to assume that safety consequences are relatively low just because there are few homes, as this area may be highly populated during business hours. Using Google Maps and 2020 census data, SoCalGas and SDG&E were able to categorize the national incident data into one of these four categories, allowing the modeled safety outcomes to align more closely with the Companies' respective service territories.

This approach is intended to accurately model the safety consequences of medium pressure risk events and account for specific characteristics of the service territories.

I. Estimate Mitigation Costs and Benefits

1. Estimating Mitigation Costs

Control and mitigation costs are derived from business unit forecasts of expected unit installations and related capital and O&M costs from 2028-2031. Costs are further broken down by labor and units (*e.g.*, number of poles) required to implement the associated mitigation. Forecasts are informed by historical units and costs of controls, where relevant data is available.

2. Estimating Mitigation and Control Benefits

Mitigations and controls either reduce or maintain risk. When risk is reduced, the LoRE or CoRE may be decreased, resulting in a potential baseline shift in the Risk Value for future years. For activities that maintain risk that otherwise would increase owing to ongoing infrastructure deterioration or exogenous factors such as climate effects, SoCalGas and SDG&E consider an alternative scenario where the activity does not exist, allowing the Companies to quantify the benefit of the activity. In this scenario, the Risk Value would be higher without the activity, and thus the LoRE or CoRE would be higher. This concept of "prevention" versus "preservation" will be discussed in the following section.

Estimating mitigation benefits depends on the availability and quality of data. In an effort to use the most reliable information, SoCalGas and SDG&E developed a data prioritization framework. This framework prioritizes: 1) internal data sources to assess mitigation effectiveness, including pre- and post-implementation reports, integrity management analysis, failure rates (*e.g.*, leak rates), incident rates, and maintenance data. When internal data is insufficient, SoCalGas and SDG&E incorporate 2) external industry sources, such as reports from the DOE, PHMSA incident data, vendor documentation, and academic research. For emerging technologies with limited empirical data, the Companies adopt a 3) qualitative approach, leveraging SME (Subject Matter Expert) insights to estimate potential benefits.

3. Calculating Benefits Through Prevention, Preservation, and Containment

The risk reduction or risk maintenance attributable to a mitigation or control – which constitutes the "benefits" for CBR purposes – is the estimated difference between the Pre-Mitigated and Post-Mitigated Risk Value resulting from application of the mitigation or the scenario of the absence of an ongoing activity. Calculating the risk reduction or risk maintenance entails modeling whether and how the mitigation or control impacts LoRE, one or more CoRE attributes, or some combination.

For this RAMP filing, SoCalGas and SDG&E modeled risk reduction or risk maintenance according to three categories of how mitigations or controls interact with risk, as described below. For simplicity, scope[55] is not considered in Equations 3.14−3.17; scope calculations are introduced in the next section.

Prevention: This involves reducing the LoRE without affecting the CoRE. Examples include replacing pipelines and undergrounding powerlines. Equation 3.14 shows the risk reduction as the difference between the Pre-Mitigated Risk and the Post-Mitigated Risk:

$$\text{Risk Reduction} = (\text{LoRE} \times \text{CoRE}) - (\alpha \times \text{LoRE} \times \text{CoRE}) \qquad 3.14$$

where $0 \leq \alpha \leq 1$.[56] Here the effectiveness of the mitigation is represented by α**,** where $(1 - \alpha)$ is the effectiveness of the mitigation. For example, for a mitigation that is 95% effective, we use $\alpha = 0.05$.

Preservation: This involves maintaining the current level of risk. Examples include routine maintenance, corrosion control, vegetation management, inspections, and safety training mitigations. Equation 3.15 shows the risk reduction as the difference between the Pre-Mitigated Risk and the Post-Mitigated Risk:

$$\text{Risk Reduction} = (\rho \times \text{LoRE} \times \text{CoRE}) - (\text{LoRE} \times \text{CoRE}) \qquad 3.15$$

where $\rho \geq 1$. Here the effectiveness of an ongoing mitigation or control is represented by ρ, where $\frac{\rho-1}{\rho}$ is the effectiveness of the mitigation or control. For example, if an ongoing mitigation or control is 50% effective, we use $\rho = 2$. Another way to estimate ρ is to determine how many more failures would be expected in absence of the ongoing activity.

Containment: This involves reducing the severity of outcomes (CoRE) without affecting the LoRE. Examples include emergency response plans, fire suppression systems, automated valves, and personal protective equipment (PPE) mitigations. Equations 3.16 and 3.17 represent this for new mitigations or controls, and ongoing mitigations or controls, respectively:

$$\text{Risk Reduction} = (\text{LoRE} \times \text{CoRE}) - (\text{LoRE} \times \gamma \times \text{CoRE}) \qquad 3.16$$

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55 Scope is the proportion of risk that could be addressed by mitigation.

