Risk Assessment Mitigation Phase

(RAMP-C)

Risk Quantification Framework
and
Risk Spend Efficiency

May 17, 2021

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RAMP C: RISK QUANTIFICATION FRAMEWORK AND RISK SPEND EFFICIENCY

I. INTRODUCTION

This joint chapter provides an overview of the quantification methods used by Southern California Gas Company (SoCalGas) and San Diego Gas & Electric Company (SDG&E) (collectively, Companies). Within this chapter, the Companies: (1) provide an overview of the quantitative assessment used for risks and mitigations/controls throughout the RAMP Report, (2) explain the methodology used to create the multi-attribute value function (MAVF) and risk spend efficiencies (RSEs), and (3) demonstrate how RSEs are used in the Reports. The Companies have used the directives established in Decision (D.) 18-12-014 and the Settlement Agreement adopted therein (the Settlement Decision) to inform the quantification methods used in the RAMP Report, as discussed in this chapter.

II. OVERVIEW OF QUANTITATIVE ASSESSMENT

This section provides an overview of how the MAVF is applied to quantitatively assess risks throughout this Report (referred to herein as the Risk Quantification Framework), including illustrating hypothetical examples of risk scores (using the ranges displayed in the examples). The Risk Quantification Framework is used to analyze risk by estimating current risk scores (the Pre-Mitigation Risk Scores) and forecasting future risk scores if new activities are started or current ones are ceased (the Post-Mitigation Risk Scores).

- Section A provides a brief overview of the quantitative analysis used to analyze each risk, according to the Settlement Decision.
- Section B describes the requirements of the MAVF per the Settlement Decision, and how the Companies' Risk Quantification Framework was accordingly constructed.
- Section C describes the steps to apply the Risk Quantification Framework in accordance with the Settlement Decision.
- Section D shows a hypothetical example of a risk score calculation using the Risk Quantification Framework.

A. Overview and Approach

The quantitative analysis applied in the RAMP Reports is derived from the Settlement Decision, and can be outlined as follows:

- Develop an MAVF, which the Companies refer to as the Risk Quantification Framework;[1]
- Consider risks as defined and scoped in the Companies' Enterprise Risk Register (ERR);[2]
- Compute a Safety Risk Score using the Safety Attribute of the MAVF for each risk included in the ERR;[3]
- For each identified risk that is required to be included in the RAMP:
    - Estimate the frequency of a risk event occurring in a given year and use that value for the Likelihood of Risk Event (LoRE);
    - Estimate the average (mean) consequences if the Risk Event were to occur;
    - Apply the average consequences to the Risk Quantification Framework to create a value known as the Consequence of Risk Event (CoRE); and
    - Multiply the values of LoRE and CoRE to determine a risk score for that risk. The result of this calculation constitutes a Pre-Mitigation Risk Score.

As required by the Settlement Decision, for planned mitigations, a resulting Pre-Mitigation Risk Score will be used: (1) to demonstrate a risk score for each risk along with a ranking, and (2) as an input into the calculations to determine the change in risk scores when a risk-reducing activity is started or ceased.

B. Risk Quantification Framework

This section presents the Risk Quantification Framework that will be used throughout the RAMP Reports, as guided by the Settlement Decision. The quantitative aspects shown in this chapter are not meant to reflect precision or a comprehensive view of risk, but rather serve as a starting point on which to build. Further, as explained below, the Risk Quantification Framework is the result of many necessary assumptions. Should those assumptions change, different results would be expected.

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1 D.18-12-014 at Attachment A, A-5 – A-6 (Step 1A).

2 *Id.* at Attachment A, A-7 (Step 1B).

3 *Id.* at Attachment A, A-8 – A-9 (Step 2A).

Under the Settlement Decision, the Risk Quantification Framework requires certain "attributes," defined as "an observable aspect of a risky situation that has value or reflects a utility objective, such as safety or reliability."[4] The attributes "should cover the reasons that a utility would undertake risk mitigation activities"[5] and must be reflected in "the way the level of an attribute is measured or expressed."[6] The determination of attributes is left to each utility's discretion, with the requirement that the attributes should include safety, reliability, and financial attributes.[7] Attributes are a subset of the many criteria used to assess and manage risk.[8]

The Settlement Decision also requires construction of a scale "that converts the range of natural units … to scaled units to specify the relative value of changes within the range, including capturing aversion to extreme outcomes or indifference over a range of outcomes."[9] Attributes also must be assigned weights reflecting each attribute's relative importance to other identified attributes.[10]

The three tables below show a Risk Quantification Framework utilized in this RAMP Report. Each table shows chosen attributes and assigned weights and scales. A narrative summary of the choices examined and made in assigning values to the variables shown below (*e.g.*, attributes, scales, weights) is described in Section II.E below.

The Risk Quantification Framework (as outlined in the Settlement Decision) is a prescribed methodology that provides a data point to help inform risk-based decision making (amongst other available data points). There are numerous ways to select attributes, scaling, and weights. However, the Settlement Decision contains a prescribed methodology for selecting attributes, scaling, and weights, limiting a utility's choices in certain ways. The choices elected in accordance with the Settlement Decision's prescribed methodology should not be viewed as a precise reflection of real-world circumstances.

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4 D.18-12-014 at Attachment A, A-2.

5 *Id.*

6 *Id.* at Attachment A, A-3.

7 *Id.* at Attachment A, A-8.

8 *Id.* at Attachment A, A-14 ("Mitigation selection can be influenced by other factors including funding, labor resources, technology, planning and construction lead time, compliance requirements, and operational and execution considerations.").

9 *Id.* at Attachment A, A-5.

10 *Id.* at Attachment A, A-6.

The Settlement Decision requires the Companies to follow six principles to construct its MAVF.[11] The Companies applied these six principles to arrive at the Risk Quantification Framework summarized in Table 1 below. The top-level attributes of safety, reliability, and financial are consistent with the minimum attributes required by the Settlement Decision.[12] The Stakeholder Satisfaction attribute is a new attribute being introduced by the Companies – the first attribute to be used by a utility in the state beyond the three required by the Settlement Decision. Given that "[a]ttributes are combined in a hierarchy,"[13] the top-level attributes are further broken down into sub-attributes.[14] Measurement of each sub-attribute is also required and is based on unique characteristics.[15] These sub-attribute measurements are then rolled up to the top-level attribute. The combined measurement of each top-level attribute is represented in Table 1 below as the Measurement Unit. The scales contained in Table 1 also reflect the Settlement Decision's MAVF principles and were constructed to represent the relative value of changes in a range of the measured units.[16] Similarly, the Companies completed a weighting process in accordance with the Settlement Decision[17] to develop the weights in Table 1 below (as further described in Section III.C, *infra*).

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[11] *Id.* at Attachment A, A-5 – A-6 ("MAVF").

[12] *Id.* at Attachment A, A-8 ("Risk Assessment").

[13] *Id.* at Attachment A, A-5 ("MAVF Principle 1 – Attribute Hierarchy").

[14] *Id.* at Attachment A, A-5, ("MAVF Principle 1 – Attribute Hierarchy") and ("MAVF Principle 2 – Measured Observations") refer to lower-level attributes in the context of building a MAVF. The term "lower-level attribute" is referred to herein as "sub-attribute."

[15] *Id.* at Attachment A, A-5 ("MAVF Principle 2 – Measured Observations") and ("MAVF Principle 3 – Comparison").

[16] *Id.* at Attachment A, A-5 ("MAVF Principle 5 – Scaled Units").

[17] *Id.*, Ordering Paragraph 2 at 67-68, and at Attachment A, A-6 ("MAVF Principle 6 – Relative Importance").

Table 1: Risk Quantification Framework Top-Level Attributes

Top-Level Attribute	Measurement Unit[18]	Scale	Weight
Safety	Safety Index	0 – 20	60%
Reliability	Reliability Index	0 – 1	23%
Financial	$	$0 - $500M	15%
Stakeholder Satisfaction	Satisfaction Index	0-100	2%

Table 2 below shows the sub-attributes contained in the Safety top-level attribute from Table 1 above. The measured unit for each Safety sub-attribute, when combined, create a single Safety Index value that is used in Table 1 above.[19] The components of the Safety Index are provided in Table 2 below.

Table 2: Risk Quantification Framework Safety Index

Safety Sub-Attributes	Value
Fatality	1
Serious Injury	0.25
Acres Burned[20]	0.00005

Like Table 2 above, Tables 3 and 4 show the sub-attributes that are included in the Reliability top-level attribute from Table 1 for SDG&E and SoCalGas, respectively. Each sub-attribute is measured by its own unit. The Companies' determination of attributes, scales and weights are explained in Section III, *infra*. When all four sub-attributes for reliability are summed together, it creates a single Reliability Index value that is used in Table 1 above.

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[18] "Measurement Unit" used herein is the measured attribute, also analogous to "Natural Unit" per the Settlement Decision Lexicon included in D.18-12-014 at Attachment A, A-3.

[19] MAVF Principle 1 - Attributes are combined in a hierarchy. *See* D.18-12-014 at Attachment A, A-5.

[20] Applicable only to Wildfire Involving SDG&E Equipment.

Table 3: Risk Quantification Framework Reliability Index for SDG&E

Reliability Sub-Attribute	Measurement Unit	Scale	Weight
Gas Meters	Number of Gas Meters Experiencing Outage	0 – 50,000 meters	25%
Gas Curtailment	Volume of Curtailments of Natural Gas exceeding 80 million cubic feet/day	0 – 250 MMcf	25%
Electric SAIDI	System Average Interruption Duration Index (SAIDI) minutes	0 – 100 minutes	25%
Electric SAIFI	System Average Interruption Frequency Index (SAIFI) outages	0 – 1 outages	25%

Table 4: Risk Quantification Framework Reliability Index for SoCalGas

Reliability Sub-Attribute	Measurement Unit	Scale	Weight
Gas Meters	Number of Gas Meters Experiencing Outage	0 – 100,000 meters	50%
Gas Curtailment	Volume of Curtailments of Natural Gas exceeding 250 million cubic feet/day	0 – 666 MMcf	50%

Because the Financial attribute is readily measured in dollars, sub-attributes are unnecessary for quantifying it. Similarly, the Stakeholder Satisfaction attribute is composed of only affected stakeholders; thus, sub-attributes are unnecessary.[21]

C. Application of Risk Quantification Framework

The Settlement Decision further requires that the Risk Quantification Framework use specific methods of applying statistical information. The following statistical concepts are key to understanding the Risk Quantification Framework: (a) risks are evaluated at the "risk level," as defined by the Companies' ERR; (b) each risk is evaluated for annual frequency using the risk quantification method; (c) each risk is evaluated by considering possible consequences attributed to a risk event (rather than specific scenarios); and (d) averages, or expected values, are used for LoRE and CoRE.

To calculate a risk score, there are four basic steps. First, estimate the frequency of a risk event occurring in a given year and set the LoRE to this value. If the frequency is estimated to

[21] For further detail regarding the Stakeholder Satisfaction attribute, *see* III.E.4 below.

be less than one per year, the frequency is put into decimal form. Second, estimate the average consequence for each attribute and sub-attribute based on the range of known possible consequences. Third, use the Risk Quantification Framework to obtain a single consequence value known as the CoRE. Finally, multiply the LoRE and the CoRE to calculate the risk score. To ease readability, the risk score is multiplied by 100,000, then rounded to the nearest whole number, or decimal, if less than 1.

D. Hypothetical Example Of Risk Score Calculation Using The Risk Quantification Framework

The following example will follow steps 1 - 4 shown above. All values in this example are illustrative and not representative of a specific risk.

Example: Risk XYZ

Step 1: Estimate LoRE. Internal and external data suggest that Risk XYZ will have an average of 12 risk events per year.

Step 2: Estimate consequences of attributes. Internal and external data suggest that if a risk event were to occur for Risk XYZ, the consequences would average as follows:

a. Fatalities: 0.02 (*i.e.*, 1 fatality for every 50 risk events)

b. Serious Injuries: 0.1 (*i.e.*, 1 serious injury for every 10 risk events)

c. Gas Meters: 0 meters

d. Gas Curtailment: 0 curtailment

e. SAIDI: 0 minutes

f. SAIFI: 0 outages

g. Financial: $1.5 million from damage to property

h. Stakeholder Satisfaction: 5 points from customer

Step 3: Estimate CoRE. Each of the estimates for each attribute/sub-attribute in Step 2 is used to generate top-level attribute scores. Those scores are then used to estimate a CoRE. The values from Step 2 are shown below in boldface type.

a. Safety Index: (Fatalities x 1) + (Serious Injuries x 0.25) = (**0.02** x 1) + (**0.1** x 0.25) = 0.045

b. Reliability Index: 0

c. Financial: **$1.5 million**

d. Stakeholder Satisfaction: **5**

e. $\text{CoRE} = \frac{Safety\ Index}{20}\ x\ 60\% + \frac{Reliability\ Index}{1}\ x\ 23\% + \frac{Financial}{\$500M}\ x\ 15\% + \frac{Stakeholder\ Satisfaction}{100}\ x\ 2\% = \frac{0.045}{20}\ x\ 60\% + \frac{0}{1}\ x\ 23\% + \frac{1.5M}{\$500M}\ x\ 15\% + \frac{5}{100}\ x\ 2\% = 0.0028$

Step 4: Calculate Risk Score. Multiply LoRE x CoRE x 100,000 and round to nearest whole number. From step 1, LoRE = 12, from step 3, CoRE = 0.0028. Risk Score = 12 x 0.0028 x 100,000 = 3,360. The Risk Score of Risk XYZ is 3,360.

III. MAVF CONSTRUCTION AND COMPONENTS

Under the Settlement Decision, each utility is required to create a multi-attribute value function that will be used in the RAMP Report for risk scoring.[22] As stated above, the MAVF is a tool for combining potential consequences of the occurrence of a risk event to create a measurement of value. This section provides a detailed description of the construction of SoCalGas and SDG&E's MAVF, including: (1) the determination of attributes, (2) the determination of scales of attributes, (3) the determination of weights of attributes, (4) how attributes were implemented, (5) details on each of the particular attributes (Safety, Reliability, Financial, Stakeholder Satisfaction), and (6) the probabilistic aspects of the MAVF.

The Companies' MAVF construction followed the steps outlined in the Settlement Decision.[23] The process of creating the MAVF is complex and should be considered a non-perfect method to enable the comparison of diverse utility risks. The complex and multilayered process to determine an effective quantitative risk methodology to enable the comparison of a broad range of risks is iterative and continually evolving, and the value functions presented in this RAMP Report should be considered in that vein. It is important to note that the construction of the MAVF discussed herein was a single effort undertaken for both SoCalGas and SDG&E. The attributes, scales, and weighting of attributes in the MAVF were determined collectively for both Companies, given the Companies' shared assets (*e.g.*, the natural gas distribution system and IT infrastructure).

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[22] *Id.* at Attachment A, A-5 – A-6 (Step 1A).

[23] *Id.*

A. Determination Of Attributes

An attribute, as defined by the Settlement Decision, is "an observable aspect of a risky situation that has value or reflects a utility objective, such as safety or reliability. Changes in the levels of attributes are used to determine the consequences of a Risk Event."[24] Following this MAVF principle (principle 1), the Companies considered a large number of attributes for the Risk Quantification Framework. The method of attribute inclusion was: (a) create a list of potential attributes (this list was a composite of attributes from various sources such as current attributes, those discussed at CPUC workshops, potential attributes as proposed through the inquiry of internal subject matter experts (SMEs), and researching external entities); and (b) determine the ability to include such attributes by considering availability of data, consistency of data, commonality of the attribute across risks, and complications arising from their inclusion, among others. The attributes included in this RAMP Report are not meant to represent all dimensions of risk management that occur at the Companies but are useful for the purposes of this filing, namely, to create estimated risk quantification that can assist in decision-making.

Like all aspects of the utilities' Risk Quantification Framework, the attributes used, and how they are weighted, will continue to evolve over time. The version of the Risk Quantification Framework that is presented in the RAMP filing is not intended as a final effort, but rather the current version that will undergo improvements through lessons learned and input received from various sources.

Despite thorough consideration, the Companies did not include an environmental attribute in this cycle's Risk Quantification Framework. The Companies are focused on environmental impacts and thoughtfully consider how to reduce those impacts; however, for the purposes of quantification, the Companies were unable to determine how to express an environmental attribute that would enable meaningful comparison of utility risks while meeting the standards of the Settlement Decision. There are several dimensions of impacts related to the environment, including impacts to water, soil, air, species, and cultural. Within those dimensions, there are numerous sub-dimensions. For example, air pollution can take many

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[24] *Id.* at Attachment A, A-2.

forms, such as greenhouse gas (GHG) emissions and near-ground pollution, including exhaust from vehicles and sources that have a local impact to air quality.

In addition to the various challenges related to the scope and impacts of the environmental attributes, it is also difficult to define relative weights between each of these environmental impacts. The difficulty becomes exacerbated by the sheer number of dimensions involved. The relative weights between each of them are convoluted and contradictory. The Companies will continue to review academic and governmental research regarding the impact levels of these environmental dimensions and may include updates in future Risk Quantification Frameworks. Although the Companies were unable to include an attribute specifically addressing environmental impacts for this RAMP Report, the Risk Quantification Framework does include "Acres Burned" in the Safety attribute for SDG&E to account for the detrimental impacts from pollution to human health. On a related note, the Companies discuss their dedication to environmental concerns in SoCalGas's Energy Resilience CFF (SCG-CFF-2) and SDG&E's Climate Change Adaptation, Energy System Resilience, and Greenhouse Gas Emission Reductions CFF (SDG&E-CFF-2).

Future versions of the Risk Quantification Framework may be designed with the goal of expanding and refining the number of attributes and sub-attributes in line with other key parameters used in day-to-day decision making.

B. Scales Of Attributes

The Settlement Decision directs the utility to construct a scale that converts the range of natural units to scaled units.[25] While the notion of applying scales for attributes appears to be straightforward, there are many aspects to consider, especially when applying the next step of assigning weights to each scale. The Settlement Decision states that the top of the scale approximates the maximum expected results for a risk. However, the Settlement Decision also requires expected values to be used. Expected values have very different "maximum expected results" depending on each scenario used. For example, a plane crash might lead to a few hundred deaths, but the annual expected value of fatalities for a particular airline in a given year is something far less. The Companies exercised their discretion to make a reasoned decision in choosing the top end of the scales for the attributes because not all risk scenarios involving a

[25] *Id.* at Attachment A, A-5 – A-6 (Step 1A).

particular risk yield the same maximum expected results. As discussed in the "Weights of Attributes" section below, scales and weights are strongly connected.

C. Weights Of Attributes

1. Quantitative Notes on Weights

The weight applied to each attribute is an important step in determining risk scores. Different weights can lead to different rankings of those risks. Below is a simplified, illustrative example of sample risks that show how weights can alter results.

Table 5: Illustrative Example of Weighting

	Safety Score	Financial Score	Risk Score Method 1: Safety: 90% Weight Financial: 10% Weight	Risk Score Method 2: Safety: 50% Weight Financial: 50% Weight
Risk A	0.5	0.2	4700	3500
Risk B	0.2	0.6	2400	4000

In Table 5 above, Risk A has a risk score nearly twice as large as Risk B (4700 compared with 2400) using Method 1 (90% Safety and 10% Financial), but it has a lower risk score using Method 2. This is because Risk A has more Safety risk relative to Risk B, and a weighting that favors Safety would therefore favor Risk A. This example illustrates that choosing weights can have a significant impact on the scoring that follows. The Companies are aware that the choice of weights is not perfect for all situations; therefore, scores should be thought of as estimates, rather than precise values.

2. Methodology for Determining Weights

The Settlement Decision requires that the Safety Attribute of the MAVF have a minimum weight of 40%.[26] Other than that safety minimum weight requirement, the Settlement Decision gives utilities the discretion to select weights through their own internal processes. The Companies' main method for determining weights for the Risk Quantification Framework considered alignment with the Companies' Enterprise Risk Management (ERM) ERR process (described in RAMP B). Using the ERR as a starting point, initial weights were identified and considered for use in the RAMP Report. Although the ERR is more of a qualitative than quantitative view of risk, it can lend itself to numerical comparisons. In addition, an industry-leading reliability study that comments on financial equivalences with reliability was considered

[26] D.18-12-014, Ordering Paragraph 2 at 67-68.

in the creation of the Risk Quantification Framework weights.[27] The Lawrence Berkeley study considers the amount of financial loss to customers due to loss of electric power. As mentioned in more detail below, because every electric outage is unique, the study is used as a guide rather than as a source of precise equivalences. While there is not an equivalent reliability study available that is specific to financial loss to customers due to loss of natural gas, the findings in the study can be extrapolated to generally apply to all utility customers.

The use of the ERR and the reliability study led to a rough approximation of how weights might look across all four attributes. Draft versions of the scales and weights were created and run through a series of real-world events to check the results for reasonableness. Adjustments were made after the reasonableness test runs and results were internally discussed. During the internal testing and discussions, it became clear that no set of scales and weights would lead to expected results for all situations. More refinements were made, and this RAMP Report utilized a set of scales and weights that may reflect an amalgam of SME and external source views.

To summarize how weights were attained for the Risk Quantification Framework, the Companies reconciled different values and data points and considered: a) the current ERR framework, b) an electric reliability study, c) a historical comparison of gas and electric reliability impacts to society, d) scenario testing, e) input from ERM staff and leadership, f) research into other utilities and industries, g) input from personnel of varying levels (including officers) at the Companies, and h) use of rounded numbers for readability.

3. Observations when Determining Weights

This section discusses several issues the Companies encountered when determining the final weights to use for the Risk Quantification Framework.

The Risk Quantification Framework uses four attributes – safety, reliability, financial and stakeholder satisfaction. In an ideal world, the relationship between each of the four pairwise combinations (*i.e.*, reliability vs. safety, safety vs. financial, and financial vs. reliability, stakeholder satisfaction vs. reliability, financial vs. stakeholder satisfaction and safety vs. stakeholder satisfaction) would be consistent. In mathematics, the transitive property is commonly stated as "If a=b and b=c, then a=c." For multi-attribute value functions, however,

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[27] *See* Ernest Orlando Lawrence Berkeley National Laboratory, *Estimated Value of Service Reliability for Electric Utility Customers in the United States* (June 2009) (Lawrence Berkeley study), *available at https://certs.lbl.gov/sites/default/files/lbnl-2132e.pdf.*

the transitive property is less clear. As noted above, for electric reliability, the Lawrence Berkeley study was used as a starting point to compare reliability to financial. Using that data, a blackout occurring across SDG&E's service territory for eight hours would have a financial impact to SDG&E's customers of over $1 billion. This estimate created one pairwise combination of the attributes (reliability vs. financial). Separately, a hypothetical question was posed to determine another pairwise combination (reliability vs. safety): "Which risk event would you least like to happen, a systemwide blackout for eight hours that harms no one or a safety incident at a substation that results in an employee fatality?" The Companies prioritized the elimination of the safety incident. With the two pairwise comparisons developed, the transitive property could be applied to derive the third and fourth pairwise comparison. When doing so, the third pairwise comparison (safety vs. financial) did not follow the first two pairwise comparisons and, thus, led to unhelpful values for the remaining pairwise comparisons.

In the illustrative example mentioned above, when an eight-hour systemwide outage is considered equal to a $1 billion financial loss, and the utility prefers to have an eight-hour systemwide outage versus the fatality of an employee, it could lead to the conclusion that the utility believes lives to be valued above $1 billion. This example highlights the complexity of creating multi-attribute value functions that have non-transitive pairwise comparisons.

Another issue is that the Companies are not accustomed to quantifying the value (financially or otherwise) of preventing safety incidents. Safety is a priority at the Companies as well as a reflection of our culture and the Companies' core values. Attempting to find pairwise comparisons with safety and other attributes can be difficult – especially at workplaces that hold safety to be non-negotiable.

Another concept observed during the creation of the Risk Quantification Framework relates to comparing the value of preventing an incident versus the value of remediating the impact if the incident were to happen. For example, if an employee becomes injured on the job, it might take some amount of financial effort and Human Resource involvement to make sure the employee is taken care of and that the employee's group has a trained person to temporarily fill the role. The value of trying to prevent the event is not equal to the value of the expected remediation costs.

D. Attribute Units

The Settlement Decision contemplates expression of attributes in "natural units."[28] The natural unit of an attribute is defined as follows:

> [T]he way the level of an attribute is measured or expressed. For example, the natural unit of a financial attribute may be dollars. Natural units are chosen for convenience and ease of communication and are distinct from scaled units.[29]

The top-level attributes of safety and reliability comprise sub-attributes that are used to create Safety and Reliability indices, respectively. The Safety Index has two sub-attributes, while the Reliability Index has four sub-attributes. The measurement units chosen to represent the natural units for the sub-attributes are shown in Table 6 below. The sub-attributes within safety and reliability are used to create an index for the top-level attribute.

Table 6: Attributes

Attribute	Sub-Attribute	Measurement Unit
Safety	Fatality	Number of Fatalities
Safety	Serious Injury	Number of Serious Injuries
Safety	Acres Burned[30]	Numbers of Acres Burned from a Wildfire Involving SDG&E Equipment
Reliability	Gas Meters	Number of Gas Meters Experiencing Outage
Reliability	Gas Curtailment	Volume of Curtailments of Natural Gas exceeding 250 million cubic feet/day
Reliability	Electric SAIDI[31]	System Average Interruption Duration Index (SAIDI)
Reliability	Electric SAIFI[32]	System Average Interruption Frequency Index (SAIFI)
Stakeholder Satisfaction	Stakeholders Satisfaction Index	Five sub-attributes measuring the satisfaction of the five stakeholder groups (customer, public, employee, government, and regulators)

28 D.18-12-014 at Attachment A, A-3.

29 *Id.*

30 Applicable to SDG&E only.

31 Applicable to SDG&E only.

32 Applicable to SDG&E only.

E. Details On Particular Attributes

1. Safety Attribute

The Safety attribute consists of a Safety Index, which is calculated by assessing its two sub-attributes for every risk except Wildfire Involving SDG&E Equipment, which takes into account the additional sub-attribute of Acres Burned. SDG&E explored the defensible notion that wildfires, which result in a significant number of acres burned, have a safety impact on the general population.[33] The Company sought to capture this impact; therefore, it included this specific sub-attribute for the Wildfire risk only. The sub-attributes included are related to data that is readily available. The relative value between Fatalities and Serious Injuries is derived from information provided through the Occupational Health & Safety Administration (OSHA) and the Federal Aviation Administration (FAA).[34] Fatalities each receive a score of one, and Serious Injuries receive a score of 0.25 each. A Serious Injury is generally defined as an event that requires hospitalization or a permanent disfigurement of an individual.[35] The sum of these three sub-attributes, where applicable, create the Safety Index, which is then used as a top-level attribute in the Risk Quantification Framework.

Table 7: Safety Attributes

Safety Sub-Attribute	Value
Fatality	1
Serious Injury	0.25
Acres Burned[36]	0.00005

In the RAMP Report, safety impacts are indifferent to: (a) the cause or reason for the event that results in safety impact, (b) the characteristics of those affected, (c) the perceived fault

33 *See* ScienceDirect, *Quantification of pollutants emitted from very large wildland fires in Southern California, USA* (June 2006), *available at* doi:10.1016/j.atmosenv.2006.02.016; *see also Transportation Benefit-Cost Analysis*, *available at* http://bca.transportationeconomics.org/.

34 *See* United States Department of Labor, *Severe Injury Reports*, *available at https://www.osha.gov/severeinjury/*; *see also* United States Department of Labor, *Reports of Fatalities and Catastrophes – Archive*, *available at https://www.osha.gov/fatalities/reports/archive*; *see also* Federal Aviation Administration, *Data & Research*, *available at https://www.faa.gov/data_research*.

35 Title 8 California Code of Regulations § 330(h).

36 Applicable to SDG&E only.

of the utilities or others, (d) the mitigating or aggravating circumstances related to any impacted person's situation, and (e) other such concerns.

2. Reliability Attribute

The Reliability attribute comprises a Reliability Index that consists of two equally weighted sub-attributes for SoCalGas and four for SDG&E. The sub-attributes with their Natural Units (Measurement Units) are shown in Table 8 below. The Reliability Index shown below is structured similarly to the overall Risk Quantification Framework and contains attributes, scales, and weights.

Table 8: Reliability Attributes for SDG&E

Reliability Sub-Attribute	Measurement Unit	Scale	Weight
Gas Meters	Number of Gas Meters Experiencing Outage	0 – 50,000 meters	25%
Gas Curtailment	Volume of Curtailments of Natural Gas exceeding 80 million cubic feet/day	0 – 250 MMcf	25%
Electric SAIDI	System Average Interruption Duration Index (SAIDI) minutes	0 – 100 minutes	25%
Electric SAIFI	System Average Interruption Frequency Index (SAIFI) outages	0 – 1 outage	25%

Table 9: Reliability Attributes for SoCalGas

Reliability Sub-Attribute	Measurement Unit	Scale	Weight
Gas Meters	Number of Gas Meters Experiencing Outage	0 – 100,000 meters	50%
Gas Curtailment	Volume of Curtailments of Natural Gas exceeding 250 million cubic feet/day	0 – 666 MMcf	50%

The Settlement Decision requires a utility to identify relative weights between sub-attributes like gas and electric reliability. Relating the gas sub-attributes to electric reliability is difficult, however, there is little industry consensus on how to do so. The rationale for the scales/weights used for the reliability attributes was therefore based on a combination of external information and internal SME judgment. "Worst case" scenarios that have occurred involving gas and electric outages were used to consider the impact from gas and electric reliability. In

1994, the Northridge earthquake affected tens of thousands of gas customers, and the Pacific Southwest blackout of 2011 affected all SDG&E's customers for several hours. As recent as 2018, the Montecito Mudslides affected thousands of gas customers. The Companies' SMEs reasoned that the respective impacts of these events could be used as a baseline to create the sub-attribute scales with the Northridge gas event approximately equaling 200 minutes of a system-wide SDG&E blackout.