56 Here, alpha is used as the parameter of LoRE reduction; in the section describing the approach to risk scaling, alpha is used to denote the scaling coefficient.

$$\text{Risk Reduction} = (\text{LoRE} \times \kappa \times \text{CoRE}) - (\text{LoRE} \times \text{CoRE}) \qquad 3.17$$

where $0 < \gamma \leq 1$ and $\kappa \geq 1$. Similar to α and ρ, γ and κ represent the effectiveness of a new mitigation or control, or an ongoing activity, through $(\gamma - 1)$ and $\frac{\kappa-1}{\kappa}$, respectively.

4. Mitigation Scope, Future Values, and Shifting the Baseline

When applying one of the parameters α, ρ, γ or κ, from prevention, preservation, or containment, to a LoRE or CoRE, it should only be applied to the portion that the mitigation or control covers. For example, if focusing on 100 miles of medium pressure mains, one must first consider the LoRE or CoRE specific to medium pressure mains and then apply the parameter to the proportion that corresponds to the 100 miles.

Certain models with high granularity allow for precise targeting of the portion addressed by the control or mitigation, while others require estimating the percentage, and some require both approaches. Step 1 involves narrowing down the slices of risk that the mitigation or control addresses as much as possible. Step 2 involves using exposure data to determine the percentage being addressed.

To demonstrate the math, SoCalGas and SDG&E assume that the LoRE/CoRE pairs in the equations represent Step 1, and the scope parameter s (or S) is the percentage of that LoRE or CoRE being addressed by the parameters α, ρ, γ or κ.

To discuss the equations for scope calculation, one must first express all LoREs and CoREs in terms of future values. In subsection E below, an explanation for how everything is discounted back to a single point in time (base year 2024 for these RAMP Reports), using three discount scenarios, is provided. This discussion focuses on applying inflation to the CoRE attributes and Costs, and degradation to the LoRE.

SoCalGas and SDG&E start with the general equations to convert CoRE and Cost into future values from the base year t_0 (for this RAMP, 2024) to a future year $T > t_0$:

$$\text{CoRE}_T = \text{CoRE}_{t_0} \cdot (1 + r_{\text{inf}})^{(T-t_0)} \qquad 3.18$$

$$\text{Cost}_T = \text{Cost}_{t_0} \cdot (1 + r_{\text{inf}})^{(T-t_0)} \qquad 3.19$$

Here, r_{inf} represents the inflation rate.

For any degradation rate, such as corrosion, that increases LoRE, the following equation is used:

$$\text{LoRE}_T = \text{LoRE}_{t_0} \cdot \left(1 + r_{\text{deg}}\right)^{(T-t_0)} \qquad 3.20$$

where r_{deg} represents the degradation rate.

Next, for a mitigation m_0 with scope s_0 and prevention parameter α_0 in year $T-1$:

$$\text{LoRE}_T = \text{LoRE}_{T-1} \cdot (1 - s_0) + LoRE_{T-1} \cdot s_0 \cdot \alpha_0 \qquad 3.21$$

This equation can be rewritten as:

$$\text{LoRE}_T = \text{LoRE}_{T-1} \cdot (1 - s_0 \cdot (1 - \alpha_0)) \qquad 3.22$$

Similarly, for mitigation M_0 with scope S_0 and containment parameter γ_0 in year $T-1$:

$$\text{CoRE}_T = \text{CoRE}_{T-1} \cdot (1 - S_0 \cdot (1 - \gamma_0)) \qquad 3.23$$

For multiple mitigations $m_0, m_1, \ldots, m_n$ with scopes $s_0, s_1, \ldots, s_n$ and prevention parameters $\alpha_0, \alpha_1, \ldots, \alpha_n$ in year $T-1$, respectively:

$$\text{LoRE}_T = \text{LoRE}_{T-1} \cdot \prod_{i=0}^{n} \big(1 - s_i \cdot (1 - \alpha_i)\big) \qquad 3.24$$

Similarly, for multiple mitigations $M_0, M_1, \ldots, M_N$ with scopes $S_0, S_1, \ldots, S_N$ and containment parameters $\gamma_0, \gamma_1, \ldots, \gamma_N$ in year $T-1$, respectively:

$$\text{CoRE}_T = \text{CoRE}_{T-1} \cdot \prod_{i=0}^{N} \big(1 - S_i \cdot (1 - \gamma_i)\big) \qquad 3.25$$

Equations 3.18−3.20 and 3.23−3.25 define LoRE and CoRE in future values.

Equations 3.21−3.25 correspond to mitigations that are preventions or new containments. These equations shift the baseline, as the left-hand sides define the start of the next year as a function of the previous year. For year T, the right-hand sides also represent the post Mitigation LoREs and post Mitigation CoREs. Specifically:

$$\text{postMitigation LoRE}_T = \text{LoRE}_T \cdot (1 - s \cdot (1 - \alpha)) \qquad 3.26$$

$$\text{postMitigation CoRE}_T = \text{CoRE}_T \cdot (1 - s \cdot (1 - \gamma)) \qquad 3.27$$

for year T.

Prevention and containment mitigations and controls do not shift baselines, and the math is the same for determining the pre-Mitigation LoREs and pre-Mitigation CoREs, as follows:

$$\text{preMitigation LoRE}_T = \text{LoRE}_T \cdot (1 - s \cdot (1 - \rho)) \qquad 3.28$$

$$\text{preMitigation CoRE}_T = \text{CoRE}_T \cdot (1 - s \cdot (1 - \kappa)) \qquad 3.29$$

for year T.

These equations help determine how the effectiveness of mitigations and controls, represented by parameters α, ρ, γ and κ, impact the LoRE and CoRE over time.

J. Discounting Costs and Benefits, and Calculating the Cost-Benefit Ratio

The previous subsection describes how to convert all LoREs, CoREs, and costs into future values. The next step is to discount everything back to a single point in time (the net present value), which, for purposes of the 2025 RAMP is 2024, the last recorded year of data available at the time of this RAMP filing. Consistent with the direction provided in the RDF, this is done using three discount scenarios: Societal, Weighted Average Cost of Capital (WACC), and a Hybrid approach. The Hybrid approach discounts the Safety and Reliability CoREs using a Hybrid rate, as prescribed by the Phase 3 Decision, while the Financial CoRE and costs are discounted using the WACC.

SoCalGas and SDG&E perform this discounting either before or after calculating the risk. For any CoRE attribute in future value, the following equation is used:

$$\mathrm{PV}_{r_{\mathrm{dis}}}[\mathrm{CoRE}_T] = \frac{\mathrm{CoRE}_T}{(1 + r_{\mathrm{dis}})^{(T-t_0)}} \qquad 3.30$$

Alternatively, this can be expressed as:

$$\mathrm{PV}_{r_{\mathrm{dis}}}[\mathrm{CoRE}_T] = \mathrm{CoRE}_{t_0} \cdot \left(\frac{1 + r_{\mathrm{inf}}}{1 + r_{\mathrm{dis}}}\right)^{(T-t_0)} \qquad 3.31$$

where r_{dis} is the discount rate.

Similarly, for costs:

$$\mathrm{PV}_{r_{\mathrm{dis}}}[\mathrm{Cost}_T] = \mathrm{Cost}_{t_0} \cdot \left(\frac{1 + r_{\mathrm{inf}}}{1 + r_{\mathrm{dis}}}\right)^{(T-t_0)} \qquad 3.32$$

Note that:

$$\mathrm{PV}_{r_{\mathrm{dis}}}[\mathrm{LoRE}_T \cdot \mathrm{CoRE}_T] = \mathrm{LoRE}_T \cdot \mathrm{PV}_{r_{\mathrm{dis}}}[\mathrm{CoRE}_T] \qquad 3.33$$

for any of the CoRE attributes (Safety, Financial, or Reliability), since LoRE is not monetary. Hence, one can now define the net present value of Risk:

$$\mathrm{PV}[\ \mathrm{Risk}_T] = \mathrm{LoRE}_T \cdot \left(\mathrm{PV}_{r_{\mathrm{dis}_s}}\left[\mathrm{CoRE}_T^{\mathrm{safety}}\right] + \mathrm{PV}_{r_{\mathrm{dis}_r}}\left[\mathrm{CoRE}_T^{\mathrm{reliability}}\right] + \mathrm{PV}_{r_{\mathrm{dis}_f}}\left[\mathrm{CoRE}_T^{\mathrm{financial}}\right]\right) \qquad 3.34$$

where r_{dis_s}, r_{dis_r}, and r_{dis_f} are discount rates for the Safety CoRE, Reliability CoRE, and Financial CoRE, respectively. As mentioned, in the two discount scenarios, WACC and Societal, all discount rates apply uniformly to all attributes. In the Hybrid scenario, while the cost and Financial CoRE use WACC as the discount rate, the safety and reliability CoRE use a Hybrid discount rate, as described in the Phase 3 Decision.[57]

What follows is the net present value of the benefit of a mitigation:

$$\mathrm{Benefit}_T = \mathrm{PV}[\ \mathrm{PreMitigation\ Risk}_T] - \mathrm{PV}[\ \mathrm{PostMitigation\ Risk}_T] \qquad 3.35$$

And the total benefit:

$$\mathrm{Benefit} = \sum_{t \in \mathrm{BY}} \mathrm{Benefit}_t \qquad 3.36$$

where BY is all the benefit years of the mitigation.