The gas reliability sub-attribute of Gas Curtailment is an innovative measurement, one that the Companies believe can be useful in describing the impact to customers and society. For various reasons – such as when there is a disturbance with a major gas transmission pipeline and a coincident high demand for natural gas – there are situations when natural gas service needs to be curtailed to non-core customers. The order in which curtailments are undertaken is systematic, with a goal to prevent severe disruptions to the community. However, when large curtailments are necessary, the impact to the greater community can eventually be felt. The Companies strive to prevent all curtailments, especially those that require curtailing over 250MMcfd at SoCalGas or 80MMcfd at SDG&E. Curtailments at that higher level can impact critical infrastructure such as electric generation, major industries, and hospitals. The use of this sub-attribute helps to value the importance of keeping curtailments limited in size and duration.

In addition to considering previous historical events to estimate the potential impact of a risk event to reliability, SoCalGas and SDG&E utilized subject matter expertise. In particular, SMEs considered the probability and impact of several events occurring at once across multiple operating groups like Distribution and Transmission or Transmission and Storage. Lastly, the Companies examined peak day usages and the occurrence of critical infrastructure impacts to produce a more realistic reliability attribute both in terms of meter outages and gas curtailment.

Valuing electric reliability is a complex endeavor but requires a simplified view for the purposes of the RAMP Report. To the customer, electric reliability is a composite of at least the following items: a) having electricity when the customer wants it, b) having a high quality of electricity without flicker or dimming, c) having power restored quickly if an outage occurs, and d) having access to information about when power will be restored.

The Institute of Electrical and Electronics Engineers (IEEE) has been viewed as a leader on topics related to electric reliability. IEEE publishes a document, known as IEEE 1366-2012, that is considered the industry "best practice" for how to measure electric reliability. The IEEE

1366-2012 has twelve distinct measurements that utilities can use to express reliability, and some of those measurements have sub-measurements providing essentially infinite combinations of measurements. For example, one measurement indicates the number of customers who experience a certain number of outages in a year. That measurement can be used to evaluate customers who experience one outage, or three outages, or seven outages, and so on. The large number of possibilities of measurements is indicative of how complex the subject can be.

Within its electric reliability group, SDG&E has considered at least eight different measurements in the past few years to internally measure its reliability (SAIDI, SAIFI, Worst Circuit SAIDI, Worst Circuit SAIFI, MAIFI, CAIDI, SAIDET, and ERT).[37] For the Risk Quantification Framework, SAIDI and SAIFI were the sole indices used due to their widespread industry usage and their relative ease of use from a forecasting perspective. Future versions of the Risk Quantification Framework may include additional methods of valuing electric and gas reliability.

The electric reliability sub-attribute of Electric SAIDI measures the average duration of service loss for each utility's electric meters over the span of a year. SAIDI is a widely used index in the electric utility industry and is frequently used to compare utilities' performance. This index does not distinguish between the type of customer or the time of day of an electric outage.

The electric reliability sub-attribute of Electric SAIFI measures the average number of outages that each utility's electric meters experiences over the span of a year. This index does not distinguish between the type of customer or the time of day of an electric outage. For example, a SAIFI value of 0.8, means that, on average, 80% of customers served by the utility experienced an outage during a calendar year. But because SAIFI measures averages, using SAIFI alone is not enough to ascertain how many different customers experienced outages. If a utility had 100,000 meters, a SAIFI value of 0.8 could mean that 80,000 meters experienced one outage during one calendar year, or it could mean that 40,000 meters experienced two outages during one calendar year.

There is significant complexity when trying to determine appropriate scales and weights to SAIDI and SAIFI in the Risk Quantification Framework. Different outages have different

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[37] MAIFI: Momentary Average Interruption Frequency Index; CAIDI: Customer Average Interruption Duration Index; SAIDET: SAIDI Exceeding Threshold; ERT: Estimated Restoration Time.

impacts depending on who is affected and when the outage occurred. For example, given a choice between three short outages or one long outage, a small retail store may prefer the shorter outages. Shorter outages may only temporarily affect its sales and not significantly affect its infrastructure. In contrast, a large factory may prefer one long outage, because some machinery may be negatively affected by outages, and having its equipment subjected to multiple outages could be detrimental to the factory's operations. Similarly, the impact of a three-hour electric outage at a residence would be dramatically different while cooking a Thanksgiving feast versus one while everyone at the residence is away from the home.

Although gas and electric sub-attributes give information to help understand levels of reliability risk, in the end, they are merely numbers that tell part of a story. Particularly with reliability, limited data exists to determine the equivalency of gas reliability relative to other attributes, resulting in the need to leverage electric reliability data at this time. Accordingly, there is no single combination of reliability attributes that will give the perfect answer on how to measure risk. The values shown throughout the RAMP Report should be thought of as an approximation of risk rather than a precise value.

3. Financial Attribute

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. However, different types of costs are measured in the attribute. The two general types of costs measured include: societal damage (including physical damages, lost wages, relocation costs, etc.) and utility repair costs (labor, materials). As required by D.16-08-018, the Financial attribute does not include any direct impacts related to shareholder financial interests, such as fines to shareholders, stock price changes, changes in credit ratings, or unrecoverable legal fees.

The quantitative approach used by the Companies considered historical events as a guide for possible future impacts. But precision for the financial attribute is difficult to achieve. Risk events are rarely reported with a single summation of all financial impacts. Depending on the risk event, differing approaches were used to estimate the financial impacts. For pipeline risks, Pipeline and Hazardous Materials Safety Administration (PHMSA) data was used in combination with internal data, but the financial values provided by PHMSA do not necessarily include all financial impacts to society. For electrical outages, estimates were made for the amount of labor and cost of repair.

Financial estimates are gathered from various sources including internal estimates based on claims data or work orders, third party sources, news reporting, among others. Because these data sources rarely include all financial impacts from a risk event, estimates are used.

4. Stakeholder Satisfaction Attribute

In this RAMP cycle, SoCalGas and SDG&E are the first California utilities to implement a fourth attribute – Stakeholder Satisfaction. The Stakeholder Satisfaction attribute is a qualitative approach to measuring changes in satisfaction levels to various stakeholders during and after a risk event. SoCalGas and SDG&E recognize that risk events, whether caused by or involving the Companies, have the potential to affect various stakeholders' satisfaction in varying degrees of severity over varying amounts of time. For example, a pipeline rupture involving fatalities would not only have a direct safety, financial and reliability impact for those involved, but it would be expected to result in a decrease in satisfaction to individuals and groups within the rupture's impact zone. This could result from a loss of service downstream of the rupture or potential mental health issues for individuals that were near the risk event when it occurred. Additionally, with respect to non-customer results, the root cause analysis of an event would likely lead to not only operational changes at the Companies but could even spark new regulations to prevent a similar rupture event from occurring again. The Stakeholder Satisfaction attribute is designed to take into account the above effects of a risk event that are not succinctly delineated by safety, financial and reliability impacts alone.

Table 10 below illustrates the elements that comprise the Stakeholder Satisfaction attribute.

Table 10: Stakeholder Satisfaction Attributes

Stakeholder Sub-Attribute	Value
Stakeholders Affected	0-100 (Up to 20 points for each of the stakeholder groups – customer, public, employee, government, and regulators.

Recognizing the difficulty in measuring any particular individual's or group's satisfaction (as noted above), SoCalGas and SDG&E explored various means to quantify the notion of satisfaction during or after a risk event beyond the safety, financial and reliability impacts. One path explored was measuring the satisfaction to stakeholders through public surveys or polling; however, the determination of pre- and post-activity measurements would require consistency of individuals and/or groups for each survey or polling, and a measurement after each activity, which could be in the thousands. The Companies determined that this would be too challenging and/or imprecise. Measuring this attribute would be further complicated by the fact that satisfaction varies between individuals and groups.

Ultimately, the Stakeholder Satisfaction attribute was determined through a qualitative assessment of risk events by ERM teams and operational SMEs. This qualitative assessment takes into consideration past events both inside and outside the Companies to determine the potential satisfaction of various stakeholders and appropriately apply that to the RAMP filing in the context of the MAVF.

F. Probabilistic Information

This section will discuss the quantitative methodologies, including statistical information and how computer software was used for this RAMP Report. The Settlement Decision requires utilization of specific quantification methods. Among those methods are the creation of LoRE and CoRE values for each current risk. These two values are then multiplied together to obtain a risk score. Additionally, LoRE and CoRE are used to calculate RSEs by estimating new LoRE and CoRE when risk-reducing activities are introduced or ceased.

1. Expected Values

As mentioned above, LoRE and CoRE utilize expected values. The term "Expected Value" is a statistical term meaning the weighted average. For example, suppose there was a casino game that paid $10 to the player 25% of the time and paid $1 to the player the other 75% of the time. The expected value of this game would $3.25 because $10 * 25% + $1 * 75% = $3.25. The term "Expected Value" is not meant to imply that the Company expects a certain outcome. Note that in the example above, the expected value of $3.25 can never occur, because only the values of $10 and $1 can be paid out. The use of expected values has known limitations in the risk management world, and great care must be taken when reviewing data that solely comprises expected values.

2. Likelihood of Risk Event (LoRE)

In the context of the Settlement Decision, the "Likelihood" is not a true likelihood in the typical statistical or probabilistic sense. In standard mathematics, a likelihood is the probability of an event occurring given a set of conditions (*e.g.*, the chance that a red jellybean is drawn from a jar of jellybeans). These standard probabilities can take a value between 0 and 1, where 0 indicates the event will never occur and 1 indicates the event will always occur. For example, in traditional terms, the probability of flipping a coin and obtaining "tails" is 0.5. The term "frequency," on the other hand, is a statistical term denoting the number of times that an event has or will occur, given a specified time frame. For purposes of the RAMP Report, the annual frequency of an event is used to estimate LoRE. An explanation of why frequency was used rather than likelihood is discussed below.

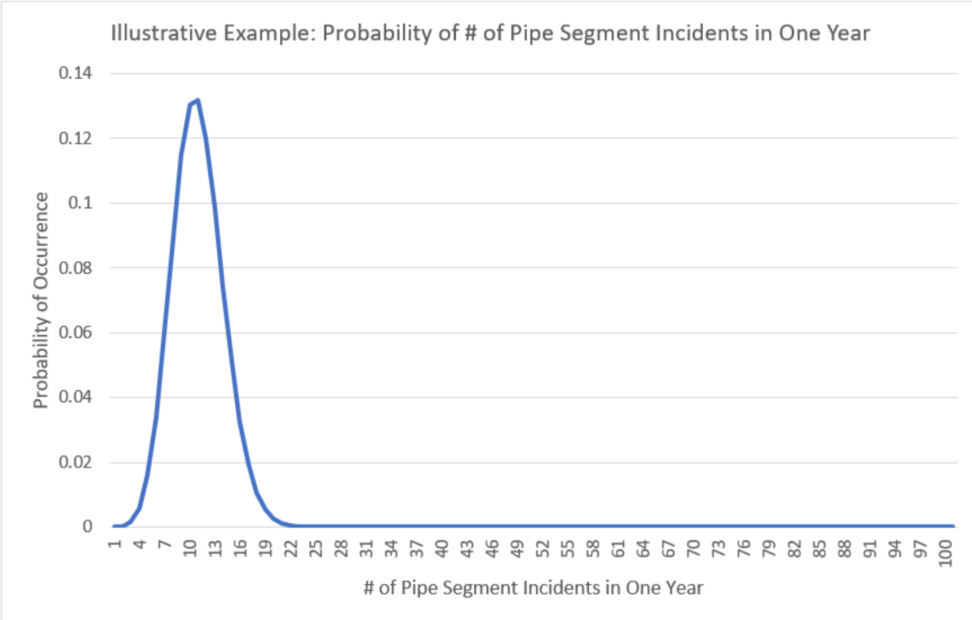
The following is an illustrative example to highlight how frequencies and likelihoods are used in the RAMP Report:

a. Example: Illustrative Gas Risk

The RAMP Report views risks at the "risk-level" over the span of a year. Suppose that a utility has an item in its ERR known as Illustrative Gas Risk. For the RAMP Report, it is necessary to determine the likelihood of that risk occurring each year. In this illustrative example, assume the following:

- The utility uses data to estimate the incident rate.
- The illustrative gas system is composed of 100 pipe segments.
- Each pipe segment has a likelihood of an event of 1/10 over a given year.
- If the pipe segment had an event, the event would cause some amount of safety, reliability, and financial impact to society and to the utility.

From a purely probabilistic point of view, and because LoRE is calculated at the risk-level, the likelihood that at least one pipe segment will have an incident in a given year is quite high (>0.999 or over 99.9%). The graph below shows the probability of the number of incidents, given the assumptions above:



For the RAMP Report, the important concept is not the *likelihood that a pipe segment will have an incident*, but rather, the number of pipe segments that are estimated to have an incident in a year. The likelihood value that is provided is the "Expected Value" of the frequency. In the example above, the expected value of pipe segments that will have an incident in a given year is determined by multiplying the number of pipe segments in the system by the likelihood of a single pipe segment incident occurring: 100 x 1/10 = 10. In this example, the LoRE for this system would be 10, which behaves like an estimated frequency of the number of incidents predicted in a year.

3. Consequence of Risk Event (CoRE)

The CoRE is determined by estimating each of the data points required by the Risk Quantification Framework, as discussed below. Like LoRE, the data points that inform CoRE are also expected values. For example, the number of serious injuries used in the calculations are the expected values of serious injuries if the risk event were to occur. Applying this to one of the RAMP risks, an illustrative example can be found in the SDG&E Employee Safety Risk Chapter (Chapter SDG&E-8), where potential safety consequences can theoretically range from one serious injury to several fatalities. The calculations used in the Risk Quantification Framework for that risk use the expected value of that range. In the case of Employee Safety, the expected value of the safety impact when a risk event occurs is 0.40.

The expected values of each of the nine attributes and sub-attributes are used as inputs into the Risk Quantification Framework to produce a CoRE for each risk. This process was undertaken many times for each risk; once to establish the current risk score, and once for each activity where the estimates of CoRE are performed as if the risk-reducing activity has been implemented, in order to calculate RSEs. As with LoRE, the data used to compute CoRE was a combination of internal data, external data, and/or SME input, depending on the particular risk.

a. Secondary Impacts

The Companies use the term "Secondary Impacts" to distinguish between the impacts that are directly caused by a risk event and the impacts that are "downstream" of the initial risk event. Because each risk has its own definition of a risk event, it is difficult to generalize the difference between the direct impacts and secondary impacts. Table 11 below provides examples, using the Companies' different RAMP risks:

Table 11: Illustrative Examples of Secondary Impacts

	Direct Impact	Secondary Impact
Electric Infrastructure Integrity	Person hurt due to touching fallen electrical wire	Vehicle driver failing to stop at traffic light that is not operating properly during electrical outage
Medium Pressure Gas Incident	Person hurt due to gas explosion	Customer experiencing gas outage decides to cook using a charcoal barbecue and is accidentally injured
Cybersecurity	Intruder uses remote attack to overload transformer, which subsequently explodes and harms individuals	Intruder uses remote attack to steal financial information from utility customer, which leads to additional downstream financial harm to customer

Secondary impacts are generally not used in risk scoring in this RAMP Report because they are difficult to estimate and track and are not always controllable by the Companies. Data sources used for risk assessments do not consistently track secondary impacts, if tracked at all. Secondary impacts will rarely be a large driver of risk scores, even if the data was well collected. One illustrative example mentioned earlier - large electrical outages that span entire cities - could have secondary impacts, but the documented history of such events lacks sufficient data to measure that risk. SDG&E experienced a systemwide blackout in 2011 due to electrical problems outside of its service territory. The blackout caused outages in all of San Diego and

Imperial counties, as well as parts of Orange County and western Arizona. The outage in SDG&E's service territory lasted nearly twelve hours, with the average customer without power for over eight hours. During that time, safety-related incidents were reported. It is clear that undesirable outcomes can occur in large electric or gas outages, but the available data is not conducive to determining expected values of impact. In future years, there may be more opportunities to determine how to effectively incorporate secondary impact information as part of risk assessments.

4. Modeling

Computer software was used for many quantitative aspects of the RAMP Report. The primary software applications used by the Companies were Microsoft Excel, Visual Basic, and @Risk. Additional work was also done with Microsoft Access, R, and Python.

Monte Carlo simulations were performed on risks. Monte Carlo analysis is a technique used to understand the impact of uncertainty related to a particular risk. Although the Settlement Decision does not specify that Monte Carlo simulations are necessary, the modeling assisted in several ways that bolstered the analysis and occasionally informed critical elements. Throughout the individual risk chapters, analytical methods are discussed, including the extent of modeling.

One of the benefits of modeling is that it can be used to demonstrate a range of outcomes that might be observed, given a set of inputs. When trying to identify ranges of outcomes or their certainty, performing Monte Carlo modeling can be easier to implement than precise statistical equations.

Considering consequence ranges is an important part of risk analysis. Consider two risks, both with an expected value of a $10 million loss, but with very different consequence ranges. Suppose Risk A rarely occurs, but when it does, it can require $1 billion of reparations; but, assuming it is a 1/100-year event, its expected value is $10 million ($1 billion x 1/100). Risk B has risk events that occur several times a year and the annual financial impact varies only slightly from $8 million to $12 million, with an expected value of $10 million. Certain stakeholders may be interested to know that, despite having similar expected values, the risks have very different consequences. Creating ranges of outcomes, whether through Monte Carlo modeling or pure statistical approaches, can illuminate differences in risks.

IV. RISK SPEND EFFICIENCIES

This section addresses how RSEs are calculated in this 2021 RAMP Report. RSEs are numerical values that attempt to portray changes in risk scores per dollar spent. The change in a risk score is one data point that can help to inform decision-making and can be due to: (a) the amount of risk reduction when a new activity is completed, or (b) the amount of risk increase if a currently on-going activity is ceased.[38] The overall guiding principle of an RSE is that it presents the difference between the risk score over a certain span of time if the activity is undertaken versus if the activity is not undertaken. However, as discussed further in sections above and below, these data points should be viewed critically. This section: (1) illustrates how RSEs are created, with examples of RSEs for both Controls and Mitigations, (2) explains how benefits over time are treated, and (3) explains the challenges presented by RSEs.

A. Determining Risk Spend Efficiencies

As discussed in the section above, each risk has a risk score, calculated using the Risk Quantification Framework. The risk score that is developed is meant to represent the current risk situation. The current situation for each risk attempts to consider existing activities (known as Controls), current work standards, and all other current characteristics, such as asset conditions, environmental conditions, etc. A risk score is calculated by multiplying the LoRE and CoRE. The risk score that results from using the Risk Quantification Framework is the baseline used when calculating RSEs. Next, a second estimate for LoRE and CoRE that considers a change in a risk-reducing activity is estimated. For Mitigations, the second LoRE and CoRE are estimated assuming the new activity is in place. For Controls, the second LoRE and CoRE reflect the estimated risk if the activity is ceased.

For purposes of this RAMP Report, the terms "pre-mitigation LoRE"[39] and "pre-mitigation CoRE" refer to the estimated risk values given current situations. The terms "post-mitigation LoRE" and "post-mitigation CoRE" refer to the estimated risk values if an activity is

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38 It should be noted that, in reality, risk reductions could be the result of other activities that have a positive effect, the improvement of industry-wide data, or other factors not necessarily tied to the mitigation itself.

39 The terms "pre-mitigation" and "post-mitigation" used herein (and referenced in the Settlement Decision) are not intended to suggest that all activities are Mitigations (*i.e.*, this terminology also applies to Controls).

ceased or a new activity is undertaken. The same terminology applies to the Risk Scores, which are the product of LoRE multiplied by CoRE. In short:

$$pre - mitigation\ risk\ score = (pre - mitigation\ LoRE)\ x\ (pre - mitigation\ CoRE)$$

And

$$post - mitigation\ risk\ score = (post - mitigation\ LoRE)\ x\ (post - mitigation\ CoRE)$$

The RSE is the ratio between the pre-mitigation and post-mitigation risk scores divided by the cost. In its most simplistic form, the equation is:

$$simplified\ RSE = \frac{(pre - mitigation\ risk\ score) - (post - mitigation\ risk\ score)}{\$\ cost\ of\ activity}$$

1. Illustrative Examples

Illustrative Example (One Year Mitigation)

The following is a more thorough example of a one-year mitigation. Suppose there is a risk in one Company's ERR, known as Risk X, which has been assessed using the Risk Quantification Framework. Suppose the assessment generated an assumption that a risk event related to Risk X would occur four times a year. Further, the assessment considered the potential consequences when the risk events occur. Assume, for this example, that when a risk event occurs, the assessment, consistent with methods described above, estimates a 1/10 chance that there will be four serious injuries, no reliability consequence, an average financial consequence of $15 million to repair damage to equipment, and a statewide satisfaction score of 5.

Step 1: The first step is to formulate the pre-mitigation LoRE and CoRE. In this example, LoRE is four, because the LoRE is the average annual frequency. To determine CoRE, the Risk Quantification Framework is applied. Key parameters from the Risk Quantification Framework discussed in the section above are in the following table:

Table 12: Risk Quantification Framework[40]

Attribute	Measurement Unit[41]	Scale	Weight
Safety	Safety Index	0 – 20	60%
Reliability	Reliability Index	0 – 1	23%
Financial	$	$0 - $500M	15%
Stakeholder Satisfaction	Satisfaction Index	0-100	2%

Step 2: Applying the formula explained in the section above, CoRE could be calculated as:

$$CoRE = \left[\frac{0.1}{20}\right] x\ 60\% + \left[\frac{0}{1}\right] x\ 23\% + \left[\frac{\$5}{\$500}\right] x\ 15\% + \left[\frac{5}{100}\right] x\ 2\% = .0055$$

Step 3: The final step is to multiply by 100,000, as discussed above, for readability purposes. Therefore, the pre-mitigation risk score is:

$$Risk\ Score = LoRE\ x\ CoRE\ x\ 100{,}000 = 4\ x\ .0055\ x\ 100{,}000 = 2{,}200$$

Suppose now that there is a proposed activity that will help reduce risk associated to Risk X. Perhaps the activity is replacing older equipment with newer equipment. Assume that, based upon data, it is estimated that undertaking the proposed activity will reduce the likelihood of Risk X occurring by 25%. In this example, the LoRE would therefore change from four to three. This activity, however, is not believed to affect the consequence if the risk event were to occur, so the CoRE stays the same.

Therefore, the post-mitigation risk score would be:

$$\begin{aligned} post - mitigation\ risk\ score \\ &= (post - mitigation\ LoRE)\ x\ (post - mitigation\ CoRE)\ x\ 100{,}000 \\ &= 3\ x\ .0055\ x\ 100{,}000 = 1{,}650 \end{aligned}$$

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40 As discussed in the section above, because of the wide range of possible choices available to each utility in assigning attributes, weights, scales, and other variables chosen through implementing the Settlement Decision, the Companies provide a range of scoring, based upon two additional alternative Risk Quantification Framework methods.

41 "Measurement Unit" as used herein is the measured attribute, also analogous to "Natural Unit" per the Settlement Decision Lexicon included in D.18-12-014 at Attachment A, A-3.

Suppose the useful life of this activity is for one year, and that it costs $10 million to perform. The RSE calculation would therefore be:

$$RSE = \frac{(pre - mitigation\ risk\ score) - (post - mitigation\ risk\ score)}{\$10M} = \frac{2200 - 1650}{\$10M}$$

$$= \frac{550}{\$10M} = 55$$

Illustrative Example (One Year Control)

A similar process is used when Control activities are considered. One important distinction for such situations is that, in the RAMP Reports, when considering the change in risk score if a control were no longer in place, the difference between the pre-mitigation risk score and the post-mitigation risk score will still be shown as a positive number because the cost of the activity in the denominator would be savings. For consistency, in the RAMP Reports, both the numerator and the denominator will be shown as positive numbers.

Suppose there is a risk in a Company's ERR known as Risk ABC and this risk has been assessed using the Risk Quantification Framework. Suppose the assessment led to the estimate that a risk event related to Risk ABC would occur once every five years. Further, the assessment estimated the consequences to be two fatalities, no reliability consequence, an average financial consequence of $50 million to repair and replace equipment damaged by the event, and a stakeholder satisfaction score of 2.

The first step is to formulate the pre-mitigation LoRE and CoRE. In this example, LoRE is 1/5 or 0.2. To determine CoRE, the Risk Quantification Framework is applied as follows:

$$CoRE = \left[\frac{2}{20}\right] x\ 60\% + \left[\frac{0}{1}\right] x\ 23\% + \left[\frac{\$50}{\$500}\right] x\ 15\% + \left[\frac{2}{100}\right] x\ 2\% \ = \ .0754$$

For readability purposes, the utilities multiply these small decimal numbers by 100,000. Therefore, the pre-mitigation risk score is:

$$Risk\ Score = LoRE\ x\ CoRE\ x\ 100{,}000 = 0.2\ \ x\ \ .0754\ x\ \ 100{,}000 = 1{,}508$$

Suppose there is an activity that contributes to the risk score as it stands currently. Further, suppose there is a proposal to alter the activity in some way, such as changing the frequency of inspection. An example might be to stop a Quality Assurance program. Lastly, assume that based upon available data and subject matter expertise, it is believed that the likelihood of the risk event will be increased by 10% and save $25 million. In this example, the LoRE would therefore change from 0.2 to 0.22 (*i.e.*, 10% more than 0.2 is 0.22). Ceasing this activity is not believed to affect the consequence if the risk event were to occur, so the CoRE stays the same.

Therefore, the post-mitigation risk score would be:

$$post - mitigation\ risk\ score = (post - mitigation\ LoRE)\ x\ (post - mitigation\ CoRE)$$
$$= 0.22\ x\ .0754\ x\ 100{,}000 = 1{,}658.8$$

Suppose the useful life of this activity is for one year. The RSE calculation would therefore be:

$$RSE = \frac{(pre - mitigation\ risk\ score) - (post - mitigation\ risk\ score)}{-\$25M}$$
$$= \frac{1508 - 1658.8}{-\$25M} = \frac{-150.8}{-\$25M} = 6.032$$

The Control therefore has an RSE of 6.04.

B. Duration Of Benefits

One of the more nuanced aspects of RSEs is how to address risk-reducing activities that have long-term benefits. The RSE is a comparison between performing an activity versus not performing that activity. In some cases, the implications of an activity have long term effects: pipelines last many years, computer software can be used for several years, etc. To utilize RSEs properly, some consideration needs to be given for the length of time, or duration, of predicted benefits.

A working assumption is that activities involving assets receive benefits for the life of the asset. Other activities, such as training or inspection programs, might have shorter durations of benefits. An illustrative example is a tree trimming program, which will only have a duration of benefits that match the time it takes for a tree to grow back to its former size.

Any activity that has a duration of benefits exceeding one year requires additional data points for the RSE calculation. The Example (One Year Control) above assumes that the activity has a one-year duration of benefits. However, if the assumption increased to three years of benefits, the activity can be considered to affect three years of risk results. The two tables below illustrate the resulting differences by assuming a duration of benefits for one year versus three years.

Table 13: Example (One Year Control)

Year					
	2022	**2023**	**2024**	**2025**	**2026**
Risk Score with Activity	980	1078	1078	1078	1078
Risk Score without Activity	1078	1078	1078	1078	1078
Difference	98	0	0	0	0

Table 14: Example (Three Year Control)

Year					
	2022	**2023**	**2024**	**2025**	**2026**
Risk Score with Activity	980	980	980	1078	1078
Risk Score without Activity	1078	1078	1078	1078	1078
Difference	98	98	98	0	0

As shown in these tables above, the three-year benefit stream provides more value than the one-year benefit stream. The RSE calculation needs to address these differences.