The ratio of Equation 3.36 and Equation 3.32 define the Cost-Benefit Ratio for a mitigation or control:

$$\mathrm{CBR} = \frac{\mathrm{Benefit}}{\mathrm{PV}[\mathrm{Cost}_T]} \qquad 3.37$$

When comparing the effects of the three discount rate scenarios on the CBRs, several observations can be made. For mitigations with a one-year benefit, the WACC and Societal discount rates yield identical CBRs. This occurs because both the numerator and denominator are inflated and discounted over the same period, causing the rates to cancel each other out. In contrast, under the Hybrid scenario, the numerator and denominator are discounted differently, leading to different CBRs.

For mitigations with benefits lasting longer than one year, if the discount rate (*e.g.*, WACC) exceeds the inflation rate, the benefits are reduced more than the costs. For instance, consider a mitigation with a 68-year benefit where a pipe is replaced in 2028. The cost is discounted over 4 years, while the benefit is discounted over a period ranging from 4 to 72 years. This creates a significant difference in CBR values between the discount rate scenarios, especially between the WACC and Societal rates.

57 D.24-05-064 at 103.

Table 18 shows the three discount rates for SoCalGas and SDG&E, respectively:

Table 18: Discount Factors Applied to the 2025 RAMP

	SoCalGas	SDG&E
Weighted Average Cost of Capital (WACC)[32]	7.49%	7.45%
Social Discount Rate	2%	2%
Hybrid rate calculated as defined in Phase 3[33]	6.1%	6.1%

K. Mitigation Strategy – Other Considerations

As stated in Chapter RAMP-2, SoCalGas and SDG&E's risk management philosophy prioritizes the prevention of catastrophic, loss-of-life events, protracted service interruptions, and the associated financial losses of such events. Row 26 of the RDF provides that a utility "is not bound to select its Mitigation strategy based solely on the Cost-Benefit Ratios produced by the Cost-Benefit Approach" and that "[m]itigation selection can be influenced by other factors." One such consideration that factors into the Companies' decision-making is the effectiveness of risk mitigations in reducing the potential for the type of catastrophic ("tail risk") outcomes described above. Providing insight into the specific question of tail risk reduction entails an analysis of pre- and post-mitigation tail risk. This section illustrates such tail risk analysis[58] as applied to certain of SDG&E's Wildfire mitigations.

For tail risk analysis, SDG&E uses the same probability distribution modeling underlying the development of the CBRs as described in the preceding sections within Step 3: Mitigation Analysis for RAMP Risks of this Chapter. In accordance with the RDF, SDG&E calculated CBRs for Strategic Undergrounding (SUG) and Combined Covered Conductor (CCC), which provide a comparison of those two mitigations on an expected value basis. In addition, SDG&E compares pre- and post-mitigation outcomes at various tail percentile values, including the 98th percentile (1 in 50 years) and the 99th percentile (1 in 100 years) to understand the potential residual tail risk remaining in the system after deploying these mitigations.

For illustrative purposes, the table below presents an evaluation of the residual risk (unmitigated) for the 98th percentile (1 in 50-year return period) for both SUG and CCC, Notwithstanding the CBRs, the post-mitigation (residual) tail risk (98th percentile outcome)

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58 The analysis presented in this section is not an application of tail risk-based CBRs in accordance Row 24 of the RDF, but a separate consideration in accordance with Row 26 of the RDF.

resulting from CCC is very large and, arguably, "intolerable."[59] Accordingly, and given SDG&E's aim of effectively and cost-efficiently reducing the risk of catastrophic outcomes, SDG&E's decision process would consider whether supplemental mitigation would be required with CCC to further reduce the P98 residual risk over the lifetime of the assets.

Table 19: Residual Tail Risk Comparison

Feeder Segment	Mitigation	Pre-Mitigation Risk at P98 [k$]	Post-Mitigation Risk at P98 [k$]	Risk Reduction at P98 [%]
235-899R	SUG	$ 4,667.33	$ 175.48	96.24%
235-899R	CCC	$ 4,667.33	$ 3,111.56	33.33%
222-1990R	SUG	$ 1,102.51	$ 445.56	59.59%
222-1990R	CCC	$ 1,102.51	$ 891.12	19.17%