C. Discounting of Benefits

The Settlement Decision allows accounting of long-term benefits of activities but requires an extra step before inclusion into the RSE.[42] The Settlement Decision mandates that future benefits have less value than present benefits. The Companies meet this requirement by applying a "discount" rate to the difference in the risk score. In this RAMP filing, the Companies use a 3% discount rate for purposes of determining the present value of the risk reduction benefits or numerator of the RSE calculation. As shown in the example below, this

42 D.18-12-014 at Attachment A, A-13 (Risk Spend Efficiency (RSE) Calculation).

discount rate lowers the benefits by 3%, compounded each year. The Companies applied a 3% discount rate based on federal recommendations.[43]

Table 15: Example (Three Year Control)

Year					
	2022	**2023**	**2024**	**2025**	**2026**
Risk Score with Activity	980	980	980	1078	1078
Risk Score without Activity	1078	1078	1078	1078	1078
Difference	98	98	98	0	0
Discounted Difference	98 / (1.03) = 95.1	98 / $(1.03)^2$ = 92.4	98 / $(1.03)^3$ = 89.7	0	0

As shown in the table above, the benefit decreases from 95.1 in the first year to 89.7 in the third year. The term "Present Value" is a financial concept that can also be used when discussing the future benefits of a long-term activity. For the example above, the present value of the benefit in 2022 is 95.1. For activities that have multiple years of benefits, the simplified RSE calculation changes from:

$$RSE = \frac{(pre-mitigation\ risk\ score\ \ ) - (post-mitigation\ risk\ score\ \ )}{\$\ of\ activity}$$

to:

$$RSE = \frac{\sum_i^L Present\ Value\ ((pre-mitigation\ risk\ score_i) - (post-mitigation\ risk\ score_i))}{\$\ of\ activity}$$

where *i* is the year of the project, and *L* is the duration of benefits measured in years.

D. Discounting of Costs

Similar to the discounting of benefits mentioned in the section above, the Settlement Decision requires that the cost of activities also be discounted. However, in a GRC, the

43 *See* Centers for Disease Control and Prevention, *Economic Burden of Occupational Fatal Injuries in the United States Based on the Census of Fatal Occupational Injuries, 2003-2010* (August 2017) (citing 1996 recommendation from U.S. Department of Health and Human Services Panel on Cost-Effectiveness in Health and Medicine), available at *https://www.cdc.gov/niosh/data/datasets/sd-1002-2017-0/pdfs/CFOI-CostTables_Methods_DetailedDescription_Final-508*.

Companies present their forecasts in base year,[44] direct constant dollars. The base year for the Companies Test Year 2024 GRC is 2021. While the Companies will be seeking approval for Test Year 2024 forecasts for O&M and 2022-2024 for capital expenditures, all these forecasts will be presented in 2021 constant dollars. These direct dollar forecasts will be converted into an overall revenue requirement through the Results of Operations (RO) model. In this RAMP Report, the Companies are presenting costs in base year, direct constant dollars, consistent with the GRC framework. As of the date of these RAMP filings, the last available year of recorded data is 2020. Accordingly, the Companies used 2020 direct, constant dollars as the basis for these RAMP Reports.

Therefore, for the purposes of the RSE calculation, the costs are effectively already discounted prior to being used in the RSE calculation. Meaning, the cost for activities with multi-year expenditures does not take into account escalation prior to their usage for RSEs. For example, suppose there was a capital project that sought $10 million a year for all three years of the next GRC forecast period (2022 through 2024). In the RAMP and in the GRC, the Companies would present these costs as $10 million for each year, 2022, 2023, and 2024. No escalation is shown for those years; therefore, there is no need to further discount costs shown for years 2023 and 2024. Additional information is provided in Chapter SCG/SDG&E RAMP-E.

E. Application of Risk Spend Efficiencies

The RAMP Report includes 174 activities for SoCalGas and 275 activities for SDG&E. In the RAMP filing, of the total amount of costs discussed, 90% of the SoCalGas costs have RSEs performed, and 89% of the SDG&E costs have RSEs performed. RSEs were calculated for a wide variety of activities, including all in-scope non-mandated activities, certain mandated Controls, and all Mitigations whether they were mandated or not. RSEs were calculated for all non-mandated activities and all new activities.

Despite best efforts, in the development of particular RSEs for the many Mitigations and Controls in this RAMP Report, the Companies discovered that, in certain situations, RSEs could not be reasonably calculated in certain circumstances or were of minimal value. These situations include the following.

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[44] The term "base year" refers to the last recorded year available prior to a GRC filing.

RSEs can be difficult to accurately determine where there is mandated work that is difficult to separate from other work. For example, when a particular regulation has been in place for decades, it is difficult to separate how the Control activity implemented to comply with the regulation would impact the likelihoods and consequences of risk events. It is difficult to unravel the value of that Control to determine quantitatively the benefits it currently gives, especially in any meaningful way.

It can also be difficult to calculate an RSE in circumstances where non-risk-reducing activities enable risk-reducing activities. For example, line inspections do not, by themselves, reduce risk directly, but they do provide information to operators and field personnel, which is then used to find appropriate remediations where necessary. Inspections are bundled together with their remediations, when calculating RSEs.

These above challenges are both present in the case of foundational activities. As described in this RAMP Report, foundational activities include activities prudent to the operation of the gas and electric system, where not performing them would not be an option for the Companies. Some examples of foundational activities are purchasing and employing the computers and vehicles that workers use to perform their job functions. It would be exceedingly difficult to determine how an enterprise risk score would change, along with changes to these types of activities.

The calculation of RSEs in this RAMP Report represents the Companies' best efforts and is in compliance with the Settlement Decision. The methodologies and processes herein have advanced the RSEs. As further discussed in section F below, RSEs should be considered as a single data point, rather than the sole source for risk-based decision-making.

F. RSE Shortcomings

Conceptually, RSEs could be a useful tool to assist in decision-making, and SoCalGas and SDG&E generally support their use and refinement. However, since they were first suggested to the Commission, RSEs have had critical shortcomings – shortcomings that continue with their most recent iteration. Because of these deficiencies (both continuing and those more recently identified), RSEs remain a data point for utilities to consider, but not the deciding factor for mitigation selection.[45] Below (in no particular order) are several of these shortcomings.[46]

Lack of data: The foundation of the RSE process is the availability of broad, accurate data for every risk and mitigation. Without such data, RSEs become drastically devalued by uncertainty. To properly calculate an RSE, as required by the Settlement Decision, there must be a unique measure of the frequency and consequences of a risk, the effects of a mitigation on both the frequency and consequence of a risk, and the cost required to implement the mitigation. The problem is that for many risks and mitigations, such data is scant or incomplete. For example, the Commission requires the Companies to inspect their systems annually, but there has been little data as to how many incidents were avoided through such annual inspections.

Nevertheless, if an anomaly is observed during an inspection, the Companies would respond as needed. While the Companies may capture additional information during an inspection, the data may not always be useful for risk reduction analysis. Therefore, the Companies cannot accurately determine the risk reduction benefit associated with annual inspections at this time. This issue is further complicated where a particular control has been done for decades. All of the utilities and the Commission's staff have acknowledged the challenge with this dearth of data.[47]

Another challenge commonly experienced with data is determining which data is most appropriate. Although utility-specific data is best, it is not always available. For example, for an asset-based risk, the nationally-relied upon data could be based on a utility that had not invested as much in the safety of its infrastructure. But, at the same time, the utility's infrastructure may

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45 California Public Utilities Commission, *Risk and Safety Aspects of Risk Assessment and Mitigation Phase Report of Pacific Gas & Electric Company* [PG&E] *Investigation 17-11-003* (March 30, 2018) at 35 (In their review of PG&E's RSE methodology, Safety and Enforcement Division (SED) agreed that RSEs were not the only factor for consideration in selecting mitigations.).

46 Although the issues discussed in this section were discussed in the last RAMP Reports, they are included here in somewhat streamlined form because they persist.

47 *See* Investigation (I.)16-10-015/-016 (cons.), *Order Instituting Investigation Into the November 2016 Submission of San Diego Gas & Electric Company's Risk Assessment and Mitigation Phase* (October 27, 2016), I.17-11-003, *Order Instituting Investigation into the November 2017 Submission of Pacific Gas and Electric Company's Risk Assessment and Mitigation Phase* (November 9, 2017), and I.18-11-006, *Order Instituting Investigation into the November 2018 Submission of Southern California Edison Risk Assessment and Mitigation Phase* (November 8, 2018).

be less likely to experience risk events for other reasons, such as population densities, the environment, or other factors. It is difficult to balance all of these factors with precision.

Frequency of Incidents: Related to the previous point, the lack of the availability of data is difficult to overcome in some instances, because of the infrequency of incidents for many risks. This is particularly the case with "tail" risks. Tail risks are those risks that occur very infrequently, finding themselves on the very extreme end of a probability curve (*i.e.*, the "tail"). Understanding the reduction in risk associated with infrequent catastrophic incidents is difficult to determine because of the frequency of events.

Reliance on Subject Matter Experts (SMEs): The lack of available data and frequency of tail risks leads to a reliance on SMEs to assess how much a risk will be reduced by the implementation of a mitigation and requires SMEs to determine whether the available data is appropriate and applicable to our operations. As the Commission's Safety Division has acknowledged, the RSE is a product of SME input.[48] Although SMEs can be a strong source of input, they can benefit from quantitative calibration. It is frequently beneficial to train SMEs how to think quantitatively and to perform "sanity checks" on their input, by considering scenarios to truth test their inputs. As a result, RSEs are subject to the potential issues that can occur when SME input is used without calibration, or without consistent care in how SME input is scrutinized.

Changes Occur: Conditions change over time. Consequences and frequencies of events, priorities for the Commission and utilities, and other important factors in decision-making can change, even within a rate case cycle. As a result, predictive RSEs can be of limited value and fairly speculative. One of the clearest examples of this is found when calculating RSEs for vegetation management mitigations. In such calculations, one cannot reasonably account for changes in growth rates, costs or even fluctuations in weather. The type and growth rate of vegetation can change in an area; unpredicted weather patterns can change the biological and geographical landscape. RSEs can therefore vary widely from forecast to reality. The Commission appears to recognize this, as evidenced by its acknowledgement that utilities require flexibility to adapt to changing conditions and in addressing risk.

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[48] California Public Utilities Commission, *Risk and Safety Aspects of Risk Assessment and Mitigation Phase Report of San Diego Gas & Electric Company and Southern California Gas Company Investigation* 16-10-015 and I.16-10-016 (March 8, 2017) at 16.

Changing Methodologies and Tools: Comparing past and future RSEs, even from one cycle to the next, is generally of limited value. Changes will occur in methodologies and tools over time. This is recognized in D.18-12-014, which notes that utilities' MAVFs will evolve over time.[49] This evolution can take many forms. It can result from simply refining data, but wholesale changes to the structure of the Companies' Risk Quantification Framework may also occur. As a basic example, in this RAMP cycle, the Companies have added a fourth attribute and a sub-attribute for SDG&E's reliability MAVF. These and future changes make comparing RSEs across cycles of limited value. These and future changes make comparing RSEs across rate case cycles of limited value.

Non-RSE Factors: Perhaps one of the most critical shortcomings of RSEs is that there is much they do not capture. The methodologies for determining RSEs do not take into consideration all the factors that go into the decision to select a mitigation. For example, if a utility intends to replace a bare wire conductor with insulated conductor, the RSE calculation will consider the risk reduction achieved by installing the new conductor and the cost of the new conductor. While factors such as resource availability, permitting requirements, and changing climate conditions are not considered within the RSE calculation, these factors are certainly taken into consideration for decision-making purposes. Similarly, certain human factor benefits, such as those related to training and communicating with the public, are not easily captured as part of the RSE calculation.

RSEs Cannot Be Compared Across Utilities: RSEs cannot be compared in a meaningful way across utilities. Although the Commission and Intervenors have previously expressed a desire for RSE comparability across utilities on similar risks or mitigations, that is not possible at this time.[50] Each of the utilities use different formulas and methodologies in calculating RSEs. Each utility might use different attributes, different weights and scaling, and even different frequency and consequence valuations.

Lack of Common View of Risk Tolerance: There is no shared viewpoint on risk tolerance. The Commission's Safety Division, individual intervenors, and a utility may have different views regarding the permissible number of incidents on a particular system. Some

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49 D.18-12-014 at 54.

50 *See* D.16-08-018 at 164.

might say they want zero incidents while others may say there should be no incidents beyond a certain size. These varying tolerances lead to different mitigations and RSEs. In addition, certain outcomes may be a higher priority to avoid because of their cause – but RSEs cannot capture that type of preference. As noted in RAMP-E, the Commission is considering whether to adopt a risk tolerance standard as a statewide issue in the ongoing S-MAP OIR.[51]

Mitigation Synergy not Recognized: As the MAVF for creation of RSEs currently stands, it is incapable of accurately determining the value of RSEs when mitigations are combined or broken up. Some mitigations work best when combined with one or more mitigations. Because RSEs must presented as standalone scores, the value of combining RSEs cannot be captured. Similarly, some mitigations apply across multiple risks. The RSE calculation methodology as it currently stands does not allow for a clear recognition of such benefits. Although combining the benefits across all risks impacted improves accuracy, doing so would significantly add to the complexity of the analysis and presentation of the mitigation benefits. For example, the replacement of live front equipment mitigation impacts both the Electric Infrastructure Integrity (EII) risk and the Employee Safety risk. However, the Companies elected to assess the mitigation benefit as part of the EII risk to minimize double counting of benefits throughout this 2021 RAMP Report. Thus, the risk reduction within the Employee Safety risk is underestimated since the mitigation was assessed against the EII risk. This is another instance of RSEs not being able to capture the entire picture when it comes to the costs and benefits of mitigations or controls.

Non-Asset Mitigations/Controls: Non-Asset mitigations may also not lend themselves well to evaluation by RSEs. Because some Non-Asset mitigations cannot always be broken down into relevant, discrete data points, trying to force them into a quantitative analysis is challenging. For example, consider the benefit of training. It is difficult to ascertain the precise amount of impact a training program has. The simplest way is to attempt to compare results with and without a program. But there are likely other changes occurring within a risk, and knowing which factor contributed to a change in risk outcomes is difficult. Consider driver training for employees. All employees who exceed a certain number of driven miles using company vehicles are required to take driver training. Simultaneously, improvements to vehicles have been made,

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51 *See* Rulemaking (R.) 20-07-013, *Assigned Commissioner Scoping Memo and Ruling* (November 2, 2020) (S-MAP OIR Scoping Ruling) at 7-9.

such as the installation of back-up cameras. It is very difficult analytically to say whether an incident did or did not occur due to the training or the installation of equipment. There are a substantial number of mitigations that utilities pursue and implement that are not asset-based. Determining how to assess them within an RSE-driven framework continues to be problematic.

RSEs Do Not Reflect the Reality of Utility or Commission Priorities: Capturing actual or strategic priorities when valuing mitigations is a challenge. Although there are several shortcomings in the RSEs that are primarily data driven, one of the most challenging to quantify is related to valuing mitigations that are strongly supported by the Commission and IOUs' strategic efforts and priorities. Certain mitigations are recognized by essentially all interested parties to be important – yet their RSEs would suggest they should be treated as lower priority work. For example, in the high-pressure pipeline incident risk, the valve automation mitigation had a relatively low RSE, yet valve automation was required by the Commission in D.14-06-007.[52] The rankings of RSEs shown in Appendix C-1 contain other examples of these types of mitigations.

[52] D.14-06-007 at 21.

APPENDIX C-1

SDG&E RSE RANKING

Appendix C-1: RSE Ranking

SDG&E

Line No.	Risk Chapter	Risk	ID	Control/Mitigation Name	Total Cost ($M)	RSE
1	SDG&E-Risk-7	Digin	C28	Warning Mesh	$ 0.06	2,702
2	SDG&E-Risk-1	Wildfire	C9/M4-T1	PSPS Sectionalizing - Tier 3	$ 0.54	2,112
3	SDG&E-Risk-1	Wildfire	C3-T3	Wireless Fault Indicators - Non-HFTD	$ 0.66	1,516
4	SDG&E-Risk-3	HP	C2-T1	Cathodic Protection – Maintenance (HCA)	$ 0.03	1,075
5	SDG&E-Risk-1	Wildfire	C9/M4-T2	PSPS Sectionalizing - Tier 2	$ 4.09	1,063
6	SDG&E-Risk-2	EII	C11	Tee Modernization Program	$ 11.47	938
7	SDG&E-Risk-3	HP	C11-T1	Measurement & Regulation Station – Maintenance (HCA)	$ 0.59	841
8	SDG&E-Risk-3	HP	M1-T1.1	PSEP: Pipeline Replacement (Phase 2B, HCA)	$ 10.00	731
9	SDG&E-Risk-1	Wildfire	C30-T1	Distribution System Inspection - CMP - Annual Patrol - Tier 3	$ 1.49	684
10	SDG&E-Risk-7	Digin	C3	Locate & Mark Activities	$ 5.25	590
11	SDG&E-Risk-1	Wildfire	C15/M10-T1	Expanded Generator Grant Program - Tier 3	$ 1.45	569
12	SDG&E-Risk-8	EMPL	M1	Purchasing and testing more protective respiratory protection for wildfire smoke particulates.	$ 0.01	516
13	SDG&E-Risk-3	HP	C1-T1	Cathodic Protection – Capital (HCA)	$ 0.20	489
14	SDG&E-Risk-3	HP	M1-T1.2	PSEP: Pipeline Replacement (Phase 2B, non-HCA)	$ 10.00	468
15	SDG&E-Risk-2	EII	C10-T1	Underground cable replacement program - UG Feeder	$ 0.53	465
16	SDG&E-Risk-7	Digin	C14	Locating Equipment	$ 0.14	456
17	SDG&E-Risk-2	EII	C8	Avian Protection Program	$ 1.87	409
18	SDG&E-Risk-3	HP	C9	Compressor Stations - Maintenance	$ 2.33	403
19	SDG&E-Risk-3	HP	C1-T2	Cathodic Protection – Capital (non-HCA)	$ 0.41	388
20	SDG&E-Risk-1	Wildfire	C6/M1-T2	SCADA Capacitors - Tier 2	$ 1.79	381
21	SDG&E-Risk-1	Wildfire	C30-T2	Distribution System Inspection - CMP - Annual Patrol - Tier 2	$ 1.78	373
22	SDG&E-Risk-3	HP	C11-T2	Measurement & Regulation Station – Maintenance (non-HCA)	$ 1.19	369
23	SDG&E-Risk-3	HP	C15-T1	Integrity Assessments & Remediations (HCA)	$ 33.69	355
24	SDG&E-Risk-1	Wildfire	C24-T2	Distribution System Inspection - IR/Corona - Tier 2	$ 0.52	322
25	SDG&E-Risk-7	Digin	C6	Locate and Mark Annual Refresher Training and Competency Program	$ 0.001	317
26	SDG&E-Risk-1	Wildfire	C11/M6-T1	Advanced Protection - Tier 3	$ 30.63	309
27	SDG&E-Risk-3	HP	C15-T2	Integrity Assessments & Remediations (Non-HCA)	$ 7.90	300
28	SDG&E-Risk-8	EMPL	C14	Enhanced Safety in Action Program	$ 0.16	299
29	SDG&E-Risk-7	Digin	C16-T4	Public Awareness Compliance – Excavators	$ 0.01	287
30	SDG&E-Risk-1	Wildfire	C15/M10-T2	Expanded Generator Grant Program - Tier 2	$ 2.18	284
31	SDG&E-Risk-1	Wildfire	C34-T1	Pole Brushing - Tier 3	$ 7.91	261
32	SDG&E-Risk-2	EII	C4-T3	High Risk Switch Replacement program - Hook	$ 1.65	241
33	SDG&E-Risk-3	HP	C6-T1	Pipeline Maintenance (HCA)	$ 0.10	240
34	SDG&E-Risk-2	EII	C10-T3	North Harbor Project	$ 14.91	201
35	SDG&E-Risk-1	Wildfire	C28-T1	Distribution System Inspection - Drone Inspections - Tier 3	$ 4.50	194
36	SDG&E-Risk-1	Wildfire	C31-T1	Tree Trimming - Tier 3	$ 44.85	192
37	SDG&E-Risk-2	EII	C4-T2	High Risk Switch Replacement program - Gang	$ 0.42	190
38	SDG&E-Risk-1	Wildfire	C8/M3-T2	Expulsion Fuse Replacement - Tier 2	$ 3.08	187
39	SDG&E-Risk-7	Digin	C13	Locating Equipment	$ 0.67	179
40	SDG&E-Risk-3	HP	M4	Adobe Falls Relocation Project	$ 2.00	167
41	SDG&E-Risk-2	EII	C10-T2	Underground cable replacement program - UG Branch	$ 15.54	166
42	SDG&E-Risk-3	HP	M1-T1.3	PSEP: Hydrotesting (Phase 2B, HCA)	$ 10.00	161
43	SDG&E-Risk-6	CYBR	C1	Perimeter Defenses	$ 26.74	160
44	SDG&E-Risk-6	CYBR	A1-C1	Perimeter Defenses	$ 19.86	157
45	SDG&E-Risk-1	Wildfire	C16/M11-T1	Strategic Undergrounding - Tier 3	$ 629.68	156

46	SDG&E-Risk-6	CYBR	A2-C1	Perimeter Defenses	$	31.30	154
47	SDG&E-Risk-1	Wildfire	C34-T2	Pole Brushing - Tier 2	$	8.96	152
48	SDG&E-Risk-2	EII	C20-T2	Bernardo 12 kV Breakers Replacements	$	1.00	146
49	SDG&E-Risk-1	Wildfire	C37-T1	Strategy for Minimizing Public Safety Risk During High Wildfire Conditions, PSPS and Re-Energization Protocols - Tier 3	$	30.75	145
50	SDG&E-Risk-9	MP	C11	Gas Distribution Emergency Department	$	27.29	144
51	SDG&E-Risk-6	CYBR	C4	OT Cybersecurity	$	20.84	142
52	SDG&E-Risk-6	CYBR	A2-C4	OT Cybersecurity	$	21.26	139
53	SDG&E-Risk-4	CONT	C1	Contractor Oversight Program	$	3.18	139
54	SDG&E-Risk-8	EMPL	C13	Enhanced Mandatory Employee Training (OSHA): Certified Occupational Safety Specialist, Certified Utility Safety Professional; Certified Safety Professional	$	0.05	138
55	SDG&E-Risk-3	HP	C4-T1	Pipeline Relocation/Replacement (HCA)	$	1.91	131
56	SDG&E-Risk-7	Digin	C15-T4	Public Awareness Compliance – Excavators	$	0.02	124
57	SDG&E-Risk-1	Wildfire	C14/M9-T1	Whole House Generator Program - Tier 3	$	19.60	120
58	SDG&E-Risk-1	Wildfire	C37-T2	Strategy for Minimizing Public Safety Risk During High Wildfire Conditions, PSPS and Re-Energization Protocols - Tier 2	$	34.80	120
59	SDG&E-Risk-1	Wildfire	C21/M14-T1	Lightning Arrester Removal / Replacement Program - Tier 3	$	7.83	113
60	SDG&E-Risk-1	Wildfire	C33/M16-T1	Enhanced Vegetation Management - Tier 3	$	15.01	111
61	SDG&E-Risk-1	Wildfire	C27-T1	Distribution System Inspection - QA/QC Tier 3 Inspections - Tier 3	$	9.01	111
62	SDG&E-Risk-6	CYBR	A1-C4	OT Cybersecurity	$	19.51	110
63	SDG&E-Risk-1	Wildfire	C31-T2	Tree Trimming - Tier 2	$	54.07	104
64	SDG&E-Risk-3	HP	M1-T1.4	PSEP: Hydrotesting (Phase 2B, non-HCA)	$	10.00	103
65	SDG&E-Risk-6	CYBR	C5	Obsolete IT Infrastructure and Asset Replacement	$	25.18	102
66	SDG&E-Risk-2	EII	C4-T1	High Risk Switch Replacement program -SCADA	$	0.62	101
67	SDG&E-Risk-2	EII	C20-T5	Miramar 12kV Replacements	$	1.42	101
68	SDG&E-Risk-6	CYBR	A1-C5	Obsolete IT Infrastructure and Application Replacement	$	19.04	98
69	SDG&E-Risk-6	CYBR	A2-C5	Obsolete IT Infrastructure and Application Replacement	$	27.60	98
70	SDG&E-Risk-6	CYBR	C2	Internal Defenses	$	36.17	95
71	SDG&E-Risk-1	Wildfire	C12/M7-T1	Hotline Clamps - Tier 3	$	4.50	93
72	SDG&E-Risk-3	HP	C8	Compressor Stations - Capital	$	31.72	91
73	SDG&E-Risk-2	EII	C28	RTU Modernization	$	2.26	91
74	SDG&E-Risk-1	Wildfire	A2	Alternative 2	$	900.87	88
75	SDG&E-Risk-6	CYBR	A2-C2	Internal Defenses	$	44.09	88
76	SDG&E-Risk-3	HP	C10-T1	Measurement & Regulation – Capital (HCA)	$	0.67	86
77	SDG&E-Risk-4	CONT	M2	Enhanced Verification of Class 1 Contractor Employee Specific Training	$	0.64	86
78	SDG&E-Risk-6	CYBR	A1-C2	Internal Defenses	$	29.43	85
79	SDG&E-Risk-7	Digin	C23	Excess Flow Valve or Curb Valve Installation	$	0.33	83
80	SDG&E-Risk-2	EII	C20-T7	Pacific Beach Bus Tie Replacements	$	2.29	81
81	SDG&E-Risk-1	Wildfire	A1	Alternative 1	$	1,643.22	79
82	SDG&E-Risk-2	EII	C1	Overhead Public Safety (OPS)	$	21.73	78
83	SDG&E-Risk-8	EMPL	C3	Strong Safety Culture	$	0.60	78
84	SDG&E-Risk-1	Wildfire	C13/M8-T1	Backup Power for Resilience - Generator Grant Program, CRCs, HPWREN - Tier 3	$	7.90	76
85	SDG&E-Risk-9	MP	M2	Cathodic Protection System Enhancements – Real Time Monitoring	$	3.00	69
86	SDG&E-Risk-3	HP	C2-T2	Cathodic Protection – Maintenance (non-HCA)	$	0.05	66
87	SDG&E-Risk-1	Wildfire	C22-T1	Distribution System Inspection - CMP - 5 year - Tier 3	$	11.43	65
88	SDG&E-Risk-1	Wildfire	C36-T1	Wildfire Infrastructure Protection Teams - Tier 3	$	6.18	63
89	SDG&E-Risk-2	EII	C24	Urban Substation Rebuild	$	4.12	63
90	SDG&E-Risk-3	HP	C4-T2	Pipeline Relocation/Replacement (non-HCA)	$	3.88	62
91	SDG&E-Risk-6	CYBR	C3	Sensitive Data Protection	$	27.64	62
92	SDG&E-Risk-1	Wildfire	C18/M13-T1	(distribution underbuilt) Overhead Transmission Fire Hardening - Tier 3	$	3.12	63
93	SDG&E-Risk-2	EII	C15	Corrective Maintenance Program- Service Connections and Minor Capital Units	$	44.63	61
94	SDG&E-Risk-7	Digin	C4	Locate & Mark Activities	$	1.49	61
95	SDG&E-Risk-1	Wildfire	C33/M16-T2	Enhanced Vegetation Management - Tier 2	$	17.77	61
96	SDG&E-Risk-9	MP	M3	Replace Curb Valves with EFVs	$	7.61	61