L. Tranching

1. SoCalGas and SDG&E's 2025 RAMP Tranching Methodology

RAMP Risks are characterized by variation in the level of risk within the Risk, meaning that certain segments are riskier than others, particularly with asset-based risks. Within the RDF, "tranching" is the method by which a risk is partitioned in accordance with the variation in the risk profiles – that is, variation in the risk scores across the Risk – and "tranches" are the partitions resulting from tranching. One of the CPUC's stated goals of the RDF tranching requirement is to provide more granular tranches to inform the Commission of the riskiest portions of the Companies' infrastructure.[60] Calculating CBRs at the tranche level generally follows the process described above in Step 3 of this Chapter (Mitigation Analysis for RAMP Risks). To produce the requisite tranche-level view of a risk, the process first entails application of a method for partitioning the risk into tranches. Further, the tranches should adhere to the guidance of RDF Row 14 in terms of being sufficiently granular and exhibiting homogeneous risk profiles within each tranche. The Phase 3 Decision adopts a Row 14 tranche granularity approach (referred to as the Phase 3 Tranching Approach (PTTA)) and requires utilities "to use this approach to determine tranches in most cases,"[61] while allowing for flexibility, as follows:

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59 "Intolerable" is used indicatively here; SDG&E is not asserting a risk tolerance.

60 D 24-05-064 at 28.

61 *Id.* at 26.

> The best practice for determining the homogeneity of risk profiles in reporting Tranches is the use of quintiles of LoRE and quintiles of CoRE, resulting in 25 reporting tranches. The utility can and should submit more granular data in workbooks included with RAMP and GRC filings if it is available, but that more granular data shall be aggregated into at least 25 reporting tranches with homogeneous risk profiles. If the assets or system associated with a given risk are less than 25 in number, the utility may use an alternative means of determining homogeneity of risk profiles, including quartiles or other smaller divisions of LoRE and CoRE, but this alternative means must be described in detail in the RAMP filing.
>
> If a utility desires to use an alternative determination of Tranches not reflecting 25 homogenous risk profiles based on LoRE and CoRE, or they wish to use a percentile ranking approach that would result in more than 25 reporting Tranches, the utility must submit a White Paper describing their preferred method for determining Tranches and relevant workpapers to SPD no later than 45 days before their first pre-RAMP workshop and must serve the White Paper to the service list of R.20-07-013 or a successor proceeding as well as the service list of the utility's most recent RAMP application proceeding no later than 45 days before their first pre-RAMP workshop. Staff and Parties may provide input on the IOU's White Paper within the 21 days from the submittal. The utility must also include the White Paper in its RAMP filing, clearly indicating any changes to the previously served version. An IOU may submit this White Paper without prejudice to the right of parties to the RAMP or GRC to challenge such alternative determination of tranches.[62]

The PTTA tranching methodology has not yet been applied or implemented in a RAMP application. Indeed, SoCalGas and SDG&E are the first utilities to test the PTTA approach in their RAMP Reports, which is especially important within the context of assessing and presenting infrastructure risk. This testing process identified inconsistencies between the stated objectives of the PTTA and the methodology itself, as SoCalGas and SDG&E explain in their Alternative Tranching White Paper (White Paper), which was served November 1, 2024, in accordance with the process set forth in Row 14, and is attached to this RAMP Report as Appendix 3.

The White Paper explains that testing of the PTTA revealed the following issues:

- Inconsistencies between the Phase 3 Decision's objective to develop tranches with "homogeneity of risk profiles" and the PTTA's guidance to produce twenty-five tranches reflective of each possible pairing of LoRE and CoRE quintiles. Specifically, many of the resultant tranches from application of the PTTA included a heterogeneous – not homogeneous – mix of risk events, in contrast

62 D.24-05-064 at 33 (describing changes to the RDF Row 14).

with CPUC objectives.[63]

- Inconsistencies between the Phase 3 Decision's objective to identify "the riskiest portions of [a utility's] infrastructure and/or management system …" and the PTTA's potential to mix unlike risk profiles in a way that does not best represent the differences in risk profiles of the assets within the risk.[64]
- Inconsistencies between the Phase 3 Decision's goal of informing the Commission on the riskiest portions of the Companies' infrastructure and the PTTA's potential to minimize the presence of risk with respect to specific assets, due to the blending of different risk profiles within a tranche.[65]

Given these results, the White Paper explains that SoCalGas and SDG&E developed and applied a methodology referred to as the Homogeneous Tranche Method (HTM). The HTM is designed to achieve the stated objectives of the PTTA process (*i.e.*, by introducing an algorithm that addresses unwanted PTTA results observed in the testing), while adhering closely to the Row 14 PTTA process. Specifically, the algorithm produces homogeneity within each tranche, meaning the elements within the tranche are of substantially the same risk profile, within the same risk quantile, and arranged into similar LoRE/CoRE regions. In turn, each tranche provides a delineation as to the tranche's asset class within the Risk (*e.g.*, medium pressure underground assets), the relative level of risk (*e.g.*, the top 20%), and the LoRE/CoRE profile (*e.g.*, lower LoRE/upper CoRE). The HTM aligns with and advances the Commission's objective to identify the "riskiest portions of [a utility's] infrastructure and/or management system," consistent with the Phase 3 Decision's stated objectives.