97	SDG&E-Risk-2	EII	C14	DOE Switch Replacement	$ 19.43	60
98	SDG&E-Risk-2	EII	C20-T3	Chicarita 12kV Replacements	$ 4.22	60
99	SDG&E-Risk-1	Wildfire	C27-T2	Distribution System Inspection - QA/QC Tier 3 Inspections - Tier 2	$ 0.01	57
100	SDG&E-Risk-3	HP	C10-T2	Measurement & Regulation – Capital (non-HCA)	$ 1.36	57
101	SDG&E-Risk-8	EMPL	C9	Safe Driving Programs	$ 0.27	57
102	SDG&E-Risk-6	CYBR	A2-C3	Sensitive Data Protection	$ 31.50	57
103	SDG&E-Risk-9	MP	C4	Regulator Station, Valve, and Large Meter Set Inspection	$ 4.46	57
104	SDG&E-Risk-1	Wildfire	C36-T2	Wildfire Infrastructure Protection Teams - Tier 2	$ 2.63	56
105	SDG&E-Risk-6	CYBR	A1-C3	Sensitive Data Protection	$ 22.21	56
106	SDG&E-Risk-1	Wildfire	C16/M11-T2	Strategic Undergrounding - Tier 2	$ 377.81	54
107	SDG&E-Risk-1	Wildfire	C17/M12-T1	Overhead Distribution Fire Hardening - Bare Conductors - Tier 3	$ 5.13	53
108	SDG&E-Risk-7	Digin	C16-T2	Public Awareness Compliance - Emergency Officials	$ 0.001	51
109	SDG&E-Risk-2	EII	C20-T4	Laguna Niguel 12kV Replacements	$ 8.70	45
110	SDG&E-Risk-7	Digin	C11	Damage Prevention Analyst Program	$ 0.25	40
111	SDG&E-Risk-7	Digin	C16-T3	Public Awareness Compliance - Local Public Officials	$ 0.004	39
112	SDG&E-Risk-7	Digin	C32	Enhance Ticket Management Software	$ 0.02	39
113	SDG&E-Risk-1	Wildfire	C13/M8-T2	Backup Power for Resilience - Generator Grant Program, CRCs, HPWREN - Tier 2	$ 15.80	38
114	SDG&E-Risk-7	Digin	C16-T1	Public Awareness Compliance - The Affected Public	$ 0.06	38
115	SDG&E-Risk-1	Wildfire	C12/M7-T2	Hotline Clamps - Tier 2	$ 4.50	36
116	SDG&E-Risk-4	CONT	C2	Field Safety Oversight	$ 15.79	35
117	SDG&E-Risk-2	EII	C20-T1	Batiquitos 12kV Replacements	$ 7.45	34
118	SDG&E-Risk-1	Wildfire	C22-T2	Distribution System Inspection - CMP - 5 year - Tier 2	$ 15.13	33
119	SDG&E-Risk-1	Wildfire	C7/M2-T1	Overhead Distribution Fire Hardening - Covered Conductors - Tier 3	$ 340.51	32
120	SDG&E-Risk-1	Wildfire	C18/M13-T2	(distribution underbuilt) Overhead Transmission Fire Hardening - Tier 2	$ 41.78	32
121	SDG&E-Risk-7	Digin	M2	Automate Third Party Excavation Incident Reporting	$ 0.004	31
122	SDG&E-Risk-2	EII	C29	SCADA Capacitors	$ 2.39	31
123	SDG&E-Risk-1	Wildfire	C10/M5-T2	Backup Power for Resilience - Microgrids - Tier 2	$ 42.39	30
124	SDG&E-Risk-2	EII	C16	Manhole, Handhole and Vault Restoration Program	$ 9.67	27
125	SDG&E-Risk-7	Digin	C27	Warning Mesh	$ 0.24	26
126	SDG&E-Risk-8	EMPL	M3	Automate notifications and employee communications when the Air Quality Index PM2.5 reaches specific thresholds during a wildfire in our service territory	$ 0.12	26
127	SDG&E-Risk-2	EII	C20-T6	Scripps 12kV Replacements	$ 12.32	25
128	SDG&E-Risk-1	Wildfire	C35-T1	Aviation Firefighting Program - Tier 3	$ 63.76	24
129	SDG&E-Risk-7	Digin	C5	Locate and Mark Annual Refresher Training and Competency Program	$ 5.00	25
130	SDG&E-Risk-9	MP	C2	Cathodic Protection Program - Capital	$ 18.73	25
131	SDG&E-Risk-3	HP	C12	Odorization	$ 0.01	22
132	SDG&E-Risk-7	Digin	M4	Locate and Mark Photographs	$ 0.10	20
133	SDG&E-Risk-7	Digin	C15-T2	Public Awareness Compliance - Emergency Officials	$ 0.003	20
134	SDG&E-Risk-7	Digin	C10	Locate and Mark Quality Assurance Program	$ 0.08	19
135	SDG&E-Risk-7	Digin	C12	Damage Prevention Analyst Program	$ 0.05	19
136	SDG&E-Risk-8	EMPL	C15	Enhanced Employee Safe Driving Training	$ 1.65	19
137	SDG&E-Risk-7	Digin	C15-T1	Public Awareness Compliance - The Affected Public	$ 0.26	17
138	SDG&E-Risk-7	Digin	C31	Enhance Ticket Management Software	$ 0.10	17
139	SDG&E-Risk-7	Digin	M1	Automate Third Party Excavation Incident Reporting	$ 0.03	17
140	SDG&E-Risk-2	EII	C6	Tree Trimming	$ 121.65	15
141	SDG&E-Risk-2	EII	A3	Avian Protection Program	$ 12.17	15
142	SDG&E-Risk-2	EII	C23	San Mateo Substation	$ 13.90	15
143	SDG&E-Risk-9	MP	C6/C7	Leak Repair & Pipeline Monitoring (Leak Mitigation, Bridge & Span, Unstable Earth and Pipeline Patrol)	$ 41.19	15
144	SDG&E-Risk-2	EII	C18	Distribution Circuit Reliability Construction	$ 11.70	15
145	SDG&E-Risk-1	Wildfire	C35-T2	Aviation Firefighting Program - Tier 2	$ 37.60	14
146	SDG&E-Risk-3	HP	C6-T2	Pipeline Maintenance (non-HCA)	$ 0.21	14
147	SDG&E-Risk-8	EMPL	C8	OSHA Voluntary Protection Program	$ 1.50	14

148	SDG&E-Risk-7	Digin	C15-T3	Public Awareness Compliance - Local Public Officials	$ 0.02	14
149	SDG&E-Risk-1	Wildfire	C7/M2-T2	Overhead Distribution Fire Hardening - Covered Conductors - Tier 2	$ 74.75	14
150	SDG&E-Risk-9	MP	C9-T1	Early Vintage Program (Components) - Oil Drip Piping Removal	$ 7.16	14
151	SDG&E-Risk-9	MP	C1	Cathodic Protection Program - O&M	$ 5.85	13
152	SDG&E-Risk-1	Wildfire	C29-T1	Distribution System Inspection - Circuit Ownership - Tier 3	$ 0.13	13
153	SDG&E-Risk-7	Digin	M3	Locate and Mark Photographs	$ 0.44	13
154	SDG&E-Risk-4	CONT	A2	Use internal resources and tools to vet contractors for safety	$ 4.38	13
155	SDG&E-Risk-2	EII	A2-T1	Modernize Manual Switches - OH	$ 33.90	12
156	SDG&E-Risk-8	EMPL	C4	Employee Behavioral Accident Prevention Process Program	$ 2.58	12
157	SDG&E-Risk-2	EII	C20-T8	Coronado 69/12kV Transformer Replacement	$ 1.65	12
158	SDG&E-Risk-2	EII	C3	4kV Modernization Program- Distribution (Overhead, Underground and package Substation removal)	$ 20.58	11
159	SDG&E-Risk-9	MP	C10	Code Compliance Mitigation	$ 6.21	10
160	SDG&E-Risk-8	EMPL	C11	Jobsite Safety Programs	$ 7.34	9.3
161	SDG&E-Risk-1	Wildfire	C28-T2	Distribution System Inspection - Drone Inspections - Tier 2	$ 39.87	8.9
162	SDG&E-Risk-9	MP	C8-T3	Underperforming Steel Replacement Program – Other Steel (Post 1965 vintage).	$ 10.70	8.6
163	SDG&E-Risk-3	HP	C5-T1	Shallow/Exposed Pipe Remediations (HCA)	$ 2.94	8.6
164	SDG&E-Risk-2	EII	C21	Distribution Substation Obsolete Equipment	$ 7.84	8.1
165	SDG&E-Risk-7	Digin	C30	Ticket Risk Assessment and Evaluating City Permit Data	$ 0.01	8.0
166	SDG&E-Risk-1	Wildfire	C29-T2	Distribution System Inspection - Circuit Ownership - Tier 2	$ 0.25	7.3
167	SDG&E-Risk-8	EMPL	M2	Purchasing break/rest trailers with filtered air systems to reduce wildfire smoke exposure	$ 0.45	6.9
168	SDG&E-Risk-3	HP	M2-T1	Gas Transmission Safety Rule - MAOP Reconfirmation (HCA)	$ 37.44	6.9
169	SDG&E-Risk-1	Wildfire	C32/M15-T1	Fuel Management Program - Tier 3	$ 18.62	6.8
170	SDG&E-Risk-9	MP	C3	Piping in Vaults Replacement Program	$ 9.06	6.3
171	SDG&E-Risk-9	MP	C8-T2	Underperforming Steel Replacement Program (1934-1965 vintage).	$ 21.90	6.3
172	SDG&E-Risk-9	MP	C21	CSF Quality Assurance (QA) Program	$ 0.97	6.3
173	SDG&E-Risk-9	MP	C9-T3	Early Vintage Program (Components) - Removal of Closed Valves between High/Medium Pressure Zones	$ 0.77	6.2
174	SDG&E-Risk-3	HP	M3-T2	Gas Transmission Safety Rule – Material Verification (Non-HCA)	$ 0.03	6.2
175	SDG&E-Risk-3	HP	C5-T2	Shallow/Exposed Pipe Remediations (non-HCA)	$ 5.98	5.9
176	SDG&E-Risk-2	EII	C13	Replacement of Live Front Equipment	$ 1.75	5.7
177	SDG&E-Risk-9	MP	C8-T1	Underperforming Steel Replacement Program – Threaded Main (pre-1933 vintage	$ 27.65	5.7
178	SDG&E-Risk-3	HP	A1	Proactive Soil Sampling	$ 0.36	5.7
179	SDG&E-Risk-7	Digin	C24	Pipeline Patrol and Pipeline Markers	$ 0.72	5.7
180	SDG&E-Risk-3	HP	C3-T1	Leak Repair (HCA)	$ 2.05	5.6
181	SDG&E-Risk-3	HP	C3-T2	Leak Repair (non-HCA)	$ 4.15	5.3
182	SDG&E-Risk-9	MP	M1	Safety Control Valves	$ 7.61	4.9
183	SDG&E-Risk-9	MP	C12	Cathodic Protection System Enhancements - Base	$ 4.94	4.4
184	SDG&E-Risk-3	HP	M2-T2	Gas Transmission Safety Rule - MAOP Reconfirmation (Non-HCA)	$ 1.56	4.1
185	SDG&E-Risk-9	MP	C16-T1	DIMP – DREAMS – Vintage Integrity Plastic Plan (VIPP)	$ 174.90	3.4
186	SDG&E-Risk-9	MP	C5	Regulator Station Replacement	$ 6.00	2.7
187	SDG&E-Risk-2	EII	A2-T2	Modernize Manual Switches - UG	$ 42.30	2.5
188	SDG&E-Risk-2	EII	A1	Customer Owned E-Structure Reconfigure	$ 0.84	2.1
189	SDG&E-Risk-1	Wildfire	C25-T2	Distribution System Inspection - CMP - 10 year intrusive - Tier 2	$ 3.36	2.0
190	SDG&E-Risk-3	HP	M3-T1	Gas Transmission Safety Rule – Material Verification (HCA)	$ 0.14	1.2
191	SDG&E-Risk-9	MP	A1	Post Training Follow-up Field Evaluations	$ 0.05	1.1
192	SDG&E-Risk-7	Digin	C9	Locate and Mark Quality Assurance Program	$ 0.64	1.0
193	SDG&E-Risk-1	Wildfire	C35-T3	Aviation Firefighting Program - Non-HFTD	$ 2.85	0.9
194	SDG&E-Risk-3	HP	A2	Expanding Geotechnical Analysis	$ 0.18	0.9
195	SDG&E-Risk-3	HP	C13	Security and Auxiliary Equipment	$ 2.21	0.8
196	SDG&E-Risk-7	Digin	C29	Ticket Risk Assessment and Evaluating City Permit Data	$ 0.04	0.7
197	SDG&E-Risk-9	MP	C9-T2	Early Vintage Program (Components) - Dresser Mechanical Coupling Removal	$ 9.29	0.6
198	SDG&E-Risk-9	MP	C20	Natural Gas Appliance Testing (NGAT) or Carbon Monoxide Testing	$ 0.33	0.5

199	SDG&E-Risk-9	MP	C14	Human Factors Mitigations – Operator Qualification Training and Certification	$ 12.01	0.4
200	SDG&E-Risk-9	MP	C19	Field and Public Safety	$ 30.79	0.2
201	SDG&E-Risk-9	MP	A2	Soil Sampling Program	$ 12.30	0.02
202	SDG&E-Risk-7	Digin	A2	Virtual Reality Training	$ 0.10	0.02
203	SDG&E-Risk-7	Digin	A1	Virtual Reality Training	$ 0.10	0.01
204	SDG&E-Risk-7	Digin	A4	GPS Tracking of Excavation Equipment	$ 0.34	0.001
205	SDG&E-Risk-7	Digin	A3	GPS Tracking of Excavation Equipment	$ 0.34	0.0002