A full explanation of the HTM is provided in the White Paper. The schematic in Figure 3 below provides a step-by-step illustration of the HTM. A similar schematic, specific to each risk, is also provided as an attachment to each Volume II risk chapter. In the graphic, the starting point is the set of risk incidents with their associated likelihood (LoRE) and consequence (CoRE) pairings. In the example below, the numerous causes of faults on SDG&E's electrical system (EII Risk) is the set of "LoRE/CoRE pairs" from which the tranches are derived. Next, the LoRE/CoRE pairs are aligned to Classes (Step 1). Classes for asset-based risks such as EII are generally asset subcategories (in the case of EII, substations, overhead infrastructure and

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63 White Paper at 8.

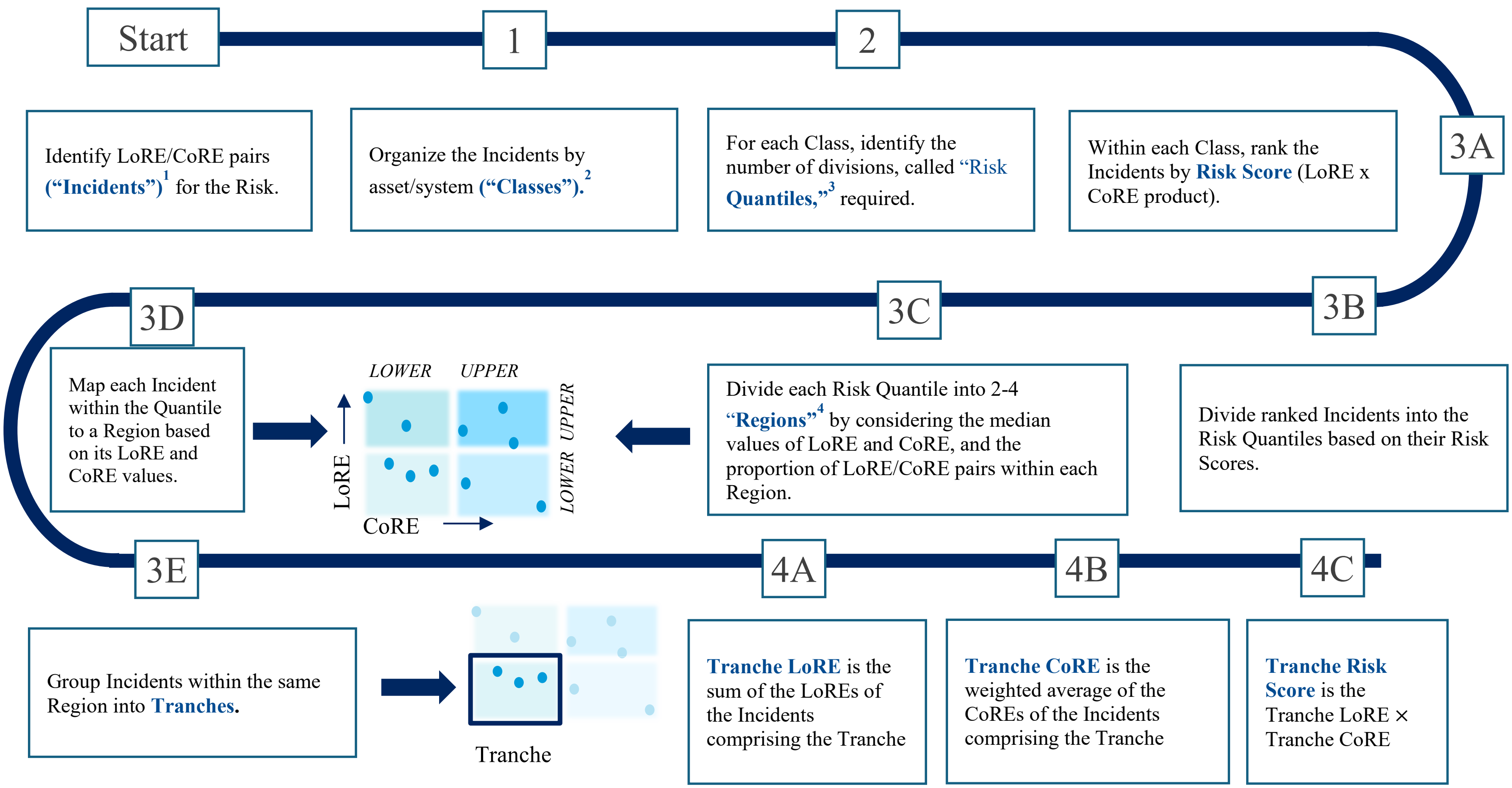
64 *Id.*

65 *Id.*

underground infrastructure). The classes provide the first "cut" of increased granularity. The next step (Step 2) is to determine how many divisions of incidents within each Class are needed to yield tranches that are homogeneous. Without this step, tranches for Classes with many incidents would be too broad (*i.e.*, too wide a range of LoRE/CoRE pairs within a tranche) and not achieve the RDF's goal of homogeneity within tranches. Accordingly, the number of "risk quantiles" is determined to facilitate homogeneity. In this way, Step 2 provides a second "cut" of increased granularity by dividing class LoRE/CoRE pairs into meaningful divisions *(e.g.*, "risk quartiles" if four divisions are determined, "risk quintiles" if five, and so forth).

As shown in Steps 3A through 3E of the graphic, the LoRE/CoRE pairs within each Class are organized highest to lowest (3A), the quantile lines "drawn" (3B), and the LoRE/CoRE pairs within each Class-quantile are mapped to the two to four LoRE x CoRE regions (3C). In this way, the resulting tranches (3E, in which LoRE/CoRE pairs within a region are group) are class-specific, within the same quantile of risk, and exhibit common LoRE/CoRE profiles. An example of a resulting tranche might therefore be "all of the low likelihood, high-consequence incidents in the first quartile of substation faults." As the original LoRE and CoRE attributes for each incident remain intact, the re-scoring of the tranche-level Risk Values is then determined (steps 4A through 4C).

Figure 3: Step-by-Step of the Homogeneous Tranching Method



NOTES

[1] *For example, **Incidents (or "Risk Incidents")** for Electric Infrastructure Integrity (EII) are generally fault types.*

[2] *For example, **Classes (or "Asset Classes")** for EII include Overhead Lines/Components, Underground Lines/Components, and Substations.*