APPENDIX C-1

SOCALGAS RSE RANKING

Appendix C-1: RSE Ranking

SoCalGas

Line No.	Risk Chapter	Risk	ID	Control/Mitigation Name	Total Cost ($M)	RSE
1	SCG-Risk-1	HP	C7-T1	Pipeline Maintenance (HCA)	$ 0.22	1,336
2	SCG-Risk-1	HP	C4-T1	Leak Survey & Patrol (HCA)	$ 0.14	901
3	SCG-Risk-1	HP	C7-T2	Pipeline Maintenance (non-HCA)	$ 0.45	856
4	SCG-Risk-2	Digin	C3	Locate & Mark Activities	$ 19.49	767
5	SCG-Risk-1	HP	C22-T4.4	PSEP: Valve Enhancement (GRC base, non-HCA)	$ 5.44	743
6	SCG-Risk-1	HP	C4-T2	Leak Survey & Patrol (non-HCA)	$ 0.29	577
7	SCG-Risk-5	EMPL	C10	Workplace Violence Prevention Programs	$ 7.70	498
8	SCG-Risk-2	Digin	C30	Warning Mesh	$ 0.19	484
9	SCG-Risk-1	HP	C23-T2	Ventura Compressor Station Modernization	$ 178.86	345
10	SCG-Risk-1	HP	C22-T4.3	PSEP: Valve Enhancement (GRC base, HCA)	$ 28.69	276
11	SCG-Risk-1	HP	C2-T1	Cathodic Protection – Maintenance (HCA)	$ 0.38	276
12	SCG-Risk-1	HP	C11	Compressor Stations - Maintenance	$ 8.24	261
13	SCG-Risk-3	MP	C22	DIMP: Gas Infrastructure Protection Program (GIPP)	$ 85.02	221
14	SCG-Risk-1	HP	C22-T3.2	PSEP: Pipeline Replacement (Phase 2A, GRC base, non-HCA)	$ 93.71	220
15	SCG-Risk-7	CONT	C3	Contractor Engagement	$ 0.01	202
16	SCG-Risk-7	CONT	C2	Third-Party Administration Tools	$ 0.05	182
17	SCG-Risk-1	HP	C2-T2	Cathodic Protection – Maintenance (non-HCA)	$ 0.77	177
18	SCG-Risk-6	CYBR	C1	Perimeter Defenses	$ 26.74	160
19	SCG-Risk-6	CYBR	A1-C1	Perimeter Defenses	$ 19.86	157
20	SCG-Risk-6	CYBR	A2-C1	Perimeter Defenses	$ 31.30	154
21	SCG-Risk-1	HP	C13-T1	Measurement & Regulation Station – Maintenance (non-HCA)	$ 3.43	129
22	SCG-Risk-2	Digin	C6	Locate and Mark Annual Refresher Training and Competency Program	$ 0.01	121
23	SCG-Risk-2	Digin	C34	Enhance Ticket Management Software	$ 0.13	115
24	SCG-Risk-3	MP	C2	Cathodic Protection- CP10 Activities	$ 3.18	115
25	SCG-Risk-6	CYBR	C4	OT Cybersecurity	$ 19.46	112
26	SCG-Risk-6	CYBR	A2-C4	OT Cybersecurity	$ 20.52	112
27	SCG-Risk-6	CYBR	A1-C4	OT Cybersecurity	$ 14.56	110
28	SCG-Risk-3	MP	C7	Electronic Pressure Monitor (EPM) Replacement & Installs	$ 1.46	107
29	SCG-Risk-2	Digin	C24	Excess Flow Valve or Curb Valve Installation	$ 2.65	105
30	SCG-Risk-6	CYBR	C5	Obsolete IT Infrastructure and Asset Replacement	$ 25.18	102
31	SCG-Risk-6	CYBR	A1-C5	Obsolete IT Infrastructure and Application Replacement	$ 19.04	98
32	SCG-Risk-6	CYBR	A2-C5	Obsolete IT Infrastructure and Application Replacement	$ 27.60	98
33	SCG-Risk-7	CONT	A2	Use a Different Third-Party Administration Tool to Vet Contractors for Safety	$ 0.03	97
34	SCG-Risk-2	Digin	C16-T3	Public Awareness Compliance - Local Public Officials	$ 0.01	97
35	SCG-Risk-6	CYBR	C2	Internal Defenses	$ 36.17	95
36	SCG-Risk-3	MP	C4	Meter & Regulator (M&R) Station and Electronic Pressure Monitors (EPM) Inspection and Maintenance	$ 3.57	93
37	SCG-Risk-3	MP	C11	Pipeline Monitoring (Pipeline Patrol, Bridge & Span Inspections, Unstable Earth Inspection)	$ 0.004	92
38	SCG-Risk-3	MP	C18	Residential Meter Protection Project	$ 27.31	91
39	SCG-Risk-6	CYBR	A2-C2	Internal Defenses	$ 44.09	88
40	SCG-Risk-1	HP	C21-T2	Integrity Assessments & Remediation (Non-HCA)	$ 427.66	86
41	SCG-Risk-2	Digin	C33	Enhance Ticket Management Software	$ 0.54	86
42	SCG-Risk-6	CYBR	A1-C2	Internal Defenses	$ 29.43	85
43	SCG-Risk-1	HP	C13-T2	Measurement & Regulation Station – Maintenance (non-HCA)	$ 6.96	83
44	SCG-Risk-1	HP	C21-T1	Integrity Assessments & Remediation (HCA)	$ 246.87	83
45	SCG-Risk-4	STOR	C6	Compressor Overhauls	$ 15.57	83
46	SCG-Risk-3	MP	C6	Meter Set Assembly (MSA) Inspection and Maintenance	$ 16.18	81
47	SCG-Risk-2	Digin	C16-T4	Public Awareness Compliance – Excavators	$ 0.06	78
48	SCG-Risk-1	HP	C1-T1	Cathodic Protection – Capital (HCA)	$ 15.21	77
49	SCG-Risk-2	Digin	M2	Automate Third Party Excavation Incident Reporting	$ 0.03	70
50	SCG-Risk-1	HP	C10	Compressor Stations - Capital	$ 61.07	67
51	SCG-Risk-3	MP	C12	Valve Inspection & Maintenance	$ 1.25	64
52	SCG-Risk-2	Digin	C15-T3	Public Awareness Compliance - Local Public Officials	$ 0.02	63
53	SCG-Risk-6	CYBR	C3	Sensitive Data Protection	$ 27.64	62
54	SCG-Risk-2	Digin	C25	Pipeline Patrol and Pipeline Markers	$ 0.09	62
55	SCG-Risk-5	EMPL	M6	Industrial Hygiene Program Expansion	$ 0.15	60
56	SCG-Risk-2	Digin	M1	Automate Third Party Excavation Incident Reporting	$ 0.14	58
57	SCG-Risk-6	CYBR	A2-C3	Sensitive Data Protection	$ 31.50	57
58	SCG-Risk-6	CYBR	A1-C3	Sensitive Data Protection	$ 22.21	56
59	SCG-Risk-2	Digin	C4	Locate & Mark Activities	$ 4.44	55
60	SCG-Risk-2	Digin	C15-T4	Public Awareness Compliance – Excavators	$ 0.23	52
61	SCG-Risk-1	HP	C1-T2	Cathodic Protection – Capital (non-HCA)	$ 30.88	51
62	SCG-Risk-3	MP	C3	Cathodic Protection- 100mV Requalification	$ 3.65	51
63	SCG-Risk-2	Digin	C11	Damage Prevention Analyst Program	$ 1.45	48
64	SCG-Risk-5	EMPL	C4	Employee Safety Training and Awareness Programs	$ 0.44	44
65	SCG-Risk-5	EMPL	C7	Near Miss, Stop the Job and jobsite safety programs	$ 0.44	41
66	SCG-Risk-2	Digin	C26	Pipeline Patrol and Pipeline Markers	$ 0.49	39
67	SCG-Risk-1	HP	C5-T1	Pipeline Relocation/Replacement (HCA)	$ 21.88	36
68	SCG-Risk-2	Digin	C12	Damage Prevention Analyst Program	$ 0.29	36
69	SCG-Risk-4	STOR	C5	Storage Field Maintenance	$ 34.35	35
70	SCG-Risk-2	Digin	C16-T1	Public Awareness Compliance - The Affected Public	$ 0.19	34
71	SCG-Risk-3	MP	C1	Cathodic Protection Base Activities	$ 11.94	34
72	SCG-Risk-5	EMPL	M1	OSHA Construction Certification Training	$ 0.05	33
73	SCG-Risk-1	HP	C6-T1	Shallow/Exposed Pipe Remediations (HCA)	$ 4.40	32
74	SCG-Risk-2	Digin	C14	Locating Equipment	$ 4.08	31
75	SCG-Risk-5	EMPL	C2	Drug and Alcohol Testing Programs	$ 0.50	29
76	SCG-Risk-3	MP	C14	Cathodic Protection – Install/Replace Impressed Current Systems	$ 20.35	28
77	SCG-Risk-2	Digin	C15-T1	Public Awareness Compliance - The Affected Public	$ 0.80	25
78	SCG-Risk-1	HP	C22-T3.4	PSEP: Hydrotesting (Phase 2A, GRC base, non-HCA)	$ 269.71	24
79	SCG-Risk-2	Digin	C35	Leverage Data Gathered by Locating Equipment	$ 17.09	24
80	SCG-Risk-1	HP	C5-T2	Pipeline Relocation/Replacement (non-HCA)	$ 44.43	23
81	SCG-Risk-3	MP	C8/C17	Leak Survey and Main & Service Leak Repair	$ 66.51	23

82	SCG-Risk-2	Digin	C5	Locate and Mark Annual Refresher Training and Competency Program	$ 0.05	23
83	SCG-Risk-5	EMPL	M4	Creating of a Safety Video Library	$ 0.05	22
84	SCG-Risk-2	Digin	C16-T2	Public Awareness Compliance - Emergency Officials	$ 0.003	22
85	SCG-Risk-2	Digin	C10	Locate and Mark Quality Assurance	$ 0.38	21
86	SCG-Risk-3	MP	C9	Pipeline Monitoring (Pipeline Patrol, Bridge & Span Inspections, Unstable Earth Inspection)	$ 0.09	21
87	SCG-Risk-3	MP	C20	Distribution Integrity Management Program - Distribution Riser Inspection Program (DRIP)	$ 73.51	21
88	SCG-Risk-1	HP	C6-T2	Shallow/Exposed Pipe Remediations (non-HCA)	$ 8.93	20
89	SCG-Risk-2	Digin	M4	Locate and Mark Photographs	$ 0.10	20
90	SCG-Risk-5	EMPL	M7	Workplace Violence Prevention Program Enhancements	$ 0.73	19
91	SCG-Risk-2	Digin	C29	Warning Mesh	$ 0.79	19
92	SCG-Risk-7	CONT	A1	Use Internal Resources and Tools to Vet Contractors for Safety	$ 0.53	17
93	SCG-Risk-5	EMPL	M3	Proactive Monitoring	$ 0.06	17
94	SCG-Risk-5	EMPL	A3	Workplace Violence Prevention Training Alternative	$ 0.05	16
95	SCG-Risk-5	EMPL	A2	OSHA Voluntary Protection Program	$ 0.35	15
96	SCG-Risk-2	Digin	C15-T2	Public Awareness Compliance - Emergency Officials	$ 0.01	14
97	SCG-Risk-2	Digin	M3	Locate and Mark Photographs	$ 0.44	13
98	SCG-Risk-3	MP	C30	Meter Set Assembly (MSA) Inspection Program	$ 66.52	12
99	SCG-Risk-7	CONT	C1	Contractor Safety Oversight	$ 1.67	11
100	SCG-Risk-5	EMPL	C5	Safe Driving Programs	$ 1.18	11
101	SCG-Risk-3	MP	C23	DIMP: Sewer Lateral Inspection Project (SLIP)	$ 73.51	11
102	SCG-Risk-1	HP	C3-T1	Leak Repair (HCA)	$ 11.52	10
103	SCG-Risk-2	Digin	C21	Prevention & Improvements-Fiber Optics	$ 7.98	10
104	SCG-Risk-2	Digin	C32	Ticket Risk Assessment and Evaluating City Permit Data	$ 0.05	10
105	SCG-Risk-5	EMPL	M5	Expanded Safety Culture Assessments	$ 0.05	8.9
106	SCG-Risk-3	MP	C28	Quality Assurance Program	$ 4.06	7.6
107	SCG-Risk-5	EMPL	C8	Safety Culture Programs	$ 0.85	7.4
108	SCG-Risk-4	STOR	A2	Alternate technology for methane monitoring	$ 3.80	7.1
109	SCG-Risk-1	HP	C3-T2	Leak Repair (non-HCA)	$ 23.40	6.8
110	SCG-Risk-1	HP	C22-T2.4	PSEP: Pipeline Replacement (Phase 1B, GRC base, non-HCA)	$ 69.25	5.7
111	SCG-Risk-4	STOR	C7	Upgrade to Purification Equipment	$ 20.08	5.7
112	SCG-Risk-7	CONT	C4	Construction Contractor Field Oversight	$ 0.30	5.2
113	SCG-Risk-3	MP	C10	Pipeline Monitoring (Pipeline Patrol, Bridge & Span Inspections, Unstable Earth Inspection)	$ 0.08	5.2
114	SCG-Risk-5	EMPL	C9	Utilizing Industry Best Practices and Benchmarking	$ 1.07	4.8
115	SCG-Risk-1	HP	C12-T1	Measurement & Regulation – Capital (HCA)	$ 27.81	4.7
116	SCG-Risk-3	MP	C5	Regulator Station Replacements/Installs	$ 9.45	4.7
117	SCG-Risk-2	Digin	C13	Locating Equipment	$ 0.40	3.5
118	SCG-Risk-3	MP	C13	Valve Installs and Replacements	$ 2.71	3.4
119	SCG-Risk-1	HP	C12-T2	Measurement & Regulation – Capital (non-HCA)	$ 56.47	3.2
120	SCG-Risk-3	MP	C32	Safety Related Field Orders	$ 298.77	3.0
121	SCG-Risk-2	Digin	C9	Locate and Mark Quality Assurance	$ 1.94	2.9
122	SCG-Risk-4	STOR	C2	Well Abandonment and Replacement	$ 126.97	2.8
123	SCG-Risk-1	HP	M1-T1	Gas Transmission Safety Rule - MAOP Reconfirmation (HCA)	$ 170.76	2.7
124	SCG-Risk-1	HP	C14	Odorization	$ 0.69	2.6
125	SCG-Risk-2	Digin	C36	Leverage Data Gathered by Locating Equipment	$ 0.09	2.1
126	SCG-Risk-3	MP	A2	Post-Training Follow-up Field Evaluation	$ 1.08	2.1
127	SCG-Risk-5	EMPL	A1	Develop internal expertise for expanded safety culture assessments	$ 0.23	2.0
128	SCG-Risk-5	EMPL	C3	Employee Wellness Programs	$ 2.65	1.9
129	SCG-Risk-3	MP	C16	Capital CP 10 Service Replacement	$ 40.20	1.9
130	SCG-Risk-1	HP	M1-T2	Gas Transmission Safety Rule - MAOP Reconfirmation (Non-HCA)	$ 69.75	1.8
131	SCG-Risk-1	HP	C8-T1	Right of Way (HCA)	$ 0.79	1.7
132	SCG-Risk-1	HP	C8-T2	Right of Way (non-HCA)	$ 1.60	1.7
133	SCG-Risk-3	MP	A1	Technical Refresher Training	$ 1.75	1.3
134	SCG-Risk-3	MP	C21-T1	DIMP – DREAMS: Vintage Integrity Plastic Plan (VIPP)	$ 657.34	1.2
135	SCG-Risk-1	HP	C15	Security and Auxiliary Equipment	$ 13.57	1.0
136	SCG-Risk-3	MP	C21-T2	DIMP – DREAMS: Bare Steel Replacement Program (BSRP)	$ 281.72	0.9
137	SCG-Risk-1	HP	A1	Proactive Soil Sampling	$ 5.63	0.8
138	SCG-Risk-4	STOR	A1	Risk-based well casing inspection frequency	$ 85.60	0.8
139	SCG-Risk-1	HP	M2-T1	Gas Transmission Safety Rule – Material Verification (HCA)	$ 0.54	0.7
140	SCG-Risk-2	Digin	C31	Ticket Risk Assessment and Evaluating City Permit Data	$ 0.20	0.5
141	SCG-Risk-5	EMPL	M2	Industrial Hygiene Program Refresh	$ 0.97	0.4
142	SCG-Risk-1	HP	M2-T2	Gas Transmission Safety Rule – Material Verification (Non-HCA)	$ 1.10	0.4
143	SCG-Risk-3	MP	C25	Field Employee Skills Training	$ 30.84	0.4
144	SCG-Risk-1	HP	C9-T1	Class Location – Hydrotest (HCA)	$ 7.37	0.3
145	SCG-Risk-1	HP	C9-T2	Class Location – Hydrotest (non-HCA)	$ 14.95	0.3
146	SCG-Risk-3	MP	C19	Main Replacements- Leakage, Abnormal Op. Conditions, CP Related	$ 72.45	0.3
147	SCG-Risk-4	STOR	C1	Integrity Demonstration, Verification, and Monitoring Practices	$ 308.83	0.3
148	SCG-Risk-1	HP	A2	Expanding Geotechnical Analysis	$ 1.40	0.2
149	SCG-Risk-2	Digin	A2	Virtual Reality Training	$ 0.10	0.1
150	SCG-Risk-2	Digin	A1	Virtual Reality Training	$ 0.10	0.1
151	SCG-Risk-2	Digin	A4	GPS Tracking of Excavation Equipment	$ 0.34	0.01
152	SCG-Risk-2	Digin	A3	GPS Tracking of Excavation Equipment	$ 0.34	0.003