[3] ***Quantiles** are divisions of equal numbers of incidents (quartiles have 4 divisions, quintiles have 5, etc.) The number of incidents dictates the number of quantiles needed.*

[4] *The four **Regions** are: 1. Lower LoRE-Lower CoRE (LL-LC), 2. Lower LoRE-Upper CoRE (LL-UC), 3. Upper LoRE-Lower CoRE (UL-LC), and 4. Upper LoRE-Upper CoRE (UL-UC).*

2. Response to Initial SPD Feedback

As contemplated in the Phase 3 Decision, SPD Staff provided input on the Companies' White Paper following its submittal, in a letter sent on November 22, 2024 (the SPD Letter).[66] While SoCalGas and SDG&E developed the HTM in good faith to align with and improve upon the PTTA and enhance transparency, consistent with the Phase 3 Decision's goal, SPD raised concerns regarding the transparency and understandability of the HTM in its letter. SoCalGas and SDG&E appreciate SPD's feedback and have endeavored to address SPD's concerns regarding the transparency and understandability of the HTM in this RAMP presentation,[67] and provide the following context in considering the SPD Letter:

SoCalGas and SDG&E are Aligned with SPD on the Policy Objectives of Tranching. The central stated policy objective of the RDF's tranching requirement is to promote targeted and efficient use of risk mitigation dollars by "prioritizing mitigations in the highest-risk tranches."[68] Pursuit of that objective was the overarching driver of the Companies' extensive, good faith effort to develop the HTM, which was designed to produce "tranches" for which the risk between tranches is measurably different, and for which the risk within each tranche is similar ("homogeneous"). The HTM also aims to achieve data-driven results, increase the transparency and granularity of information contained in the Companies' RAMP filing, and align with and inform risk mitigation efforts compatible with the Companies' existing and prospective operating procedures.[69]

SoCalGas and SDG&E Exercised Transparency in Developing the HTM. SoCalGas and SDG&E conducted a testing analysis of the Phase 3 Decision's PTTA to understand how to model it and undertook a good faith effort to develop an empirical model with

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66 Letter from Danjel Bout, Director, Safety Policy Division, CPUC, to Kathe Hunter Córdova, GRC Program Manager, GRC Case Management – SoCalGas/SDG&E (November 22, 2024) Re: Safety Policy Division Response to the Sempra Alternative Tranching Method Whitepaper.

67 SPD Letter at 4.

68 *See* D.24-05-064 at 13; *see also id.* at 28 ("[U]sing LoRE/CoRE quintile tranches will aid the Commission and parties understand if a utility is requesting funding for mitigations in the riskiest portions of their infrastructure and/or management system.").

69 White Paper at 2.

the goal of producing tranches that adhere to the guidance contained in the PTTA.[70] The PTTA was not tested in S-MAP Phase 3, and there was no known pilot analysis the Companies could reference to understand how to model the Phase 3 Decision's PTTA guidance empirically. The Companies met with SPD staff on August 16, 2024 to discuss their intent to test the Phase 3 Decision's tranching methodology, then subsequently on September 10, 2024 and October 14, 2024, to provide status updates and share preliminary observations from that testing. SoCalGas and SDG&E's PTTA testing provided a critical foundational context for the HTM, as it was developed specifically to address the fact that the resulting PTTA tranches were not homogenous. The Companies have attempted in good faith to convey these steps in the meetings with SPD on tranching, as well as in the detailed White Paper, and remain committed to sharing information and analysis that serves the goal of achieving transparency and understandability.

Use of the HTM Aligns with the Phase 3 Decision's Desired Tranching Results. SoCalGas and SDG&E include in their 2025 RAMP filings a significantly greater number of tranches compared with their 2021 RAMP filings. The Companies' tranching results are consistent with the Phase 3 Decision's intent and represent significant progress in advancing stated policy goals related to tranching. The Companies understand from the SPD Letter and subsequent meetings with SPD staff a concern that the HTM approach's mathematical complexity may hinder its ability to support risk-based decisions. While this feedback is appreciated, to provide additional context, the HTM's complexity is a function of the intent to improve upon the PTTA results while deviating as little as possible from the Phase 3 Decision's RDF Row 14 guidance. During the December 17 Pre-RAMP Workshop, certain participants posited alternative methodologies – including TURN's recommended asset-centric approach and OEIS's suggested "clustering" – that were suggested could produce even more homogeneous and useful tranches. While constructive, those suggestions depart even further from the Phase 3 Decision's Row 14 guidance than using the HTM.[71] While SoCalGas and SDG&E are receptive to consideration of alternative, more simplified approaches proposed by Stakeholders, the

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[70] White Paper at 5-7.

[71] Additionally, tranching alternatives suggested at the Pre-RAMP Workshop could not have been considered for use in this 2025 RAMP Report, given RDF Row 14's White Paper requirement and timing constraints.

Commission would need to express support for such approaches. In sum, SoCalGas and SDG&E are in alignment with SPD and intervenors on the important policy goals that tranches are intended to advance and submit that the development and application of the HTM has resulted in significant progress in the development and use of tranching in the Companies' 2025 RAMP filings. Constructive feedback on the mechanics of tranching is appreciated in considering future enhancements to the RDF. For purposes of their 2025 RAMP presentations, SoCalGas and SDG&E have utilized their HTM[72] and appreciate consideration of their good faith tranching presentation and results, which were designed to adhere to the RDF's Row 14 both in letter and in spirit, and to comply with the Phase 3 Decision while advancing the CPUC's stated policy goals.

VII. QUANTITATIVE WORKPAPERS

SoCalGas and SDG&E are providing workpapers to support the quantitative analysis in their RAMP Reports. The RDF Row 29 states the following:

> The methodologies used by the utility should be mathematically correct and logically sound. The mathematical structure should be transparent. All algorithms should be identified. All calculations should be repeatable by third parties using utility data and assumptions recognizing that, dependent on the models used, some variation of result may occur. This requirement is subject to practicality and feasibility constraints of sharing data and models (such as confidentiality, critical energy infrastructure data, volume of information and proprietary models). If these constraints arise, the utility will walk through the calculations in detail when requested by intervenors or the CPUC staff.

The Companies are providing quantitative workpapers that include (1) Excel-based workbooks and calculations and (2) tranche visuals in HTML format. For the workbooks and calculations, the Companies are producing these quantitative workpapers in the format for which the calculations were executed. For some RAMP risks, the quantitative modeling was performed either partially or entirely in Excel, and in these instances, Excel modeling workbooks with formulas intact are being provided. For other RAMP risks, Python and MATLAB programming languages were used to perform the quantitative risk modeling and calculations. When analytical programs are used, Excel-based workpapers are generated to present the output data. These workpapers may not include all underlying formulas. When this is the case, detailed calculation

[72] In workpapers, SoCalGas and SDG&E have also provided as points of comparison examples of tranching using the PTTA method for two risks: Underground Storage System and Wildfire and PSPS.

steps are provided for each mitigation that explain how the benefit-cost ratio is derived.

Risk quantification is further supported by additional resources and workpapers that include calculations, pseudocode, formulas, and detailed explanations, as applicable. In accordance with the RDF and Commission Rules, the Companies will walk through the calculations when requested by intervenors or the CPUC staff.